Final Basis of Design Report

Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall

St. Louis, Michigan

Prepared for:

United States Environmental Protection Agency – Region 5

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Acronyms and Abbreviations

Acronym	Definition
°F	degree(s) Fahrenheit
µg/m^3	microgram(s) per cubic meter
AACE	American Association of Cost Engineers
AISC	American Institute of Steel Construction
amsl	above mean sea level
ANP	adjacent and nearby properties
ARAR	applicable or relevant and appropriate requirement
ASTM	ASTM International
bgs	below ground surface
BMP	best management practice
BODR	Basis of Design Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CH2M	CH2M HILL, Inc.
cm/s	centimeter(s) per second
COC	contaminant of concern
CRA	Conestoga-Rovers and Associates
CWA	Clean Water Act
DBCP	1,2-dibromo-3-chloropropane
DDT	dichlorodiphenyl trichloroethane
DGVBW	downgradient vertical barrier wall
DNAPL	dense nonaqueous phase liquid

Acronym	Definition
DNAPL/GWCS	dense nonaqueous phase liquid/groundwater collection system
EO	Executive Order
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EPA	U.S. Environmental Protection Agency
FPS	Former Plant Site
FS	feasibility study
GLAES	Great Lakes Architect Engineer Services
GWECT	groundwater elevation control tile
HDPE	high-density polyethylene
ISST	in situ thermal treatment
JPA	Joint Permit (Equivalent) Application
MCC	Michigan Chemical Corporation
MCL	*Michigan Compiled Laws*
MDOT	Michigan Department of Transportation
MI Administrative Code	*Michigan Administrative Code*
MIOSHA	Michigan Occupational Safety and Health Act
NAPL	nonaqueous phase liquid
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NREPA	Natural Resources and Environmental Protection Act
NRHP	National Register of Historic Places
OU	operable unit
P.A.	Public Act
PBB	polybrominated biphenyl

Acronym	Definition
ppm	part(s) per million
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
ROD	Record of Decision
SESC	soil erosion and sedimentation control
SHPO	State Historic Preservation Office
site	Velsicol Chemical Corporation Superfund Site
SPT	standard penetration testing
SRD	substantive requirements document
SVOC	semivolatile organic compound
TRIS	tris(2,3-dibromopropyl)phosphate
U.S.C.	*United States Code*
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VE	value engineering
VOC	volatile organic compound
Weston	Weston Solutions, Inc.
yd^3	cubic yard(s)

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1. Introduction

The U.S. Environmental Protection Agency (EPA) contracted CH2M HILL, Inc. (CH2M), a wholly owned subsidiary of Jacobs, to prepare selected components of the remedial design (RD) for Operable Unit (OU) 1 of the Velsicol Chemical Corporation Superfund Site (site) in St. Louis, Michigan. This final Basis of Design Report (BODR) pertains to the design of a vertical barrier wall to surround the Former Plant Site (FPS). The vertical barrier wall is one of several components of the OU1 remedy that is being implemented in accordance with the *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan* (ROD; EPA, 2012). Specifically, this final BODR is for the downgradient vertical barrier wall (DGVBW). In accordance with the ROD, the DGVBW will consist of interlocking, sealed sheet piles to decrease the potential for dense nonaqueous phase liquid (DNAPL) and dissolved-phase contaminants to directly discharge to the Pine River from the shallow outwash unit (EPA, 2012). CH2M is performing this RD under the Great Lakes Architect Engineer Services (GLAES) II modified Statement of Work dated May 28, 2021, under Contract 68HE0519D0007, Task Order 68HE0521F0106. The RD was completed in accordance with the *Remedial Design/Remedial Action Handbook* (EPA, 1995) and Jacobs' *Quality Management Plan Great Lakes Architect-Engineer Services II (GLAES II) Contract, Contract No. 68HE0519D0007* (Jacobs, 2021).

This final RD package provides the engineering design approach, design drawings, construction specifications, results of a value engineering (VE) screening, a construction cost estimate (American Association of Cost Engineers [AACE] International Class 2, with an accuracy of plus 20% to minus -15%), a draft construction schedule, and general provisions necessary to implement the DGVBW remedial activities. The remedial action (RA) phase will be performed under a separate contract or task order.

1.1 Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses a 52-acre land parcel commonly referred to as the FPS and includes the adjacent and nearby properties (ANP). A chemical plant once occupied the FPS, which is in a predominantly residential area. The Pine River flows along the western and northern boundary of the FPS into Mill Pond, where a hydroelectric dam is located (about 0.25 mile east of the FPS). The boundary of the 52-acre FPS is fenced, and access is controlled through a lockable main gate. Figure 1-1 shows the FPS location and the surrounding OUs. The Michigan Department of Environment, Great Lakes, and Energy (EGLE)[1] was the lead agency for the remedial investigation (RI)/feasibility study (FS). EPA is the lead agency for the RD and RA. Project stakeholders include EGLE, Weston Solutions, Inc. (Weston; an EGLE contractor), and the City of St. Louis, Michigan, who are referred to collectively in this BODR as "stakeholders."

The site consists of four OUs, as follows:

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which a Proposed Plan was completed in August 2022

[1] Effective April 22, 2019, the Michigan Department of Environmental Quality was reorganized and renamed the Michigan Department of Environment, Great Lakes, and Energy.

- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee Rivers, for which RI activities are ongoing

The activities described in this RD will support the overall OU1 remedy.

1.2 Site History

The FPS was used for industrial operations beginning in the mid-1800s until 1977. Historical operations at the site included a lumber mill, oil refinery, salt-processing plant, and chemical manufacturing plant. The FPS included numerous buildings that housed manufacturing, maintenance operations, administrative functions, and laboratories for product research and development. Storage facilities for raw and finished products, including warehouses and storage tanks constructed above and belowground, were also integrated throughout the FPS. Historical documents identify several lagoons that are either known or presumed to be associated with waste disposal practices.

In 1935, Michigan Chemical Corporation (MCC) purchased the property and operated a chemical manufacturing business. In 1965, Velsicol Chemical Corporation gained a controlling interest in MCC. MCC manufactured a wide variety of products at the FPS from 1936 through 1977, including various salts; magnesium oxide; rare earth chemicals; fire retardants, including polybrominated biphenyl (PBB); tris(2,3-dibromopropyl)phosphate (TRIS); and the pesticide, dichlorodiphenyl trichloroethane (DDT).

In 1977, production operations were terminated, and MCC initiated facility demolition and decommissioning in 1978. The aboveground site buildings were demolished, and some structures were buried onsite, including storage tanks and process piping. Building and tank foundations were not removed, and a significant volume of debris remains buried at the site.

1.3 Historical Investigations and Remedial History

Multiple field investigations have been performed within OU1, including an RI, which was performed in four phases from 2002 through 2008 (Weston, 2006, 2009). The FS for OU1 was completed in 2011 (Weston, 2011). Since the ROD for OU1 was issued in 2012 (EPA, 2012), the following remedies have been completed or are in progress:

- Excavation and offsite disposal of soil exceeding 5 parts per million (ppm) of total DDT, 1.2 ppm of PBB, and 4.4 ppm of TRIS in the ANP to address risk to human health and the environment were completed in 2016 (CH2M, 2016).
- Implementation of in situ thermal treatment to address the nonaqueous phase liquid (NAPL) and 1,2-dibromo-3-chloropropane (DBCP)-contaminated area NAPL/DBCP Area 1 was completed in 2018 (CH2M, 2019).
- Implementation of in situ thermal treatment to address the NAPL-contaminated area NAPL/DBCP Area 2 was completed in 2022 (CH2M, 2022c).
- Replacement of the City of St. Louis, Michigan municipal water supply to avoid increased, non-cost-effective, long-term groundwater extraction and treatment costs is in progress. The Gratiot Area Water Authority began providing the City of St. Louis, Michigan, with drinking water in October 2015. The project was finished with the installation of Well 12 in 2023.

- Excavation and offsite disposal of soil that exceeds the soil saturation concentration according to Michigan Natural Resources and Environmental Protection Act (NREPA) Part 201 is currently in progress within Potential Source Areas 1 and 2.
- Continued operation of the existing DNAPL/groundwater collection system (GWCS) to capture DNAPL and contaminated groundwater migrating from the shallow unit and to prevent recontamination of the Pine River and its sediments is ongoing.

1.4 Existing Site Conditions

The following subsections describe existing conditions at the site.

1.4.1 Sitewide Geology

Weston performed an RI from 2002 through 2005 and defined the site geology. There are three naturally occurring unconsolidated deposits sitewide: shallow unit, till unit, and lower unit. On the FPS, two human-made units are also present, including a clay cap and fill.

The clay cap was constructed as part of the 1982 Consent Judgment and ranges from 2 to 10 feet in thickness. A sand layer is present directly above the clay cap, and a layer of topsoil is present above the sand layer. The thickness of these two layers has been observed to be up to 2.5 feet.

The shallow unit is composed of fill, alluvium, and lacustrine deposits. Debris is also present within the shallow outwash unit (for example, concrete and metal) from the operation and demolition of the FPS. The thickness of the shallow outwash unit varies between 20 and 30 feet.

The till unit thickness ranges from 30 to 80 feet and is composed of sandy silt with variable amounts of sand, gravel, and cobbles. The thickness of sand and gravel seams within the till unit range from a few inches to several feet.

The lower unit extends from the base of the till unit to the top of bedrock (approximately 280 feet below ground surface [bgs]) and consists of a series of saturated sands subdivided by the two aquitards. The lower unit is composed of the following:

- The upper lower outwash consists of the saturated sands immediately underlying the till unit. The upper lower outwash has been observed to be up to 10 feet thick but is typically about 2 to 4 feet thick. A granular unit is immediately under the upper lower outwash and is finer grained and more gradational. This portion of the lower unit is referred to as the lower outwash.
- The upper aquitard is a cohesive unit of very stiff to hard, gray to grayish-brown clay or very stiff to hard, gray silt approximately 10 to 30 feet thick.
- The upper city well intake zone consists of fine to coarse saturated sand, with gravel noted at some locations.
- The lower aquitard is a cohesive unit of very stiff to hard, gray to grayish-brown clay or very stiff to hard, gray silt approximately 20 feet thick.
- The lower city well intake zone consists of saturated fine to coarse sand with some fine gravel.

1.4.2 Hydrology and Hydrography

Surface water runoff from the FPS flows directly into the Pine River. The Pine River is a tributary that flows to the northeast and converges into the Chippewa River, which flows into the Tittabawassee River. The *Hydrogeologic Atlas of Michigan* indicates that all surface waters within the Tittabawassee River Drainage Basin discharge into the Tittabawassee River, which flows into the Saginaw River and ultimately into Lake Huron at Saginaw Bay (Curran et al., 1981; Weston, 2006).

In the shallow unit, groundwater flow is influenced by the Pine River, St. Louis Dam, ground surface elevation, and presence of the site perimeter slurry wall (Weston, 2006). The saturated thickness of the shallow unit at the site ranges from 0.5 foot to approximately 21.0 feet (Weston, 2006). Generally, shallow unit groundwater flow below the FPS is toward the Pine River. As part of the RI completed by Weston (2006), slug tests were performed on eight monitoring wells within the shallow unit. The hydraulic conductivity calculated from the slug test results averaged between 1.26 to 44.8 feet per day (4.46×10^{-4} to 1.58×10^{-2} centimeter per second [cm/s]). The geometric mean across the site was 7.31 feet per day (2.58×10^{-3} cm/s). The most recent slug testing results performed by CH2M in 2017 indicate that the hydraulic conductivity ranges from 3.06×10^{-5} to 8.92×10^{-3} cm/s (CH2M, 2017). Grain size analysis and falling head permeability testing results for soil samples collected between 7.0 and 25.0 feet bgs indicate that the soil types within the shallow unit include fine- to medium-grained sand, silty sand, and some silt (Weston, 2006).

Regional flow conditions, local geology, and municipal well usage influence groundwater flow in the lower unit (Weston, 2006). In October 2015, the cities of St. Louis and Alma, Michigan, formed the Gratiot Area Water Authority, which began providing potable water to St. Louis residents from the combined system, resulting in the cessation of operation of the City of St. Louis municipal supply wells. Previous interpretations of lower-unit groundwater flow indicated that groundwater primarily flowed to the northeast in the northern portion of the FPS and to the southeast in the southern portion of the FPS, toward the City of St. Louis municipal water supply wells. Based on groundwater elevation monitoring data collected to date, groundwater elevations in the lower unit have increased by approximately 10 feet, with groundwater flow in the lower unit to the east to southeast.

1.4.3 Topography, Land Use, and Land Cover

The FPS topography consists of fairly flat to gently rolling areas across the entire property, likely resulting from the earthwork that occurred during remedial work in the 1980s (Weston, 2006).

The FPS is bordered on the south and east by the ANP, with Washington Avenue along the southern edge. Watson and North Streets mark the eastern edge, and the Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the FPS boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The FPS is currently fenced, restricting access to the public and larger animals.

1.4.4 Ecological Resources

Wildlife habitats at the FPS consist of clear, open areas and low vegetation. Signs of small mammals and Canada geese have been observed on the property. Other wildlife likely present on or directly adjacent to the FPS includes various songbirds, reptiles, fish, and amphibians common to central Michigan. The FPS is currently fenced, restricting access to larger animals; however, deer have been observed on the

property. The Pine River is a warmwater fishery supporting a wide range of fish species, including smallmouth bass, carp, suckers, and several species of minnows (Weston, 2006).

1.4.5 Existing Site Perimeter Slurry Wall and Clay Cap

As part of the 1982 Consent Judgment with EPA and EGLE, a 2-foot-thick, low-permeability slurry wall was installed around the FPS. In addition, a clay cap was constructed over the entire FPS. The construction was completed in 1984.

The thickness of the clay cap ranges between 2 and 10 feet and extends over the entire 52-acre parcel. The cap is composed of clay with a permeability of 1×10^{-7} cm/s or less. The purpose of the clay cap is to minimize the infiltration of precipitation to the water table and enhance surface runoff.

The slurry wall runs along the entire perimeter of the FPS, over 7,200 linear feet in length. In accordance with the Consent Judgment Technical Appendix, the slurry wall was required to be a minimum of 24 inches thick (nominal), to achieve a permeability of 1×10^{-7} cm/s or less, and to be keyed in a minimum of 36 inches (nominal) into the underlying till layer.

The existing containment area (cap and slurry wall) was evaluated in the RI/FS completed by EGLE. That evaluation confirmed the presence and extent of the cap through the completion of RI soil borings and geotechnical sampling. The slurry wall was evaluated through the completion of paired piezometer installation and water level measurements, geotechnical soil borings, slurry wall sample collection for hydraulic conductivity testing, and a dye tracer study. The RI concluded that several areas of the slurry wall did not meet the 1×10^{-7} cm/sec hydraulic conductivity design criterion but that the slurry wall was constructed sufficiently to influence shallow unit groundwater flow patterns. During the RI, 20 samples were collected from the slurry wall for grain size and permeability analysis. The permeability test results yielded hydraulic conductivity values ranging from 1.20×10^{-7} to 4.10×10^{-6} cm/sec. The RI did not document details as to why the slurry wall did not meet the design specifications. The *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* presents a full evaluation of the clay cap and slurry wall, among other features of the site (such as the till unit) (Weston, 2006).

1.4.6 Existing Dense Nonaqueous Phase Liquid/Groundwater Collection System

A DNAPL/GWCS was installed in segments from 2003 to 2006 as part of the remedy for OU2, which addressed impacted sediment in the Pine River. The purpose of the DNAPL/GWCS is to collect the residual DNAPL that may be present within sand seams in the glacial till underneath the Pine River and to protect the river from residual contamination present on the FPS.

The DNAPL/GWCS consists primarily of collection trenches, collection laterals, and three manholes—MH-1, MH-2, and MH-3—as shown on the design drawings in Appendix A. The manholes consist of a 5-foot sump installed in the middle of each trench segment to facilitate DNAPL separation and accumulation during pumping operations. The trenches and trench laterals were constructed of 4-inch-diameter, perforated high-density polyethylene (HDPE) piping sloped back toward each manhole. The trenches were filled with 2 feet of stone fill, followed by compacted granular fill, after placement of the HDPE pipe. The conveyance piping that transports wastewater from the manholes to the frac tank is 3-inch by 6-inch, double-walled HDPE. The system is manually operated on a weekly basis by pumping water from the manholes to a storage tank on the FPS. Extracted fluids from this system are currently disposed offsite.

1.4.7 Existing Groundwater Elevation Control Tile

A nonoperational groundwater elevation control tile (GWECT), installed by Conestoga-Rovers and Associates (CRA), is present along the perimeter of the FPS, adjacent to the Pine River. Not much is known about the historical operations of the GWECT. As shown on the CRA Securement of Plant Site as-built drawings, the GWECT is separated into a north system and a south system at Manhole Sumps 6A and 6B (CRA, 1984). Collectively, the GWECT consists of approximately 8,210 linear feet of 4-inch and 6-inch perforated clay pipe, 9 manholes, 7 manhole sumps, and 13 granular sumps.

The GWECT was operated from June 1994 through the end of 1996 (MEC, 1997). Water was pumped from the GWECT at Manhole 9 and disposed of offsite (MEC, 1997). Through the end of 1996, a total of 4,030,000 gallons of water was removed from the FPS during three separate pumping events (MEC, 1997).

The approximate location and arrangement of the GWECT is presented on the CH2M design drawings summarizing existing site conditions (Appendix A).

1.5 Nature and Extent of Contamination

The RI indicates that there is extensive soil and groundwater contamination at the FPS. As described in Section 1.4.5, a perimeter slurry wall was constructed around the FPS to contain waste and debris historically associated with former operation and demolition activities performed on the site. Soil within the containment area is known to be contaminated by volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls, pesticides, specialty chemicals, and inorganic constituents, which is consistent with the materials, manufacturing, and disposal activities performed onsite. Elevated contaminant concentrations typically occur 1 to 2 feet above the water table. NAPL in surface and subsurface soil has the potential to leach or migrate into groundwater when water infiltrates through the soil, carrying dissolved contaminants with it. Based on historical investigation findings, site contaminants have partitioned from soil and waste materials and have entered the groundwater.

1.6 Selected Remedy and Remedial Action Objectives

A ROD was issued on June 22, 2012, that defined the selected remedy for OU1. This BODR describes the final RD for the DGVBW established as a part of the overall remedy for OU1. The new DGVBW will be installed outside of the existing slurry wall that encompasses the entire FPS. The DGVBW will be constructed of sheet piles and circular king piles set at varying depths into the till unit. The design drawings in Appendix A show the alignment of the sheet pile wall and describe embedment requirements. Backfill will be placed between the riverbank and the new DGVBW in accordance with the drawings and specifications (Appendix B). Future RDs will be developed for OU1 to address the ROD requirements not relevant to the DGVBW.

The DGVBW is designed to achieve the remedial action objectives (RAOs) established for the site; RAOs are goals that are specific to media or OUs to protect human health and the environment. The DGVBW will be installed to achieve RAOs for contaminants of concern (COCs) on the FPS in accordance with the ROD (EPA, 2012). RAOs applicable to the DGVBW are as follows:

- Prevent ingestion, inhalation, and direct contact of site-related COCs in soil to human and ecological receptors at the FPS.
- Prevent the migration of site-related COCs from unsaturated and saturated subsurface media to the groundwater or surface water beyond the point of compliance, as defined in the ROD.

- Eliminate offsite migration of DNAPL to prevent contamination of surface water and recontamination of Pine River sediments.

1.7 Design Changes Based on Preliminary Design Comments and Value Engineering Findings

After CH2M submitted the Draft Preliminary RD BODR on December 23, 2022, EPA and project stakeholders provided comments. Additional comments on the preliminary design were received during a CH2M-led VE screening conducted in March 2023. Multiple agency and VE comments mentioned uncertainty obtaining the 10-foot embedment depth required in the preliminary DGVBW design approach. Therefore, the DGVBW design was modified during the prefinal design stage to a combination wall approach with both steel sheet pile sections and cylindrical king piles.

2. Design Delivery Strategy

The development, preparation, and delivery of the design was accomplished in three phases: (1) preparation and submittal of a preliminary design (submitted in December 2022), (2) preparation and submittal of a prefinal design (submitted in August 2023), and (3) preparation and submittal of this final design.

2.1 Preliminary Design

The primary objective of the preliminary design was to define in detail the technical parameters that the design will be based on. It was also the intent of the preliminary design to develop the conceptual strategies and ideas that compose the framework of the remediation project for stakeholder review and to gain concurrence with the technical approaches proposed. Ultimately, this document aimed to foster acceptance of the preliminary design concept among the stakeholders, as early as possible, so completion of the prefinal and final design may proceed with minimal changes (that is, minimal cost and schedule impacts). The Preliminary BODR consisted of the following:

- Preliminary BODR text, tables, figures, calculations, and appendices
- Preliminary list of construction specifications
- Preliminary list of project design drawings
- Preliminary construction schedule
- Rough order of magnitude cost estimate (AACE International Class 4, with an accuracy of plus 50% to minus 30%)
- Project delivery strategy

2.2 Prefinal and Final Design

Following submission of the preliminary design, CH2M participated in a design review meeting on April 26, 2023, to discuss and adjudicate comments provided by EPA and stakeholders. CH2M also facilitated a VE screening from March 6 through March 20, 2023, with staff not directly involved with the DGVBW design. Findings from the VE screening were incorporated into the prefinal design and are also reflected in this final design.

The conceptual strategies and ideas developed during the preliminary design were expanded into a set of prefinal design documents. After receipt of comments from EPA and EGLE on the prefinal design, CH2M reviewed the agencies' comments and updated the design documents accordingly. The updated prefinal design documents are being submitted as this final design package. The prefinal and final designs consist of the following:

- BODR text, tables, figures, and appendices
- Construction specifications
- Project design drawings
- Cost estimate
  - Prefinal design: AACE International Class 3, with an accuracy of plus 30% to minus 20%
  - Final design: AACE International Class 2, with an accuracy of plus 20% to minus 15%
- Constructability review
- Revised project delivery strategy
- Draft construction schedule

Detailed design drawings and specifications were prepared for most of the selected components. Some components of the design are based on performance specifications, and the RA Contractor will be required to propose to EPA means and methods to achieve the performance requirements.

2.2.1 Value Engineering Screening

CH2M performed a VE screening during the prefinal design phase to optimize costs for the DGVBW design without sacrificing the reliability or efficiency of the project. Staff within CH2M, separate from the DGVBW design team, completed the VE screening. The VE screening review and response is documented in the VE technical memorandum included in Appendix C.

CH2M modified the design of the DGVBW based on the VE team's recommendations. The VE team's primary finding was that construction of the DGVBW, as described in the preliminary design, presented difficulties that increased construction risk. The preliminary design approach was a traditional sheet pile wall that required a deadman and tieback system along nearly half of its alignment. The bulkhead required a 10-foot embedment depth into the till unit, and the deadman required a 9-foot embedment depth into till in the upland portion of the FPS. The VE team's comments reflected concern about obtaining those embedment depths because of the till unit properties. The team noted that if those embedment depths could not be obtained, the design would need to be modified during construction, which would cause schedule delays and increase costs. The VE team comments also questioned the ease of installing the tiebacks because their proposed placement was below the elevation of the river. Tieback installation would also require excavation of potentially contaminated soil.

To address the primary concerns identified during the VE screening, the design of the DGVBW was updated to a combination wall during the prefinal design stage. The combination wall design allows for use of interlocking steel sheet piles set to the till while relying on structural reinforcement derived from structural sockets drilled into the till unit, providing strength to driven DGVBW components.

2.3 Remedial Action Delivery Strategy

Construction activities using the final design documents will be executed by EPA. It is assumed that EPA will issue a single task order to complete the RA to one of their contractors based on the final design documents. The contractor will be required to present a detailed proposal and work plan to EPA describing how the work will be executed. The EPA contractor that will complete the RA is referred to as the "RA Contractor" in this document.

3. Design Criteria and Assumptions

CH2M used the following design criteria and assumptions to complete the RD:

- According to an informal Information For Planning and Conservation Resource List, produced on June 12, 2023, the following federally-listed species are potentially present in the project area and could be affected by the project: Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), proposed endangered tricolored bat (*Perimyotis subflavus*), threatened eastern massasauga (=rattlesnake) (*Sistrurus catenatus*), eastern prairie fringed orchid (*Platanthera leucophaea*), and the candidate species monarch butterfly (*Danaus plexippus*). To confirm the presence or absence of these species in the project area, as well as the potential impacts of the project on these species, official formal consultation with the U.S. Fish and Wildlife Service (USFWS) will be required. Depending on the effects determination made by EPA and USFWS during this consultation, clearing limitations and other time-of-year restrictions may be placed on the project, which may affect the project schedule. This consultation is the responsibility of the RA Contractor and should be completed before any ground- or tree-disturbing activities.
- No cultural resources are present within the project area. CH2M has completed a data search to identify existing cultural resources, and EPA will commence consultation, as appropriate, following submittal of this RD. Results of the data and literature search are included in Section 6.5 and Appendix O.
- The FPS will be used for staging and support. Because the FPS is fenced, it is assumed that additional security services will not be required.
- The former sediment remediation loading platform onsite will be used to access the Pine River.
- Compensatory excavation was performed during the OU2 remedy and is assumed not to be required for this RA. In 2006, EPA completed the OU2 sediment RA, which removed approximately 639,975 cubic yards (yd^3) of sediment from the Pine River (CH2M, 2006). The Federal Emergency Management Agency (FEMA) floodplain maps from 1989 and 2011 are consistent, indicating the OU2 RA was not considered in the floodplain map after 2006. The 100-year floodplain elevation at the FPS is 722 feet above mean sea level (amsl). Based on the prefinal design calculations, approximately 26,700 yd^3 of fill material will be placed within the floodplain for construction of the DGVBW and future engineered cap, which is significantly less than the 639,975 yd^3 of sediment previously excavated during the OU2 RA.
- The DNAPL/GWCS main header and laterals will not be encountered during installation of the DGVBW. Based on the as-built drawings included in Appendix D, the elevation of the main header is 685 feet amsl. Based on till elevation data collected during previous investigations, the DGVBW design does not require the sheet piles to be installed below plus or minus 692 feet amsl near the DNAPL/GWCS. The DGVBW is aligned such that the DNAPL/GWCS main header is located between the DGVBW and existing slurry wall, and the DGVBW is set a minimum of 10 feet from the DNAPL/GWCS main header, based on the main header location illustrated in the as-built drawings (Appendix D). The DGVBW will be constructed within the limits of the geomembrane installed as part of the DNAPL/GWCS. Figure 3-1 shows the conceptual construction of the DGVBW in relation to the DNAPL/GWCS.
- There are no active utilities present within the alignment of the DGVBW, aside from those related to the DNAPL/GWCS. This assumption is based on the responses to MISS DIG 811 Design Ticket 2022061701421. Appendix E includes utility owner responses. Therefore, this design assumes

that no debris is present along the DGVBW alignment that would impede installation of the sheet pile.

- The DGVBW will be completed to 723 feet amsl based on the assumptions detailed in the *Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design, Velsicol Chemical Corporation Superfund Site* technical memorandum (Appendix F).
- It is assumed that the U.S. Army Corps of Engineers (USACE) does not plan to dredge this area of the Pine River in the future and that the bathymetry will not significantly change during the lifetime of the DGVBW. The bathymetry at the time of this design is included in Appendix G.
- Natural river and soil conditions, as well as onsite NAPL and dissolved-phase COCs, are not anticipated to accelerate corrosion of the DGVBW; therefore, standard corrosion protection measures for the DGVBW are included in this RD. The corrosion protection measure included in the DGVBW design is a 1/8-inch-thick sacrificial steel layer on steel surfaces exposed to either the imported fill or the Pine River. This provides a design life of 50 years for the DGVBW.
- All soil and liquids encountered during the RA are expected to be nonhazardous. This assumption is based on analytical results for the soil samples collected around the site perimeter within the existing slurry wall during the geotechnical investigation, as summarized in Appendix H. The RA Contractor will conduct waste sampling, analysis, and characterization in accordance with their own procedures during the RA.
- Since the DGVBW alignment is within the Pine River, river water will be displaced during construction of the DGVBW. The design assumes up to 1,600,000 gallons of river water will be managed from dewatering activities during construction. It is assumed that the water will be treated using a weir tank, sand filtration, and carbon polishing before discharge back to the Pine River.
- The elevation of the Pine River will be maintained at approximately 719 feet amsl by the City of St. Louis, Michigan by the presence of the city hydroelectric dam for the lifetime of the DGVBW.
- Subsurface geotechnical properties used for the DGVBW design are based on the July 2022 geotechnical investigation (Appendix H) and are assumed to be consistent along the alignment of the DGVBW.
- A minimum safety factor of 1.5 was applied to the structural design requirements for sheet piles specified for DGVBW construction. This is based on static conditions only; pseudo-static and rapid drawdown conditions do not apply.
- The site gate along Washington Avenue will be used for site access to eliminate heavy truck traffic through the ANP.
- Temporary access roads will be constructed from gravel and will remain in place after construction activities are complete to support future site work.
- Topsoil and clay cap material stripped for site access road construction is uncontaminated and will be stockpiled and reused during site restoration activities.
- For cost estimating purposes, it is assumed that the DGVBW will be constructed from land and that a barge will not be required for construction.
- Ditches and stormwater outlets were sized assuming a 25-year storm event. Stormwater management and control features included in this design will be temporary. Permanent stormwater conveyance and management features will be addressed during design and construction of the engineered cap described in the ROD. It is assumed that the engineered cap and final site drainage will be constructed within 10 years following completion of the DGVBW installation.

4. Basis of Design

Section 4 summarizes the technical parameters that the RD is based on.

The DGVBW will be one component of the future FPS containment system required by the ROD. The ROD-required FPS containment system will also consist of a new perimeter drain system and new engineered cap that are not included in this design. The ROD states that a new vertical barrier will be installed around the entire perimeter of the FPS, outside of the existing slurry wall, to decrease the potential for NAPL and dissolved-phase COCs in the shallow unit to discharge into the Pine River. The vertical barrier will extend from the existing ground surface to allow connection with and construction of the new engineered cap. Although it is continuous, the existing slurry wall has historically been referenced as two sections: the upgradient slurry wall and the downgradient slurry wall. As such, separate RDs will be completed for the upgradient vertical barrier wall and DGVBW. This final design is for the DGVBW only; containment measures taken on the upgradient side of the site will be evaluated and presented in a separate submittal.

4.1 Design Data Sources

Several investigations have been completed at the FPS. Results from the investigations are summarized in the following documents:

- *Source Migration Investigation Report, Velsicol Chemical/Pine River Site, OU1, St. Louis, Michigan* (CH2M, 2005)
- *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2006)
- *Remedial Investigation Addendum Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2009)
- *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2011)
- *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan* (EPA, 2012)
- *Remedial Action Report, Velsicol Chemical/Pine River Site, Sheet Piling Removal, Operable Unit 1, St. Louis, Michigan* (CH2M, 2015)
- *Hydrographic and Topographic Survey Results Summary, Velsicol Chemical Corporation/Pine River Superfund Site* (CH2M, 2022b)
- *Perimeter Drain and Geotechnical Investigation Data Evaluation, Velsicol Chemical Corporation/Pine River Superfund Site* (CH2M, 2023c)

Data were collected during the RD investigation to support the DGVBW design work for the OU1 remedy in accordance with the ROD (EPA, 2012). Table 4-1 summarizes the historical and recent field activities performed to support DGVBW design preparations in accordance with the OU1 remedy described in the ROD.

Table 4-1. Summary of Field Investigations and Data Sources

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Data Source and Purpose	Description of Investigation Activities	Primary Conclusions
NAPL Investigation		
The primary purpose of the work within the Pine River was to assess the lateral extent of NAPL in the soils below the river sediments.	A NAPL investigation was conducted between September and December 2002 to characterize and delineate potential sources of residual NAPL and migration pathways at the site. The field investigation consisted of geophysical surveying in the Pine River bordering the FPS, drilling and sampling both in the Pine River and on the FPS, and test trenching on the FPS. Sixty-eight soil borings were advanced in the Pine River between the M-46/Washington Avenue Bridge and Mill Street Bridge. Samples were collected using a 2- or 3-inch split spoon, and the sampler was driven with a 300-pound hammer using a rope and cathead assembly. Borings were typically advanced through sediment, sand and gravel, and a few feet into the glacial till. A few borings were advanced deeper into glacial till in an attempt to identify any sand seams that may be present within the till. Standard penetration tests were performed on most of the soil borings.	NAPL or NAPL-characteristic odors were observed in the till-contact gravel and sand underlying fine-grained river sediments at five locations located to the west of DNAPL or GWCT Manhole 3 (west of OU2 sediment remediation Area 3). The NAPL-impacted sediment was incorporated into OU2 sediment remediation Cell 5 and was remediated in 2003. No other areas with observed NAPL were identified within the Pine River. The standard penetration test results were considered during development of this RD. Additional detail regarding the NAPL investigation is summarized in the *NAPL Investigation Summary Report, Velsicol/Pine River Superfund Site, St. Louis, Michigan* (CH2M, 2003).
OU2 Sediment Remedy Sheet Pile Installation and Sheet Pile Removal RA		
The OU2 sediment remedy consisted of excavating contaminated sediments in the Pine River extending from the northwestern corner of the FPS downstream to the hydroelectric dam in Mill Pond. Sheet pile was installed to support the remedy. The sheet pile removal RA was performed to remove the OU2 remedy sheet pile that was left in place.	OU2 sheet pile installation commenced in October 1999 and sediment excavation began in July 2000. Seasonal work was performed at the site in each of the following years through 2006. Phase 1, involving the remediation of sediments in the Pine River's southern portion immediately adjacent to the FPS, was completed in 2003. Phase 2 of the RA, involving sediments in the river's northern portion and Mill Pond, began with sheet piling work in October 2003 and was completed in 2005. The infrastructure in the river (for example, haul road, equalization basin, and sheet piling) was removed in 2006 (CH2M, 2010). Sheet pile removal activities for the sheet pile left in place began on November 4, 2014, under the OU1 RA and were completed on December 12, 2014. Sheet piling removal was accomplished using a vibratory driver or extractor. After extraction, the sheets were transported back to the FPS where they were decontaminated, stockpiled, and transported offsite for reuse or for salvage as scrap steel. Approximately 1,480 linear feet of sheet piling was left in place in the Pine River, as it was thought it would likely be useful as part of a remedy for OU1 (CH2M, 2006).	During the OU2 remedy, design embedment depths for the sheet pile were not met in several areas due to the properties of the till. Additionally, upon removal of the sheet piling from the Pine River, it was discovered that most of the toe ends of the sheet piles had been curled under and tops of the piles had been mushroomed due to the hard embedment conditions in the glacial till making up the riverbed. For sheet piles to be transported to the decontamination area, these curled ends were cut off either on the barge or at the offloading area and were handled or disposed of separately. Recycling of the cutoff ends was arranged with a local scrap metal recycling facility (CH2M, 2015). Details and observations from the OU2 sediment remedy sheet pile installation and sheet pile removal RA were considered during development of this RD.
Bathymetric Survey		
The DGVBW will be installed in the Pine River. To support RD of the DGVBW, river bottom elevation data were required; therefore, a bathymetric survey was performed to map the topography under the Pine River.	The bathymetric survey was performed by Seaworks Group, LLC in April 2022 using a R2Sonic 2020 multibeam sonar system within 10 to 20 feet of the riverbank with an approximate survey area of 5,000 feet by 380 feet (Seaworks, 2022). Shallow areas closer to the riverbank were surveyed using a single-beam, Z-Boat drone. In addition, high-resolution, side-scan sonar imagery data were collected simultaneously. An Edgetech 4125 side-scan sonar system was used to perform the side-scan imaging. Survey line spacing for the side-scan sonar survey was 40 feet at a minimum. Because of the shallow water depths within the survey area, the side-scan sonar was hung directly over the side of the jon boat rather than towed behind it. The magnetometer survey was also performed. A Geometrics G-882 Cesium Vapor Marine Magnetometer was used to complete the survey. The survey line spacing was 25 feet to maximize coverage and minimize the chance of missing small targets between the lines. Because of the shallow water depths, Seaworks Group, LLC, attached the magnetometer to foam floats and towed it behind the jon boat.	The multibeam bathymetric survey resulted in a digital terrain model illustrating current sediment elevations. Sediment elevations from the Mill Street Bridge to approximately 2,300 feet upriver range from approximately 699 feet amsl in the deepest section of the river (water depth of approximately 20 feet) to 717 feet amsl along the northern riverbank. This area of the river was remediated as part of the OU2 RA, and the lower sediment elevations in this section of the river reflect the sediment removal activities that were performed during the RA. The remainder of the survey area was not affected by historical OU2 RA activities. Sediment elevations from 2,300 feet upriver from the Mill Street Bridge to the M-46 Bridge range from 706 to 717 feet amsl. The main river channel in this section of the river appears to range between 6 and 12 feet deep with shallower, flat benches along either side. Based on the side-scan survey results it appears that subaqueous vegetation is present within the shallow benches. Some vegetation was observed in the main river channel in this area as well. The bathymetric survey results represent the acoustic bottom, and, because of the vegetation in this area, it is likely that the sediment surface is actually a few inches deeper than the acoustic bottom. The side-scan and magnetometer surveys revealed numerous debris and utility-type features: ▪ A 12-foot by 6-foot rectangular shaped object, likely composed of some ferrous metal, was observed approximately 1,500 feet upriver of the Mill Street Bridge. ▪ A linear feature approximately 60 feet in length was observed within the river sediments. Based on the strong magnetometer returns, this object is likely ferrous in nature. This feature was identified approximately 2,400 feet upriver from the Mill Street Bridge. ▪ A potential utility crossing approximately 2,700 feet upriver from the Mill Street Bridge was identified only by the magnetometer, indicating it is buried under the sediment.

Table 4-1. Summary of Field Investigations and Data Sources

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Data Source and Purpose	Description of Investigation Activities	Primary Conclusions
		▪ A potential utility crossing approximately 800 feet downriver from the M-46 Bridge was identified. The data collected during these surveys were sufficient to support the DGVBW design and to provide fill volume estimates in the preliminary design. The debris features observed from the side-scan and magnetometer surveys are illustrated in the drawings.
Topographic Survey		
A topographic survey was completed to define the surface elevations of the riverbank and riverbed up to the Pine River's edge.	The topographic survey was performed concurrently with the hydrographic survey on April 8 and 9, 2022. Topographic data were collected using a Trimble Real-Time Kinematic Global Positioning System rover. The data were collected on approximately 50-foot-spaced transects to capture top and toe of slope and significant slope breaks. Site features of interest were also mapped.	The topographic survey resulted in a digital terrain model of the southern and eastern riverbanks within the survey area, located along the FPS, which is reflected in the drawings (Appendix A). The digital terrain model also supported volume calculations. Appendix G depicts the results of the topographic survey.
Geotechnical Drilling Investigation		
Although numerous investigations have been performed on the FPS, the geotechnical properties of the shallow unit and till unit were not sufficiently defined for the DGVBW design. These parameters are critical components to barrier design; therefore, a geotechnical investigation was performed to support the RD.	Seven soil borings were advanced with a track-mounted drill rig from ground surface to up to 20 feet into the till unit. Because of budgetary and site access constraints, borings were drilled along the shoreline instead of along the wall alignment in the river. Exploration included SPT, pocket penetrometer tests, and vane shear tests. However, all but two of the vane shear tests were invalid as most of the tests were performed on soils whose unconfined compressive strength exceeded 2.0 tons per square foot, or the soil was too hard to perform the test. Split-spoon and Shelby tube samples were obtained for classification and laboratory testing. Pitcher tube samples were used to recover soil that was too hard or soft to permit satisfactory recovery. Samples were taken at approximately 2.5-foot intervals for the first 20 feet, and then at 5-foot intervals. Laboratory testing consisted of grain size analysis, water content, Atterberg limits, and unit weight to aid in classification and soil property determination. Triaxial tests (consolidated undrained) with pore water pressure measurements were performed to estimate drained properties of the fine-grained till.	The results of the standard penetration tests and geotechnical laboratory tests were considered during this design. Appendix H provides the results of the geotechnical investigation.

4.2 Utilities and Debris

An assessment of suspected Pine River debris locations was completed using the results of the bathymetric survey performed by Seaworks Group, LLC in April 2022 (Seaworks, 2022). The magnetometer data showed several magnetic anomalies along the proposed alignment of the DGVBW. These anomalies also appear in the side-scan sonar data, although not clearly, and include the following:

- One magnetic anomaly in the southern third of the survey area, approximately 800 feet downstream of the M-46/Washington Avenue Bridge
- Two magnetic anomalies in the middle of the survey area, approximately 1,000 feet downstream of the M-46/Washington Avenue Bridge

Utility lines are not known to exist near these anomalies. CH2M submitted a design ticket through MISS DIG 811 (Ticket 2022061701421) to verify the presence of potential utilities in the river. Based on the utility owner responses to the MISS DIG 811 design ticket, there are no active utilities within the alignment of the DGVBW. Appendix E includes utility owner responses.

The design drawings in Appendix A show areas along the DGVBW alignment with anomalies identified by the magnetic survey. Removal of debris along the final DGVBW alignment may be necessary as a preconstruction debris removal task to facilitate sheet pile installation. However, based on the MISS DIG ticket responses, the design assumes that no debris is present along the DGVBW alignment that would impede installation of the sheet pile.

4.2.1 Downgradient Vertical Barrier Wall Placement Relative to Existing DNAPL/GWCS

The lateral and vertical locations of the sheet pile relative to the existing DNAPL/GWCS will allow for continued operation of the DNAPL/GWCS. Although these two remedial components will be installed in close proximity to each other, the DGVBW will not tie into the DNAPL/GWCS. The DGVBW alignment is offset a minimum of 10 feet from the main DNAPL/GWCS header pipe, as it is depicted on the DNAPL/GWCS as-built drawings (Appendix D). The bottom of the DGVBW will be set above the laterals that run perpendicular to the DNAPL/GWCS header pipe, into the Pine River. The location of the DGVBW related to the understood location of the DNAPL/GWCS is shown on the design drawing cross sections (Appendix A).

4.2.2 Continuity of the Hydraulic Barrier

During DGVBW installation, the sheet pile will be driven through 2 feet of compacted clay fill and 40 mil of HDPE geomembrane, which is part of the DNAPL/GWCS, to reach its planned placement depth. The sheet pile and king pile interlocks will be filled with a joint sealant.

4.3 M-46 Bridge

Given the proximity of the DGVBW to the M-46 bridge, CH2M consulted with the Michigan Department of Transportation (MDOT) to determine if bridge monitoring would be required during construction. A summary of discussions with MDOT is as follows:

- On March 1, 2023, CH2M made initial contact with MDOT to describe the project and its proximity to the M-46 bridge.
- On March 6, 2023, CH2M emailed preliminary drawings to MDOT at their request.

- April 13, 2023, MDOT informed CH2M that geotechnical monitoring was not required during DGVBW construction based on the data review by MDOT's bridge and geotechnical divisions.

Correspondence with MDOT is included in Appendix E.

4.4 Nearby Residents

Installation of the DGVBW is not likely to impact any residential structures. However, given the proximity of a residence on the northeast side of the DGVBW, geotechnical monitoring will be performed in the easement between the FPS boundary and residential property boundary. The geotechnical monitoring requirements are outlined in the specifications (Appendix B).

4.5 Soil Description

Based on the current and historical soil borings, the soil profile along the DGVBW generally consists of very soft riverine/alluvial sediments overlying very dense glacial till.

The depth of the sediment shown in the historical river borings ranged from approximately 8 to 15 feet. However, in OU2, where the sediment was dredged in the early 2000s, most of the sediment is now nonexistent, except for the area close to shore (inner bend of the river), where sediment has reaccumulated from ongoing water movement. Material in this layer was weak and consisted of granular alluvium with organic matter. Most standard penetration test N-values in the alluvial sediment ranged from 0 to 10 blows per foot.

Very dense glacial till lies below the sediment, where standard penetration testing (SPT) typically encountered refusal in the historical borings. The elevations where SPT values were greater than 40 blows per foot were used to estimate the top-of-glacial till profile along the DGVBW alignment. The design drawings (Appendix A) show the top of till elevations along the DGVBW based on the river soil borings advanced during the 2002 NAPL investigation (CH2M 2003).

The most recent project-specific borings, drilled on land in July 2022, encountered approximately 5 to 7 feet of topsoil and fill material. Underlying this layer was soft to medium stiff clay with trace sand and silt extending approximately 15 to 20 feet bgs. At this depth, the clay had a higher consistency, from very stiff to hard, until 20 to 30 feet bgs. Underlying this layer was very hard cohesive till.

To estimate the glacial till properties in the Pine River, samples for triaxial tests were chosen from the 2022 borings that most closely coincided with the elevation of till in the Pine River (based on historical information) and reflected the till's properties. From the triaxial tests, effective friction angles ranged from 27.8 to 36.7 degrees, effective cohesion ranged from 0 to 740 pounds per square foot, and dry unit weights ranged from 125.4 to 137.0 pounds per cubic foot.

Bedrock was not encountered in any of the borings. Borings extended to termination elevations ranging from 683.9 feet to 687.2 feet amsl. All borings were terminated at 40 feet bgs, as specified in the *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site, Remedial Design* (CH2M, 2022a). The 2022 soil boring logs are included in an attachment to the *Perimeter Drain and Geotechnical Predesign Investigation Technical Memorandum, Velsicol Chemical Corporation Superfund Site, Remedial Design* (Appendix H).

4.6 Geotechnical Engineering Evaluation

The results of the geotechnical field investigation were evaluated, and geotechnical engineering properties along the alignment of the DGVBW were assigned in preparation for analyses and computations. Geotechnical parameters were selected based on correlations with the soil types, consistency and relative density, correlations with index parameters, strength testing, and engineering experience. Given the relative consistency of the till and sediment properties, CH2M used a simplified soil profile for the DGVBW alignment. The same till and sediment properties were used throughout, with the elevations and thicknesses of each layer varied along the DGVBW. The *Geotechnical Exploration and Evaluation Report, Velsicol Chemical Corporation Superfund Site Remedial Design (Operable Unit 1), St. Louis, Michigan* (Appendix I) documents geotechnical parameters.

Appendix I contains assumed soil design parameters for the backfill material and clay cap. To achieve acceptable compaction of materials immediately behind the wall in standing water, an open-graded, large -diameter stone is proposed, with a procedure developed to vibrate the materials in a manner to achieve compaction adequate to prevent problematic settlement after the final engineered cap is installed. The recommended material for this purpose is an open-graded stone with a maximum particle size of 2.5 inches topped with 12 inches of an open-graded aggregate with a maximum particle size of 1 inch. The open-graded nature of these materials, combined with a surficial compaction (when the aggregate heights are above the elevation of the Pine River) should result in a stable subgrade to construct the remaining remedy components. Non-woven geotextile should be placed on the existing site soils before placement of the open-graded stone and again above the 12 inches of open-graded aggregate to prevent gradual loss of material. The geotextile will be covered with additional backfill layers in accordance with the specifications and drawings to facilitate vegetative growth as a temporary erosion control until the future engineered cap is constructed.

Because USACE does not plan to dredge the Pine River adjacent to this site in the future and because the river is not a traditional navigable waterway, this analysis assumes that the current bathymetry will not change significantly. The geotechnical analysis also assumes a long-term stream elevation of 719 feet amsl, which is the approximate controlled river elevation. The groundwater elevation was also approximated to an elevation of 719 feet amsl. Appendix I provides further details on water table assumptions.

The geotechnical stability evaluations for the DGVBW design included analysis of the following limit states: (1) rotational stability, (2) global stability, and (3) structural resistance. The International Building Code (ICC, 2021); American Concrete Institute Building Code Requirements for Structural Concrete (ACI, 2019); and American Institute of Steel Construction (AISC) *Steel Construction Manual*, 15th edition (AISC, 2017), were used in these analyses. When guidance from either source was lacking, other reputable sources were referenced. Load and resistance factor design methodology was used along with a uniform static surcharge load of 100 pounds per square foot in the analysis to account for construction loading and future (lightly loaded) site use (ICC, 2021).

The rotational stability and deflection of the wall were evaluated for critical cross sections using the software PYWall (Version 2019.6.9) by Ensoft Inc. PYWall uses the soil-structure interaction method of analysis, modeling a one-dimensional finite element model of the DGVBW and soil system, consisting of linearly elastic beam-column elements for the DGVBW and nonlinear (Winkler) springs to represent the soil (USACE, 1994). The critical cross sections were analyzed for both short-term and long-term (undrained and drained) soil and backfill conditions. Long-term (drained) conditions resulted in a lower factor of safety; therefore, further analysis focused on the long-term soil conditions. Lateral deflection was estimated under final geometry and service -state (factor of safety = 1.0) loading conditions, with a

maximum permissible deformation of 0.01 times the wall height. Structural adequacy of the various wall elements was calculated using a load factor of 1.6 on the retained earth pressure and a load factor of 1.75 on the applied surface load. A resistance factor of 0.9 was used for moment capacity, and a resistance factor of 0.75 was used for shear capacity.

The required structural capacity of the combination (king) piles and the design of the internal reinforcement was based on the maximum shear and moment obtained from PYWall. The maximum design strength was based on International Code Council, American Concrete Institute, and American Institute of Steel Construction Load and Resistance Factor Design guidelines (ICC, 2021; ACI, 2019; AISC, 2017), using the load and resistance factors mentioned in the previous paragraph.

Critical cross sections (that is, tallest or steepest sections with the least favorable subsurface conditions) were modeled for global stability using the Rocscience software package Slide2 (Version 9.009) and the proposed wall geometry. Circular and noncircular failure surfaces were evaluated for each drained and undrained scenario. The Spencer method, which equilibrated both forces and moments, was used within the Slide program. An acceptable factor of safety, in excess of 1.5, was achieved in all scenarios (ICC, 2021).

The *Geotechnical Exploration and Evaluation Report, Velsicol Chemical Corporation Superfund Site Remedial Design (Operable Unit 1), St. Louis, Michigan* (Appendix I) further summarizes the geotechnical engineering evaluation.

The corrosivity of the site was considered in the selection of the steel used for both the sheet piles and the cylindrical (king) piles. Understanding that neither the Pine River nor the necessary imported backfill material (by specification) will be environmentally impacted and considering the presence of an intact and functional slurry isolation wall encasing the heavily impacted soil in OU1, the potential for corrosion is assumed to be low, likely similar to corrosion on a nonenvironmental project. A sacrificial allowance of 0.125 inch on steel surfaces exposed to either the imported fill or the Pine River has been allotted to address corrosion. This sacrificial allowance results in an estimated wall life in excess of the 50-year requirement. This corrosion estimation considers typical structural grade (ASTM International [ASTM] A572) steel for both the sheet piling and the cylindrical (king) piles.

5. Project Approach

This section presents the technical details and design assumptions for the DGVBW construction within the project area.

The implementation of the remedial activities will consist of several project- and task-specific components. Although some of the components will occur concurrently, the sequencing of the primary components is anticipated to be as follows:

- Preconstruction activities, including permitting
- Mobilization and site preparation activities
- DGVBW construction, including the following:
  - Turbidity curtain deployment
  - Sheet pile and cylindrical (king) pile installation
  - Turbidity monitoring
  - Backfill and compaction
  - Site restoration
- Demobilization

5.1 Preconstruction Activities

Preconstruction work includes preparation of site plans, obtaining substantive requirements documents (SRDs), EPA review and approval of the RA Contractor submittals, identification and approval of clean borrow sources and disposal facilities, and coordination with the City of St. Louis and USACE, as needed. This work will be conducted by the RA Contractor before mobilization.

5.1.1 Site-specific Plans and Preconstruction Submittals

Preconstruction activities will include verifying the necessary SRDs have been obtained, verifying compliance with the requirements of the SRDs and other applicable regulations, and developing applicable preconstruction submittals, including site-specific plans and samples of materials as required in the specifications and identified in the Construction Quality Assurance Plan (Appendix J). The RA Contractor will submit necessary preconstruction submittals to EPA, EGLE, and other relevant agencies for review and approval before mobilization.

Site-specific plans to be prepared by the RA Contractor include, but are not limited to, the following:

- Select SRD applications
- Health and Safety Plan
- RA Contractor Quality Control Plan
- Work Plan, including the following:
  - Dust Control Plan
  - Spill Prevention, Control, and Countermeasures Plan
  - Noise Control Plan
  - Survey Plan
  - Waste Management Plan
  - Transportation and Disposal Plan
- Turbidity and Resuspension Management Plan
- Soil Erosion and Sedimentation Control (SESC) Plan

- Geotechnical Monitoring Plan
- Sheet Pile Installation and Sealing Plan
- Water Control Plan

Additional plans required during the RA are included in the specifications.

5.1.2 Borrow Source Identification

The RA Contractor will identify transportation firms and soil borrow sources. The proposed transportation firms and soil borrow sources will be submitted to EPA for review and approval as part of the preconstruction activities.

Samples of fill materials will be collected by the RA Contractor and submitted to an approved laboratory subcontractor for analyses to verify that the material meets specifications and is appropriate for use. Specifically, the fill materials will be tested by a prequalified laboratory for target compound list VOCs (including DBCP), SVOCs, target analyte list metals, pesticides, herbicides, and selected site-specific contaminants (including hexabromobenzene, PBB, and TRIS). Particle-size distribution analyses will also be performed to confirm physical properties of the DGVBW backfill. Aggregate fill materials will not be chemically tested. Borrow sources will be required to meet Michigan NREPA Part 201 criteria and project specifications included in this design before use onsite. Supplemental borrow samples will be collected during construction activities to verify continued compliance with project specifications.

Borrow source materials can be staged at appropriate locations at the FPS. Specific staging areas will be approved by EPA but are projected to be located in the central area of the FPS. The FPS is secured with fencing and has adequate space for stockpiling soil and storing equipment and temporary field trailers. Erosion control measures as described in the SESC Plan will be placed as required. The staging areas will be constructed and maintained by the RA Contractor.

5.1.3 Coordination with the City of St. Louis; Michigan Department of Environment, Great Lakes, and Energy; and U.S. Army Corps of Engineers

A preconstruction meeting will be held before construction begins and will include the RA Contractor, City of St. Louis, EGLE, USACE, and EPA. Discussion topics will include construction activities, approvals or SRDs, required licenses, allowable work hours, use of city water, transportation routes, SESC, city debris pickup, health and safety, site security, and special requirements and considerations. Any modifications resulting from this meeting will need to be reviewed and approved by EPA.

During construction, the EPA and RA Contractor will continuously coordinate with EGLE, the City of St. Louis, and USACE, as needed.

The community will be informed of the general progress of the DGVBW construction through the site newsletter or monthly community meetings. The timing and content of the documents and meetings are to be determined by the EPA.

5.1.4 Coordination with Other Onsite Activities

In situ thermal treatment (ISTT) activities at the Velsicol Burn Pit Site will be ongoing during the anticipated DGVBW construction period. At the time of BODR development, Burn Pit ISTT activities are in progress and will continue through early 2025. ISTT activities will occur 24 hours per day, 7 days per week. Anticipated Burn Pit support areas, including a temporary pontoon bridge for conveying vapors and

liquids from the Burn Pit to the FPS for treatment, temporary vapor and liquid process lines, temporary overhead electric, and ISTT laydown areas, are shown on the drawings. The RA Contractor shall coordinate with the Burn Pit RA Contractor to maintain clearance around these areas so the Burn Pit RA Contractor can access them 24 hours per day, 7 days per week.

5.2 Mobilization and Site Preparation

Mobilization includes that of the RA Contractor and any of their subcontractors. Mobilization is assumed to consist of the following, as needed:

- Performing utility locates
- Conducting a preconstruction site survey
- Installing SESCs and stormwater management
- Constructing or establishing temporary facilities, such as field trailers, material storage facilities, and sanitary facilities
- Constructing temporary roads
- Delivering and assembling equipment
- Installing turbidity control measures
- Installing site and environmental controls
- Conducting a migratory bird survey and bat surveys if construction occurs within restricted nesting or roosting periods
- Establishing site security and coordination

Equipment to be used by the RA Contractor and any subcontractors is expected to be transported by trucks. Mobilization of equipment will be completed on a schedule approved by EPA and will not occur sooner than 30 days before the construction start date. The RA Contractor will provide and maintain required temporary facilities for the duration of the project, along with a field trailer(s), if desired by the RA Contractor and in accordance with the specifications.

5.2.1 Utility Location and Protection of Site Features

Work will be conducted in a manner to avoid damaging any active aboveground or subsurface utilities. Before the start of intrusive work, the RA Contractor will identify and protect all aboveground and underground site features and utilities within the project area that are not designated for removal. Site features include the following:

- Monitoring wells
- Existing stormwater structures
- Existing subsurface utilities
- Existing groundwater collection trench
- Existing slurry wall

The RA Contractor will contact Michigan's one-call utility location system (MISS DIG 811) and will also use a third-party utility-locating service to identify utilities within the work area. Known aboveground and subsurface utilities, including the existing groundwater collection trench, are shown on the drawings (Appendix A). The DNAPL/GWCS is operated weekly and must remain operable throughout construction of the DGVBW. The locations of known utilities will be flagged or otherwise

field marked and protected before intrusive work. All utility markings will be maintained throughout the duration of removal activities. Other site features that require protection will be marked in the field and protected using traffic cones, construction fencing, caution tape, or other approved methods.

Several areas within the Pine River were identified as possible utility crossings during the bathymetric survey completed in 2022; however, based on utility owner responses to MISS DIG 811 Design Ticket 2022061701421, there are no active utilities within the alignment of the DGVBW. Appendix G contains the bathymetric survey results, and Appendix E contains utility owner responses to MISS DIG 811 Design Ticket 2022061701421.

5.2.2 Preconstruction Site Survey

A preconstruction survey will be conducted to identify the location and layout of the DGVBW and document existing site conditions. The survey will also provide the basis for the limits of clearing and grubbing activities and be used for payment quantities for that line item. Surveying will be performed by a Michigan-licensed land surveyor. Horizontal and vertical control points for the survey will be established or recovered for the site and will be shown in the as-built drawings. The datums to be used at the site are as follows:

- Horizontal datum: Michigan State Plane South, North American Datum of 1983, International Feet
- Vertical datum: North American Vertical Datum of 1988

The vertical accuracy will be Third Order (0.05 √m), as outlined in Part 4 of the *Geospatial Positioning Accuracy Standards* (FGDC, 2002).

5.2.3 Erosion and Sediment Control and Construction Stormwater Management

SESC measures will be implemented on the project site and are outlined in the drawings and draft SESC Plan included in the specifications. The SESC measures will be consistent with the requirements of Part 91 (Soil Erosion and Sedimentation Control) of the Michigan NREPA (Public Act [P.A.] 451 of 1994), as amended, and *Michigan Administrative Code* (MI Administrative Code) R 323.1709. Erosion control measures to be implemented may include silt fencing, inlet protection, and appropriate best management practices (BMPs) at the construction site. BMPs will include administrative controls (for example, planning-related and scheduling-related BMPs) and BMPs aligned with RA implementation, including good housekeeping practices, stormwater management, and sediment erosion control measures. Stormwater runoff will be controlled by maintaining erosion control measures, such as the silt fence downgradient of intrusive subsurface activities. Contaminated materials, if encountered, will be stored on a lined, bermed area and covered, if storage is required.

Inspections will be performed by the RA Contractor during construction activities and afterward for as long as necessary, based on the SESC Plan and in compliance with Michigan's Permit-by-Rule for construction activities (Rule 2190, promulgated under Michigan NREPA Part 31). SESC measures will be inspected by a certified stormwater operator weekly and within 24 hours of a significant rain event. Damaged or insufficient SESC measures will be promptly replaced or repaired. SESC measures will be removed after all onsite work has been completed and vegetation has been established.

5.2.4 Temporary Facilities and Laydown Areas

The RA Contractor will provide temporary facilities for all site workers (including subcontractors), as necessary to complete the work and as required by the specifications for the duration of the project. Temporary facilities may include the following:

- Field office trailers, including a separate field office trailer for USACE
- Storage trailers
- Temporary utilities (water, electrical, lighting, and communications), including utilities for USACE
- Material and equipment laydown areas
- Temporary boat launch
- Stockpile areas
- Sanitation facilities
- Waste containers
- Nonpotable water supply
- Decontamination facilities

If desired, the RA Contractor will provide a field office trailer and temporary power for RA Contractor personnel and subcontractors. The RA Contractor will provide a field office trailer and temporary utilities exclusively for USACE. Material and equipment laydown areas will be constructed, as necessary, to facilitate equipment assembly, maintenance, and storage. The laydown areas will be located to minimize interference with other RA operations at the FPS.

Temporary sanitary facilities will be provided and maintained by the RA Contractor for all site workers during the work, including EPA representatives. In addition, appropriate waste containers will be supplied for the disposal of general trash and refuse.

The RA Contractor will perform decontamination to remove contaminated soil and debris from vehicles and equipment before leaving the project site. During the progress and upon completion of the work, the RA Contractor will decontaminate all tools, heavy equipment, vehicles, truck exteriors, and other items used at the work site to perform intrusive activities involving contaminated soil or debris. If haul trucks that are used to transport impacted soil are later used for uncontaminated backfill materials, the RA Contractor will decontaminate the beds of the haul trucks between hauling impacted and uncontaminated soil. The RA Contractor will decontaminate construction tools and equipment that contact impacted soil before use for uncontaminated soil. The RA Contractor will collect and contain liquids, rinse water, solids, and sludge generated during decontamination operations for offsite disposal.

5.2.4.1 Temporary Road Construction

The RA Contractor will construct temporary roads, as required, to support construction activities. The roads will support truck traffic to haul materials to and from the Pine River access point to the site entrance. Existing site roads will be supplemented, as necessary, for river access.

Temporary roads will be constructed in accordance with the drawings and specifications, with final layouts determined by the RA Contractor during the RA.

5.2.4.2 Equipment and Assembly

The necessary equipment to complete the work can be mobilized to the FPS in stages, or all equipment can be mobilized before the start of work. Mobilization of equipment shall not occur sooner than 30 days before the construction start date.

5.2.4.3 Turbidity Control

The RA Contractor will minimize the potential to create turbidity and impact Pine River water quality by adhering to BMPs specific for DGVBW construction. The RA Contractor will implement BMPs to minimize resuspension during in-water construction activities. Turbidity control requirements will be established in accordance with Michigan's NREPA Parts 303 and 30 and associated rules. Section 6 describes this process.

5.2.5 Site and Environmental Controls

The RA Contractor will establish site and environmental controls during mobilization and maintain the controls throughout the work duration. Site and environmental controls will consist of the following:

- Site access control and security
- Dust control
- SESC
- Stormwater management control
- Water management
- Turbidity and resuspension management
- Spill control
- Traffic control
- Waste management
- Vibration monitoring
- Noise monitoring

These controls are implemented to minimize impacts from the work to the public, onsite workers, and the environment. Sections 5.3.3, 6.2, and 6.6 discuss these controls in greater detail.

5.2.6 Site Security and Coordination

The RA Contractor will use the FPS for equipment storage, stockpiling clean materials, and temporary field offices. The FPS is fenced, and the RA Contractor can elect to subcontract security to monitor site equipment and the staging area during nonworking hours. The RA Contractor will install temporary fencing, as needed, to maintain site security during active construction. The RA Contractor will maintain control over its work areas during working hours at the site. EPA will not be held responsible for theft or damage to RA Contractor equipment, materials, facilities, or field offices.

Other activities may occur at the FPS during the DGVBW construction activities, including soil and groundwater sampling and collection and offsite disposal of groundwater and NAPL. The RA Contractor will make allowances to minimize interference with other planned work at the FPS during DGVBW construction activities.

5.3 Downgradient Vertical Barrier Wall Construction

5.3.1 Clearing and Grubbing

Once SESCs are in place and consultation with USFWS is complete, the RA Contractor will conduct clearing and grubbing, as necessary, to perform the work. For construction purposes, clearing will consist of removing all aboveground vegetation as near to the ground surface as efficiently as feasible while leaving root mass intact and underground; grubbing will consist of clearing and removing associated root mass. Clearing and grubbing will be limited to August 16 to March 14, which is outside of the nesting

period for migratory birds, or provisions will be made to minimize and mitigate disturbance to active nests.

The RA Contractor will be responsible for offsite disposal of materials generated from clearing and grubbing activities. The RA Contractor may reuse the grubbed materials with EPA approval. For cost-estimating purposes, this design assumes that clearing and grubbing materials will be chipped and spread onsite. However, if material is to be transported offsite for disposal, waste sampling, characterization, and disposal will be completed in accordance with the RA Contractor's plans for waste disposal.

5.3.2 Surveys

The RA Contractor will use surveys for construction payment quantities and for as-built records. Surveying activity associated with the DGVBW construction will include the following:

- Payment survey(s) for DGVBW construction activities
- Payment survey(s) for backfill activities
- Final topographic survey for site restoration activities and as-built documentation

Surveys will be conducted as described in Section 5.2.2.

5.3.3 Downgradient Vertical Barrier Wall Installation

Because of challenges driving sheet pile during the OU2 sediment remedy (refer to Appendix K for OU2 sheet pile installation documentation), the design team recommends against a wall design that will require significant penetration into the very stiff to hard glacial till soil. Instead, a combination (that is, king pile) wall is recommended for the DGVBW, consisting of king piles separated by a pair of sheet piles. The king piles are recommended to consist of an open-ended steel section in which a drilled concrete shaft can be constructed. This configuration will require installation of both sheeting and the cylindrical (king pile) units to the till using a moderate-sized vibratory hammer (minimum rated centrifugal force specified in plans). The elevation of the till is of reduced importance because the structural resistance of the cantilevered wall will be developed in the drilled shaft extension of the cylindrical piles. A shortened length of a steel rebar cage will be placed in the drilled extension (extending nominally 3 feet into the cylindrical steel pile), and the entire unit will be filled with concrete to the top of the cylindrical pile (that is, the planned top of the wall).

The recommended sheet pile section is a NZ-14, which was selected because it is the widest of the commonly available steel sheeting sections (minimizing the number of cylindrical piles used). The function of the sheeting is to transfer lateral load from the new fill to the cylindrical (king) piles and to provide a hydraulic barrier. The cylindrical piles are recommended to have an outside dimension of 36 inches and a wall thickness of 0.5 inch. Both the sheet piles and the cylindrical piles are recommended to consist of typical grade steel. ASTM A252 Grade 3 (with chemical composition adhering to ASTM A572 Grade 50) steel is recommended for the cylindrical piles and ASTM A572 Grade 50 is recommended for the sheet piles.

A sealant will be added to the interlocks (both between sheet piles and between the sheet piles and the cylindrical piles) before installation. The sealant that is recommended is Steelant (also marketed as Wadit) or an equivalent, to be approved before construction.

The DGVBW installation will incur vibrations proximate to the site. The magnitude and frequency of the vibrations experienced at any specific location will depend on the location of the installation and the depth of the sheeting. Although the magnitude and frequency of the incurred vibrations are not anticipated

to result in structural damage to either the site equipment or private property adjacent to the site, vibration monitoring will be necessary proximate to private residences that may become alarmed by the vibrations. Vibration monitoring requirements during construction are detailed in the specifications.

Installation of the DGVBW will require a vibratory hammer, which may cause nuisance noise outside of the FPS boundaries. The City of St. Louis does not require permits for noise emitted from a construction site. Working hours will be limited as described in Section 6. Prior to construction activities, the RA Contractor will develop a Noise Control Plan as outlined in the specifications. The Noise Control Plan will outline noise monitoring locations, frequency, and equipment, as well as reporting and noise control procedures. The RA Contractor will adhere to the approved Noise Control Plan requirements during construction.

As mentioned previously, installation of the cylindrical piles will include a drilled shaft extension into the till unit. Drill cuttings will be containerized and disposed of offsite. For cost estimating purposes, this design assumes that the drill cuttings will be disposed of offsite as nonhazardous waste. However, waste sampling, characterization, and disposal will be completed in accordance with the RA Contractor's plans for waste disposal.

The *Geotechnical Exploration and Evaluation Report, Velsicol Chemical Corporation Superfund Site Remedial Design (Operable Unit 1), St. Louis, Michigan* (Appendix I) a provides additional details for the construction of the DGVBW.

5.4 Stormwater Management Features

Surface water that accumulates onsite is currently conveyed to the Pine River via multiple onsite swales and ditches. Construction of the DGVBW will impede current surface water routes to the Pine River because the top elevation of the DGVBW (723 feet amsl) will be higher than the river elevation (719 feet amsl) until the future engineered cap is constructed. Therefore, a stormwater analysis was performed to design an interim stormwater management system to adequately convey surface water to the Pine River between construction of the DGVBW and engineered cap.

To complete the stormwater analysis, the FPS was split into 13 basins. The hydrology was completed using the Soil Conservation Service unit hydrograph method applied within the HEC-HMS model Version 4.10. The head water was calculated using HY-8 version 7.50. The analysis was based on a 25-year rainfall event. The soil survey data from the U.S. Department of Agriculture Natural Resources Conservation Service (USDA, 2016) were used to identify the soil group type within the project area, which was used as a parameter to estimate the flow.

The results of the stormwater analysis were used to design the site grading plan and determine the sizes and locations of the stormwater outlets. All primary channels will be 1-foot deep trapezoidal ditches with a 2-foot bottom width, except where noted in the drawings. Channels that convey stormwater from the primary channels to the stormwater outlets will be 1.5-foot deep trapezoidal ditches with a 2-foot bottom width.

Stormwater outlets will consist of steel pipe of varying sizes to accommodate the modeled stormwater flow rates. The size of each stormwater outlet pipe is shown on the drawings. The steel pipe will be welded to the sheet pile. The invert of the stormwater outlet pipes will be at 719.5 feet amsl.

The grading plan, stormwater ditches, and outlet details are included in the drawings (Appendix A). A summary of the stormwater modeling analysis is included in Appendix L.

5.5 Final Restoration

Final restoration will include restoring disturbed areas to their original condition in accordance with the SESC Plan.

Restoration will consist of the following tasks:

- Removing temporary facilities as indicated on the drawings; it is assumed temporary access roads will remain in place for future site work
- Final grading
- Hydroseeding
- Performing watering and maintenance of restoration work

This design assumes no replacement of trees or plants removed as part of the site preparation or DGVBW construction activities. It is assumed that revegetation will be performed via hydroseeding with a seed mix appropriate for the site. Restoration will also include constructing drainage features (for example, swales) to ensure existing site drainage is maintained. A grading plan and restoration plan are included in the design drawings (Appendix A).

Backfill will be placed between the existing shoreline and DGVBW from the existing ground surface to the elevations shown on the drawings to support future construction of the engineered cap and convey surface water to the Pine River in the interim. It is assumed that the clay cap material stripped for construction of the site access roads will be used for backfilling above the stone fill and aggregate fill layers; imported material will supplement the clay clap material, as needed. Disturbed areas will be hydroseeded following the placement of 6 inches of topsoil. It is assumed that the topsoil stripped for construction of the site access roads will be reused and supplemented with imported material as needed. A seed mix native to the local area will be used, subject to acceptance by EPA. The seed mix will contain species appropriate to the hydrologic regime anticipated for the planting site and will be certified weed-free and free from any state-listed noxious species, non-native species, or non-native invasive species. Fertilizer and mulch will also be applied simultaneously with the seed as part of the hydroseeding process. Hydroseeding will occur during the growing season, which is defined as the period when soil temperatures reach 50 degrees Fahrenheit (°F) or greater in the spring, with a limited possibility of frost, and greater than 45°F in the fall; these conditions are typical of May 1 through October 16.

The RA Contractor will maintain all areas that will be seeded and planted until satisfactory stand is established, which will be defined in the design specifications. For cost estimating purposes, it is assumed that satisfactory stand will be established in a 12-week maintenance period; however, the maintenance period may be shorter or longer than 12 weeks depending on the length of time it takes to achieve satisfactory stand. The RA Contractor will provide water for restoration. Temporary SESC measures will not be removed until the site has been adequately stabilized in accordance with the approved SESC Plan.

5.6 Demobilization

Demobilization will include removal of temporary facilities such as field trailers, utilities, material storage facilities, equipment decontamination facilities, and SESC features. In addition, the RA Contractor will properly dispose of all waste materials before demobilization. Until site restoration and demobilization are completed, SESC features must comply with the SESC Plan. The RA Contractor will perform wet decontamination on all trucks and equipment that hauled or handled contaminated soil or

liquid before final demobilization. The RA Contractor will collect all wet decontamination waste and containerize it for characterization and offsite disposal.

5.7 Postconstruction Documentation

The RA Contractor will prepare an RA Completion Report. The RA Completion Report will document the work completed by the RA Contractor and its subcontractors in a report format used for other Superfund sites and in accordance with *Close Out Procedures for National Priorities List Sites* (EPA, 2022).

5.8 Green Remediation

Green remediation is a valuable consideration to help reduce the environmental burden of the remedy and to reduce costs. CH2M's experience suggests a strong correlation between reducing the footprint of a project and reducing the costs of the project. CH2M has technology-specific sustainability BMPs, as well as footprint, lifecycle assessment, and cost-benefit analysis tools to identify the best sustainable remediation attributes that could provide the greatest cost reductions. CH2M has found that the following are associated with the best outcomes for cost-saving, sustainable remedies:

- Materials
- Residual solid and liquid management
- Site preparation or land management
- Surface and stormwater management
- Vehicles and equipment

Based on the scope of work for the design, CH2M identified six EPA BMP documents that are potentially applicable to the DGVBW construction activities. From these BMP documents, CH2M identified approximately 86 green remediation BMPs that will potentially be implemented as part of the DGVBW construction activities (Appendix M).

6. Environmental Management

This section identifies and describes the regulatory requirements for the RD and RA.

6.1 Applicable or Relevant and Appropriate Requirements

This project is being performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) ROD for OU1 (EPA, 2012). Under CERCLA, a requirement under environmental or facility siting laws may be either applicable or relevant and appropriate to an RA, but not both. Only state standards that are more stringent than federal requirements may be applicable or relevant and appropriate. Once a requirement is determined to be relevant and appropriate and is included in a ROD, it must be complied with as if it were applicable.

Under CERCLA Section 121I, onsite RAs do not require environmental permits; rather, the action must only comply with the substantive requirements of applicable or relevant and appropriate requirements (ARARs). EGLE typically issues an SRD, which provides conditions to meet the regulations.

The statutes and regulations listed in Tables 6-1 through 6-6 contain requirements from the ROD (EPA, 2012) that are deemed to be ARARs for the DGVBW, and the tables describe actions to be taken to attain compliance. Where the State of Michigan has authorization to administer federal laws, the state requirements are described. Tables 6-7 and 6-8 describe other key regulatory requirements that must be fully complied with, both substantively and administratively, because they pertain to offsite actions. A discussion about key ARARs follows the ARARs tables.

Table 6-1. Federal Chemical-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance

No federal chemical-specific ARARs apply.

Table 6-2. State Chemical-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
CWA (33 U.S.C. Section 1251 et seq.)		
Water Resources Protection Part 4, Water Quality Standards (MI Administrative Code R 323.1041-323.1117)	Establishes water quality requirements applicable to the Great Lakes, the connecting waters, and all other surface waters of the state to protect the public health and welfare, enhance and maintain the quality of water, and protect the state's natural resources	Compliance with these standards is anticipated to be addressed through an SRD for point-source discharges and a CWA Section 401 Water Quality Certification equivalent that are anticipated to be issued by EGLE. Compliance with the SRD is required during the RA.
Water Resources Protection Part 8, Water Quality-Based Effluent Limit Development for Toxic Substances (MI Administrative Code R 323.1201-323.1221)	Prescribes maximum concentrations of various contaminants that may be discharged to the waters of the state	Compliance with these standards is anticipated to be addressed through an SRD issued by EGLE for point-source discharges. Compliance with the SRD is required during the RA.

Table 6-2. State Chemical-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Wastewater Reporting Rules (MI Administrative Code R 299.9001-9019)	Prescribes requirements for monitoring, reporting, and measuring contaminant discharge	Compliance with these standards is anticipated to be addressed through an SRD issued by EGLE for point-source discharges. Compliance with the SRD is required during the RA.

CWA = Clean Water Act

U.S.C. = United States Code

Table 6-3. Federal Action-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
EPA Regulations on Test Procedures for the Analysis of (Water) Pollutants (33 U.S.C. Section 1251 et seq.)		
Guidelines for Establishing Test Procedures for the Analysis of Pollutants (40 CFR 136.1-136.4)	Requires adherence to sample preservation procedures, including container materials, sample holding times, sample measurement, and sample preservation	Compliance is anticipated to be addressed through an SRD issued by EGLE for point-source discharges. Compliance with the SRD is required during the RA.

CFR = *Code of Federal Regulations*

Table 6-4. State Action-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Air Pollution Control Rules (MI Administrative Code R 336.110-2910)	Emission Limitations and Prohibitions—Particulate Matter provisions apply to the following as sources of fugitive dust: (2) Open storage piles of bulk materials, including clay, sand, and gravel (3) Transport of bulk materials, including clay, sand, and gravel (5) Roads and lots located within industrial, commercial, and government-owned facilities	Fugitive emission controls will be implemented as indicated in rules. Anticipated dust control measures will include covering the piles when not working, wetting the piles with water, covering trucks during transport, and cleaning the wheels and body of the truck after loading. If objectionable odors are present during construction, the RA Contractor may evaluate application of an odor-suppression foam. The opacity of a visible emission will be determined by a qualified observer and shall be certified in accordance with and using the procedures specified in EPA Method 9 or an alternative method approved by the department.
NREPA (P.A. 451 of 1994) Part 55, Air Pollution Control, as amended (MCL Section 324.5524)	Regulates emission of contaminants into the air.	Emissions of contamination from construction activities is not anticipated.
Water Resources Protection Rules Part 21, Wastewater Discharge Permits	Establishes permit requirements for treatment, pretreatment, and discharge requiring NPDES permit	Compliance is anticipated to be addressed through an SRD issued by EGLE for point

Table 6-4. State Action-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
(MI Administrative Code R 323.2101-2197)		source discharges. Compliance with the SRD is required during the RA.
NREPA (P.A. 451 of 1994) Part 31, Water Resources Protection, as amended (MCL Sections 324.3109a-3109c)	Addresses discharges to both surface waters and groundwater of the state, developed in accordance with Part 31 of Act 451	Compliance is anticipated to be addressed through an SRD by EGLE for point source discharges. Compliance with the SRD is required during the RA.
NREPA (P.A. 451 of 1994) Part 91, Soil Erosion and Sedimentation Control, as amended (MCL Sections 324.9101-324.9123a) Water Resources Protection Part 21, Wastewater Discharge Permits (MI Administrative Code R 323.2190, National Permit for Storm Water Discharge from Construction Activity)	Prevents uncontrolled erosion and sedimentation in lakes, streams, and rivers from earth-changing activities. Requires SESCs for soil disturbance of 1 or more acre or that is within 500 feet of the water's edge of a lake or stream.	The area of disturbance is greater than 5 acres. Substantive requirements of the rule will be met through implementation of the SESC Plan, which will incorporate appropriate BMPs, SESC measures, inspections, and other substantive requirements of the Michigan NPDES Construction Stormwater Permit-by-Rule.
Department of Transportation Rules for Hazardous Materials Transport (49 CFR 107 and 49 CFR 171-180)	Establishes requirements for offsite transportation of site-generated waste. Regulates the packaging, shipping, placarding, and transporting of hazardous waste materials	Packaging and placarding originate onsite. The design requires full substantive and administrative compliance for all offsite activities, including shipping and transporting hazardous materials.
NREPA (P.A. 451 of 1994) Part 111, Hazardous Waste Management, as amended (MCL Section 324.11138)	Establishes generator requirements for the management of hazardous waste	Hazardous waste is not anticipated to be generated. However, hazardous wastes must be properly managed in accordance with the RCRA generator standards.
Hazardous Waste Management Part 3, Generators of Hazardous Waste (MI Administrative Code R 299.9302 and 299.9305)	Establishes requirements for hazardous waste determination and generator rules for managing hazardous waste, including pre-transport and accumulation requirements	Wastes generated during the DGVBW installation portion of the OU1 remedy are not anticipated to be hazardous. If determined to be hazardous, such waste will be packaged, labeled, marked, and managed onsite as indicated in the rule. If found to be hazardous, excavated soil, NAPL, and/or oil will be subject to full substantive and administrative requirements of the Land Disposal Restrictions (MI Administrative Code R 299.9620) because disposal would occur offsite. Hazardous wastes will be properly characterized and will be properly managed for compliance with the RCRA generator standards.
NREPA (P.A. 451 of 1994) Part 121, Liquid Industrial Waste, as amended (MCL Section 324.12103)	Requires liquid industrial waste generators to properly characterize the waste and use haulers that are licensed and bonded.	The RA will generate liquid waste requiring management in accordance with this rule. Wastes will be characterized and labeled, and transporters will be in accordance with Part 121. The offsite transportation and disposal of liquid waste is not an ARAR; rather, full compliance with Part 121 and R 324.12101-

Table 6-4. State Action-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
		324.12117 is required and will be adhered to. The RA Contractor will comply with the requirements of sampling, characterization, storage, and disposal.
NREPA (P.A. 451 of 1994) Part 115, Solid Waste Management, as amended (MCL Sections 324.11501-324.11550)	Addresses solid waste management, as promulgated in the administrative rules of the Michigan Solid Waste Management Regulations	The RA may produce nonhazardous solid waste. Nonhazardous solid waste destined for offsite disposal will be disposed of in a Michigan Type II landfill.

MCL = Michigan Compiled Laws

NPDES = National Pollutant Discharge Elimination System

RCRA = Resource Conservation and Recovery Act

Table 6-5. Federal Location-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Fish and Wildlife Coordination Act (16 U.S.C. 661-667(e))	Requires consultation when a federal department or agency proposes or authorizes structural modification of any stream or other waterbody. Requires adequate provisions for the protection of fish and wildlife resources.	The USFWS database and the Michigan Natural Features Inventory was accessed during the RD to evaluate whether protected species or their habitat are likely to be present in the project area. If impacts to protected species or their habitat are possible, USFWS will be consulted during the RA.
CWA Section 404, Permits for Discharges of Dredged or Fill Material into Waters of the U.S. (40 CFR 230.10)	Regulates the discharge of dredged or fill material to waters of the U.S. Establishes permit requirements for actions that involve dredging or filling in a navigable waterway or wetland	Through NREPA Part 301, Inland Lakes and Streams, and Part 31, Water Resources Protection (Floodplain Regulatory Authority), EGLE has authorization to implement this federal CWA Section 404 regulation at certain locations within the state, including the project location. Refer to those Michigan regulations therein.
Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. 401 et seq.) Rivers and Harbor Act Section 10	Prohibits construction of dams or dikes over navigable waters without authorization. Prohibits discharge of refuse in navigable waters unless USACE allows. Prohibits unauthorized obstruction or alternation of any navigable water.	No action is needed. This reach of the Pine River is not considered a traditional navigable water subject to the Rivers and Harbors Appropriation Act of 1899 because it is not listed on the USACE Detroit District July 2022 Navigable Waters List.
Migratory Bird Treaty Act (16 U.S.C. 703 et seq.)	Makes it unlawful to take, kill, or possess any migratory bird or any part, nest, or eggs of any such bird without appropriate authorization	Grounds, trees, shrubs, structures, and equipment at the site may be used by protected migratory birds (for example, the American robin) during the nesting season. Construction activities will require ground disturbance and vegetation clearing and have the potential to support migratory bird nests. Disturbance to migratory birds and nests containing hatchlings or eggs will be avoided

Table 6-5. Federal Location-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
		and mitigated by clearing vegetation and completing ground disturbance outside the nesting season, rescheduling work to avoid disturbing active nests, limiting removal to only those shrubs or structures absolutely necessary to support the work, or removing nests as they are being built before they are inhabited. Although CERCLA onsite actions are exempt from environmental permits (in accordance with CERCLA Section 121(e)(1)), the RA Contractor will seek concurrence with USFWS on the mitigation measures, if required. If needed, a USFWS Special Purpose-Miscellaneous permit application-equivalent will be submitted to obtain formal documentation within the USFWS process.
Endangered Species Act (16 U.S.C. 1531 et seq.)	Establishes requirements to protect species threatened by extinction and habitats critical to their survival	According to an informal Information for Planning and Conservation Resource List, produced on June 12, 2023, protected species or species proposed for protection are potentially present in the project area and could be affected by the project. To confirm the presence or absence of these species in the project area, as well as the potential impacts of the project on these species, official formal consultation with the USFWS will be required during the RA. Depending on the effects determination made by EPA and USFWS during this consultation, clearing limitations and other time-of-year restrictions may be placed on the project, which may affect the project schedule. This consultation is the responsibility of the RA Contractor and should be completed before any ground- or tree-disturbing activities.

Table 6-6. State Location-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Inland Lakes and Streams (MI Administrative Code R 281.811-281.846)	Establishes permitting requirements and conditions for any operation involving lakes and streams	EGLE is anticipated to issue an SRD for compliance with the federal CWA Section 404 and with this rule, which implements Part 301 of NREPA. Due to the amount of waters to be impacted, the Project will require the equivalent of an Individual Permit from EGLE. Backfill material will be placed outside the floodway to the extent practical. 670,000 yd^3 of river sediment was removed from the floodway as part of previous site remediation. A CERCLA-

Table 6-6. State Location-specific Applicable or Relevant and Appropriate Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
		streamlined permit equivalent application will be provided to EGLE after the RD is finalized, in accordance with the JPA process to describe the project. If necessary, the RD will be modified to comply with the Joint Permit equivalent substantive requirements of Part 301 and Part 31.
NREPA (P.A. 451 of 1994), Part 301, Inland Lakes and Streams, as amended (MCL Sections 324.30101-324.30113)	Lists operations that are prohibited in the bottom land of a lake or stream without a permit	EGLE is anticipated to issue an SRD for compliance with the federal CWA Section 404 and with Part 301 of the NREPA. Due to the amount of waters to be impacted, the Project will require the equivalent of an Individual Permit from EGLE. Backfill material will be placed outside the floodway to the extent practical. 670,000 yd^3 of river sediment was removed from the floodway as part of previous site remediation. A CERCLA-streamlined application will be provided to EGLE after the RD is finalized, in accordance with the JPA process to describe the project. If necessary, the RD will be modified to comply with the Joint Permit equivalent substantive requirements of Part 301 and Part 31.
Wetlands Protection (MI Administrative Code R 281.921-281.925)	Prohibits the construction, operations, or maintenance of any use of development in a wetland without a permit. Outlines the requirements for obtaining permits, performing wetlands determinations and mitigating wetland impacts.	The EGLE Wetlands Map Viewer indicates the presence of wetlands within the project area, as identified on National Wetlands Inventory and Michigan Resource Inventory System Land Cover Map (Figure 6-1). However, these databases and maps may not represent current conditions. A field assessment completed in June 2023 did not identify wetlands within the area to be disturbed as part of the DGVBW construction. The RA Contractor will perform a wetland delineation during the RA if it is determined to be required in consultation with the agencies for the project area.

Table 6-6. State Location-specific Applicable or Relevant and Appropriate Requirements

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
NREPA (P.A. 451 of 1994) Part 303, Wetlands Protection, as amended (MCL Sections 324.30301-324.30323)	Provides for the preservation, management protection, and use of wetlands by prohibiting certain activities and by requiring a permit to alter certain wetlands, as follows: ▪ Regulates the construction, operations, and maintenance of a development in a wetland ▪ Outlines the requirements for performing wetlands determinations and mitigating wetland impacts	Refer to the Michigan Wetlands Protection Rules previously described.
NREPA (P.A. 451 of 1994) Part 365, Endangered Species Protection, as amended (MCL Sections 324.36501-324.36507)	Contains a listing of the fish, wildlife, and plant species that have been determined to be endangered or threatened. Prohibits the taking of listed species.	The Michigan Natural Features Inventory was accessed during the RD to evaluate whether protected species or their habitat are likely to be present in the project area. If impacts to state-listed protected species or their habitat are possible during the RA, the Michigan Department of Natural Resources will be consulted.

JPA = Joint Permit (Equivalent) Application

Table 6-7. Other Federal Key Regulatory Requirements

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Occupational Safety and Health Standards (29 CFR 1910, Subpart Z, Toxic and Hazardous Substances)	Requires specific training and monitoring for RA based on contaminant concentrations and risk.	The project specifications require remediation worker compliance during implementation of the remedy.
Safety and Health Regulations for Construction (29 CFR 1926)	Establishes regulations for construction standards.	The project specifications require remediation worker compliance during implementation of the remedy.
Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	Requires transporters to be licensed hazardous waste haulers. In the event of a discharge during transportation, the transporter must take immediate action to protect human health and the environment and to clean up the discharge such that it no longer presents a hazard.	The design requires that hazardous waste, if generated, will be transported in compliance with these rules.
Use of Manifest System and Transportation Standards and Recordkeeping (MI Administrative Code R 299.9608-9609)	Include requirements for using a manifest system to track the type and quantity of hazardous waste received by or shipped from a licensed facility	A manifest system will be used for offsite transport of contaminated soil, sediment, and debris. Although it is not anticipated that waste will be hazardous, the RD requires that the RA Contractor prepare a Transportation and Disposal Plan that describes compliance with these and other requirements, if triggered.

Table 6-7. Other Federal Key Regulatory Requirements

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Land Disposal Restrictions (MI Administrative Code R 299.9627)	Requires any hazardous waste placed in land disposal units to comply with Land Disposal Restrictions by either attaining specific performance- or technology-based standards. Prohibits certain listed or characteristic hazardous wastes from placement or disposal on land without treatment. Provides treatment standards and best demonstrated available technology.	Wastes generated from the site, if hazardous, will be disposed of offsite at a commercial landfill approved under the EPA Offsite Rule (40 CFR 300.440) and properly permitted under RCRA. Waste will be treated at the commercial landfill to comply with Land Disposal Restrictions.

Table 6-8. Other State Key Regulatory Requirements

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Michigan Public Health Code (P.A. 368 of 1978) Part 127, Water Supply and Sewer Systems (MCL Sections 333.12701-333.12771)	Regulates the construction of private drinking water wells, monitoring wells, test wells (mineral wells), dewatering wells, and sewer systems	Dewatering activities are expected to only include surface water, and installation of dewatering wells is not expected.
Groundwater Quality Control Rules, Part I, Well Construction Code (MI Administrative Code R 325.1601-325.1781)	Establishes regulations for well construction, pump installation, and well abandonment, including dewatering wells	Dewatering activities are expected to only include surface water, and installation of dewatering wells is not expected.
MIOSHA (P.A. 154 of 1974) (MCL Sections 408.1001-408.1094)	Dictates and regulates working conditions and the duties of employers and employees as to places and conditions of employment. Establishes rules for safety standards in the workplace.	Onsite RAs have the potential to expose workers to contaminants. Construction, excavation, and other site actions may present potential health hazards to workers. Human labor could construct remedial systems and provide long-term maintenance on the systems. Such activities are governed by worker safety and health standards under this act, and MIOSHA standards and safety standards will be followed for all site actions and activities. The design specifies compliance with these standards for work that is triggered by these regulations.
MIOSHA (P.A. 154 of 1974) Parts 194, General Industry Safety Standards, and Parts 301-591 and Rule 3303, Occupational Health Standards for General Industry	Provide standards for healthful employment or places of employment. Standards have been developed for air contaminants, physical agents, health hazard control measures, illumination, sanitation, employee right-to-know, and more.	Onsite RAs have the potential to expose workers to potential health hazards. Human labor could construct remedial systems and provide long-term maintenance on the systems. Such activities are governed by worker safety and health standards under this act, and MIOSHA standards and safety standards will be followed for all site actions and activities. The design specifies compliance with these standards for work that is triggered by these regulations.
MIOSHA (P.A. 154 of 1974) Parts 1-91, Construction Safety Standards, and Parts 303-681,	Establish safety standards for construction and construction-related activities. Standards adopted include those for	The design specifies compliance with these standards for work that is triggered by these regulations.

Table 6-8. Other State Key Regulatory Requirements
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Requirement	Requirement Synopsis	Action to be Taken to Attain Compliance
Occupational Health Standards for Construction	excavations, trenching and shoring, ladders, demolition, personal protective equipment, and electrical use.	
Michigan Vehicle Code (P.A. 300 of 1949) (MCL Section 257.722, as annotated)	Governs the reduction of maximum axle loads from March through May (that is, frost laws)	RA may require heavy loads of equipment or media to be moved via roads affected by these rules. The design specifies compliance with these standards for work that is triggered by these regulations.

MIOSHA = Michigan Occupational Safety and Health Act

6.2 Water Resources Protection

CWA establishes the water quality and toxic effluent standards that must be incorporated into the design as the target criteria for discharges to surface water. Michigan NREPA (P.A. 451 of 1994), as amended, Part 31 (Water Resources Protection), Part 301 (Inland Lakes and Streams), and Part 303 (Wetlands Protection), and the associated MI Administrative Code rules govern activities that will occur as part of the DGVBW RA.

6.2.1 Dredged and Fill Material Discharges

CWA Section 404 prohibits discharging dredged or fill material into waters of the U.S., including inland lakes and streams, the Great Lakes, and wetlands, without authorization. CWA Section 401 gives states and authorized tribes the authority to grant, deny, or waive certification of proposed federal licenses or permits that may discharge into waters of the U.S. Although a Water Quality Certification is considered administrative in accordance with CERCLA guidance, it can describe substantive requirements for compliance with water quality standards. Michigan NREPA Part 301 and the Michigan Inlands Lakes and Streams Rules implement CWA Section 404 at this site. Because Michigan follows an SRD process, it is anticipated that EGLE will request submittal of a JPA describing the project to the EGLE Water Resources Division and that EGLE will issue an SRD, including a Water Quality Certification. EPA will submit the JPA after completion of the final design. The RA Contractor will be required to comply with the SRD once its issued.

6.2.2 Wetland Disturbances

The JPA process also addresses disturbance to wetlands. NREPA Part 303 and the associated Wetlands Protection Rules regulate construction in a wetland. The EGLE Wetlands Map Viewer indicates the presence of wetlands within the project area, as identified on the National Wetlands Inventory and Michigan Resource Inventory System Land Cover Map (Figure 6-1). However, a field assessment completed in June 2023 did not identify wetlands within the area to be disturbed as part of the DGVBW construction. These databases and maps do not likely represent current site conditions. The RA Contractor will perform a wetland delineation during the RA if it is determined to be required in consultation with the agencies for the project area.

6.2.3 Floodplains

The project area lies within a 100-year floodplain, as documented in the Floodplain Delineation Report approved and published by EGLE in accordance with MI Administrative Code R 560.303. Disturbances

such as grading, construction, or filling below the 100-year floodplain of a river with a drainage area of 2 square miles or more are subject to the substantive requirements of NREPA Part 31.

In accordance with the substantive requirements, the floodway will be kept clear of obstructions during the RA. The project will introduce fill material on the landward side of the DGVBW. Hydraulic floodplain modeling activities are in progress. It is anticipated that the floodplain modeling results will demonstrate that the project will not increase flooding at other properties. Compensatory excavation will not be performed because the volume of fill material that will be introduced is significantly less than the volume of fill material that was removed during previous phases of remediation of OU2 (after 1989), when 639,975 yd^3 of sediment was removed from the Pine River (CH2M, 2010).

6.2.4 Surface Water Discharges

Michigan EGLE has authorization for the federal NPDES program, which regulates point-source discharges to surface waters, including the Pine River. EGLE administers the regulations that govern point-source discharges to surface water under NREPA Part 31, Water Resources Protection, and the Part 8 Rules. Water from the Pine River that is behind the DGVBW as it is being installed will need to be managed by the RA Contractor. A large-diameter stone will be placed in the standing surface water behind the DGVBW to lessen the amount of dewatering required. It is estimated that 1,600,000 gallons of displaced river water and stormwater will need to be managed during the RA. The RA Contractor may elect to discharge the displaced river water and stormwater back into the Pine River. With this approach, the river water and stormwater may need to be treated in an onsite treatment system before discharging it to the Pine River. It would be necessary for the treatment to meet the applicable effluent standards in accordance with R 323.2101 through 2197. It is anticipated that EGLE will issue an SRD if such treatment system is needed; the RA Contractor will comply with the substantive requirements of the SRD. Alternatively, the RA Contractor may elect to contain displaced water and stormwater and dispose of the liquids offsite.

Given the large volume of river water and stormwater that will need to be managed during the RA, this design assumes that the displaced river water and stormwater will be discharged back into the Pine River. For cost estimating purposes, it is assumed that water treatment will include a weir tank, sand filtration, and carbon polishing. However, the water treatment equipment will be determined by the RA Contractor in conjunction with the SRD process during the RA.

6.2.5 Stormwater Runoff and Soil Erosion and Sedimentation Control

To minimize impacts to surface waters from overland stormwater flow to the Pine River, an SESC Plan will be developed that will be prepared in accordance with the substantive requirements stated in *MI Administrative Code* Part 17, R 323.1701 through 323.1703 and R 323.1708 through 323.1710, as well as local requirements. The RD incorporates SESC measures and BMPs to reduce sediment erosion and runoff into the Pine River during the RA. The SESC Plan will be prepared by the RA Contractor in consultation with the Lansing District Office, which covers Gratiot County. Erosion control measures will be implemented before the start of site remediation activities. The controls will include installing silt fences, covering soil piles, and using construction entrances and exits.

6.3 Air Pollution Control

Part 55 of the Michigan Air Pollution Control Rules of NREPA (P.A. 451 of 1994), as amended, is the state law that regulates sources of air contaminants. Part 7 of the Michigan Air Pollution Control Rules defines a new source as any emission unit placed into service on or after July 1, 1979. According to R

336.1702, when installing a new source of VOCs or modifying an existing source, a facility must evaluate the following four emission rates and use whichever one results in the lowest maximum allowable emission rate of VOCs: (1) an emission rate based on best available control technology, (2) the maximum allowable emission rate specified by a New Source Performance Standard promulgated by EPA, (3) the maximum allowable emission rate specified as a condition of a Permit to Install, or (4) the maximum allowable emission rate specified in Michigan Air Pollution Control Rules Part 6.

Because the water that may be treated will be sourced from the Pine River, it is anticipated that the potential to emit other contaminants will not exceed thresholds and will not trigger the need for an Air Quality SRD in accordance with R 336.1201 or a Renewable Operating SRD in accordance with R 336.1211. If it is determined that thresholds are triggered, the substantive requirements that must be complied with during the RA are anticipated to be included in an SRD from EGLE, and the RA Contractor will comply with the SRD.

The project will create no permanent sources of air emissions. The primary air quality issues are potential fugitive dust and other contaminants emitted during the RA from sediment or soil management (that is, loading or unloading) onsite and water treatment processes (that is, pumping untreated surface water), respectively. To comply with the substantive requirements associated with particulate matter emissions, fugitive dust emission controls will be implemented during earth-moving and storing activities to minimize dust generation.

6.4 Other Natural Resources

This section details the Endangered Species Act Section 7, the Migratory Bird Treaty Act, and the Fish and Wildlife Coordination Act.

On June 21, 2023, a general habitat assessment was completed along the banks and shoreline of the FPS. Habitat along the banks and shoreline of the Pine River consisted primarily of herbaceous riparian vegetation on the eastern half of the site, transitioning into more of a scrub-shrub riparian habitat to the west, with scattered trees along the west-facing bank. Typical vegetation along the shoreline to the north and northeast of the site includes common reed (*Phragmites australis*), bird's-foot trefoil (*Lotus corniculatus*), and Canada anemone (*Anemonastrum canadense*). Shrub species included a few species of dogwood (*Cornus* spp.) and short box elders (*Acer nigra*). To the west along the shoreline, there are taller trees, box elders and cottonwoods (*Populus deltoides*), and fewer dogwoods. A few snags providing potential bat roost habitat are present near the fenceline throughout. Species observations included several species of Odonata, red-winged blackbird (*Agelaius phoeniceus*), American robin (*Turdus migratorius*), bumblebees (*Bombus* spp.), and white-tailed deer (*Odocoileus virginianus*). There were no wetlands identified along the banks and shoreline, just a transition from upland to open water of the Pine River.

6.4.1 Endangered Species Act Section 7

The Endangered Species Act (16 U.S.C. 1531 et seq.) is administered by two federal agencies, USFWS and the National Oceanic and Atmospheric Administration (NOAA). Since NOAA's jurisdiction applies only to marine species, only the USFWS has jurisdiction within the Project area in Michigan. Construction of the DGVBW will include vegetation disturbance and disturbance in the Pine River. Updated federal and state threatened and endangered species data searches were conducted for the DGVBW disturbance areas, and the results are included in Appendix N. During the RA, USFWS or EGLE will be consulted to develop appropriate measures to minimize any potential adverse effects to the protected species. Work will only proceed in areas where impacts cannot be avoided after consultation with USFWS or EGLE, as appropriate. USFWS or NOAA may issue authorization under Section 10(a) if

an action will result in a "take" of a threatened or endangered species. Documentation of the data searches and, if warranted, the coordination will be included with the CWA Section 404 JPA.

6.4.2 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. 703) protects almost all species of native birds in the United States from unlawful taking, possession, or sale of any bird, in whole or part, as well as the nest, egg, or any product manufactured therefrom. Project specifications limit clearing of vegetation with the potential to support migratory bird nests from August 16 to March 14 (inclusive of those dates) to not interfere with the bird nesting/breeding season. For proposed clearing beyond this period, the RA Contractor will be required to take additional measures, such as performing preconstruction surveys, and to coordinate in advance with USFWS. Work will proceed in areas where impacts to breeding birds, active nests, and fledglings cannot be avoided only after consultation with USFWS or EGLE.

6.4.3 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), Executive Order 11988, and 40 CFR 6 require that activities avoid adverse effect and minimize potential harm, preserve natural and beneficial values, or compensate for impacts to fish, wildlife, and their habitats through restoration. Additionally, NREPA contains a requirement that the RA supports any state or federal endangered or threatened fish, plants, or wildlife as specified in MI Administrative Code R 281.924 ("6501 of P.A. 1994").

The USFWS database and the Michigan Natural Features Inventory were accessed as part of the RD to evaluate whether protected species or their habitat are likely to be present in the project area; documentation is included in Appendix N. If impacts to protected species or their habitat are possible, USFWS or EGLE will be consulted during the RA.

6.5 Historical and Cultural Resources

6.5.1 National Historic Preservation Act Section 106

The National Historic Preservation Act (16 U.S.C. 469 to 470; 36 CFR 65 and 800) establishes procedures for evaluating, preserving, and avoiding impacts to cultural, historical, and archaeological resources that might be impacted by a construction project or licensed activity or program. Section 106 compliance is required for federal actions, including Michigan's authorization to implement CWA Section 404.

The Michigan State Historic Preservation Office (SHPO) evaluates, protects, and promotes Michigan's historical built environment, archaeological sites, and cultural resources. Research was conducted in person at the SHPO office in Lansing, Michigan, between June 19 and 29, 2023, to collect data on identified cultural resources properties and cultural resources surveys within a 1-mile radius of the project area. A records review identified no historic properties in the Area of Potential Effects. In the 1-mile radius Study Area, a total of 10 archaeological sites, 44 aboveground resources, 1 historic district, and 1 cemetery were recorded by previous cultural resources investigations. Of those 56 cultural resources, there is 1 National Register of Historic Places (NRHP)-listed historic district, 3 NRHP-eligible archaeological sites, and 5 NRHP-eligible aboveground resources. All the previously identified cultural resources are in the Study Area, and none are within or adjacent to the Area of Potential Effects. No additional cultural resources field investigations are recommended, pending SHPO concurrence.

If it is determined that significant cultural resources cannot be avoided, an effects assessment will be carried out and the SHPO will be consulted to determine measures to address adverse effects on cultural

resources. Section 106 consultation is in progress. Literature review documentation is included in Appendix O.

6.6 Joint Permit (Equivalent) Application

JPA activities commenced after completion of the preliminary design. EPA, EGLE, and CH2M participated in a pre-application call on April 14, 2023. EGLE requested that hydraulic floodplain modeling be performed to verify that construction of the DGVBW will not impact the existing capacity of the floodplain (refer to Section 6.2.3). This modeling effort is in progress and will be included under separate cover. After completion and EPA approval of the final design and floodplain modeling results, CH2M will submit the application via EGLE's MiEnviro website.

6.7 Minimizing Public and Environmental Impacts

Environmental and public health and welfare impacts will be minimized through the following methods:

- Site access control
- Noise control
- Limitation of working hours
- Dust control
- Transportation and disposal offsite

6.7.1 Site Access Control

Access control to the FPS during construction is necessary to prevent exposure of trespassers to contaminated soil. In addition to the existing site perimeter fence, access will be controlled by construction fencing or temporary barricades installed around work areas to prevent workers involved in other activities on the FPS from entering the project work areas. The site entrance gates will be locked when the site is vacant.

6.7.2 Noise Control

The RA Contractor will submit a Noise Control Plan in accordance with the specifications. The City of St. Louis does not require permits for noise emitted from a construction site according to the City of St. Louis Community Services Coordinator. Any work onsite that could create excessive noise must be during normal working hours of 7:00 a.m. to 6:00 p.m. on the weekdays and from 9:00 a.m. to 5:00 p.m. on the weekends. Exceedances of noise outside of these boundaries can result in a municipal civil infraction by the City of St. Louis.

6.7.3 Limitation of Working Hours

Typical working hours for construction activities are 7:00 a.m. to 6:00 p.m., Monday through Friday. The RA Contractor will need to obtain approval from EPA for alternate work hours during the week or for work on the weekend.

6.7.4 Dust Control and Monitoring

Transporting material by trucks, operating offroad equipment that runs on diesel, grading and clearing, creating access routes, and compacting processes can affect air quality. Although construction activities related to installation of the DGVBW are not expected to exceed federal air quality standards and the amounts of airborne particulates generated will likely be minimal, the RA Contractor will submit a Dust

Control Plan that describes the measures that will be used for dust control. Dust abatement will be performed, as needed, to avoid significant dispersion of fugitive dust. Dust abatement measures typically include water application and dry decontamination of trucks before exiting the site.

The RA Contractor will perform dust monitoring throughout construction. Although excavation of contaminated material is not anticipated, the RA Contractor will conduct real-time air monitoring for particulate matter continuously during construction activities to verify that nuisance dust particles are not migrating offsite. Real-time air monitoring for particulate matter will be conducted continuously near the work area in accordance with an approved Dust Control Plan. The dust monitoring equipment will be placed at locations to verify the effectiveness of engineering controls in minimizing dust generation that may potentially leave the work area. Data will be recorded to a data logger once per minute. Dust monitors will be placed upwind and downwind of earthwork activities to determine the impact of construction activities on air quality.

Dust monitoring data will be evaluated against the EPA National Ambient Air Quality Standards for particulate matter smaller than 10 microns in diameter (PM_{10}) of 150 micrograms per cubic meter ($\mu g/m^3$). The standards are based on a 24-hour average, but active construction activities will only be performed for approximately 10 to 11 hours per day, so no dust generation is assumed during the nonworking hours. During work hours, an alarm will be set at 500 $\mu g/m^3$ to observe activities, determine the cause for elevated particulate concentrations, and evaluate potential mitigation measures to maintain the 24-hour average concentration at less than the criteria. Exceedances of the dust monitoring criteria will require dust abatement measures by the RA Contractor, which typically includes applying water or stopping work and performing further evaluation.

6.7.5 Transportation and Disposal of Waste Materials Offsite

The RD will require that the RA Contractor prepare and submit plans describing the transportation and disposal of waste materials and debris to approved disposal facilities, if needed. Transportation firms and disposal facilities will be approved before offsite disposal. Disposal facilities will be required to provide proof of EPA approval under the CERCLA Offsite Rule, set forth in the National Contingency Plan (40 CFR 300.440). Waste profiles will be signed by EPA, and waste manifests will be prepared and signed on behalf of EPA by authorized and trained RA Contractor personnel before leaving the site. The waste characterization requirements will be determined by the approved disposal facility. The Waste Management Plan will address the following:

- Waste streams identification
- Decontamination procedures
- Waste characterization and profiling
- Waste and container management, storage, labeling, and marking
- Waste transportation practices
- Manifests/haul tickets and other shipping documentation
- Qualified RA Contractor personnel who can sign the waste manifests on behalf of EPA
- Waste disposal
- Spill response and reporting
- Dust abatement
- Traffic control, including road closure permits or protective measures
- Records and reporting

7. Pine River Turbidity Monitoring

The RA Contractor will develop a Turbidity and Resuspension Management Plan during the RA that will describe the water quality monitoring objectives, turbidity monitoring methods and equipment, BMPs, and corrective action measures for the DGVBW construction activities. Upstream and downstream monitoring are anticipated to be performed during construction; however, specific details regarding the turbidity monitoring and compliance requirements will be known once the JPA is submitted and the SRD is issued during the RA.

8. Schedule

Appendix P contains the final construction schedule for the proposed work. The final construction schedule is conceptual and focused on the overall duration of tasks, rather than specific start and end dates. The schedule assumes that ISTT activities for the Burn Pit will be in progress when DGVBW construction starts and will be completed in early 2025. DGVBW construction is estimated to be completed in approximately 405 days total.

9. Constructability Review

CH2M senior construction project management staff reviewed the BODR, drawings, and specifications, with an emphasis on constructability. In addition, this BODR, drawings, and specifications were reviewed by the project review team, and comments were incorporated, as appropriate. The review did not identify significant concerns.

10. Cost Estimate

Appendix Q contains the final cost estimate for the DGVBW RA and details the costs to perform the work as described in this document. The engineer's estimate of construction costs, as described in this report, is estimated at $32,273,000. The cost estimate is considered to be a Class 2 cost estimate as defined by AACE International and is considered to have an accuracy of plus 20% to minus 15% based on the results of the assumptions presented in this BODR. The cost estimate is considered a bottom-rolled-up type of estimate, with detailed direct cost breakdown of labor, materials, and equipment. Estimator judgment and experience were used to price materials and services. The estimate includes allowance cost for certain components of the estimate (for example, weather delays and production restraints).

The engineer's estimate of construction costs has been prepared for guidance in project evaluation and implementation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, competitive market conditions, actual site conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the cost estimate presented herein. Because of these factors, project feasibility and funding needs must be carefully reviewed before specific financial decisions are made or project budgets are established to help ensure project evaluation and adequate funding.

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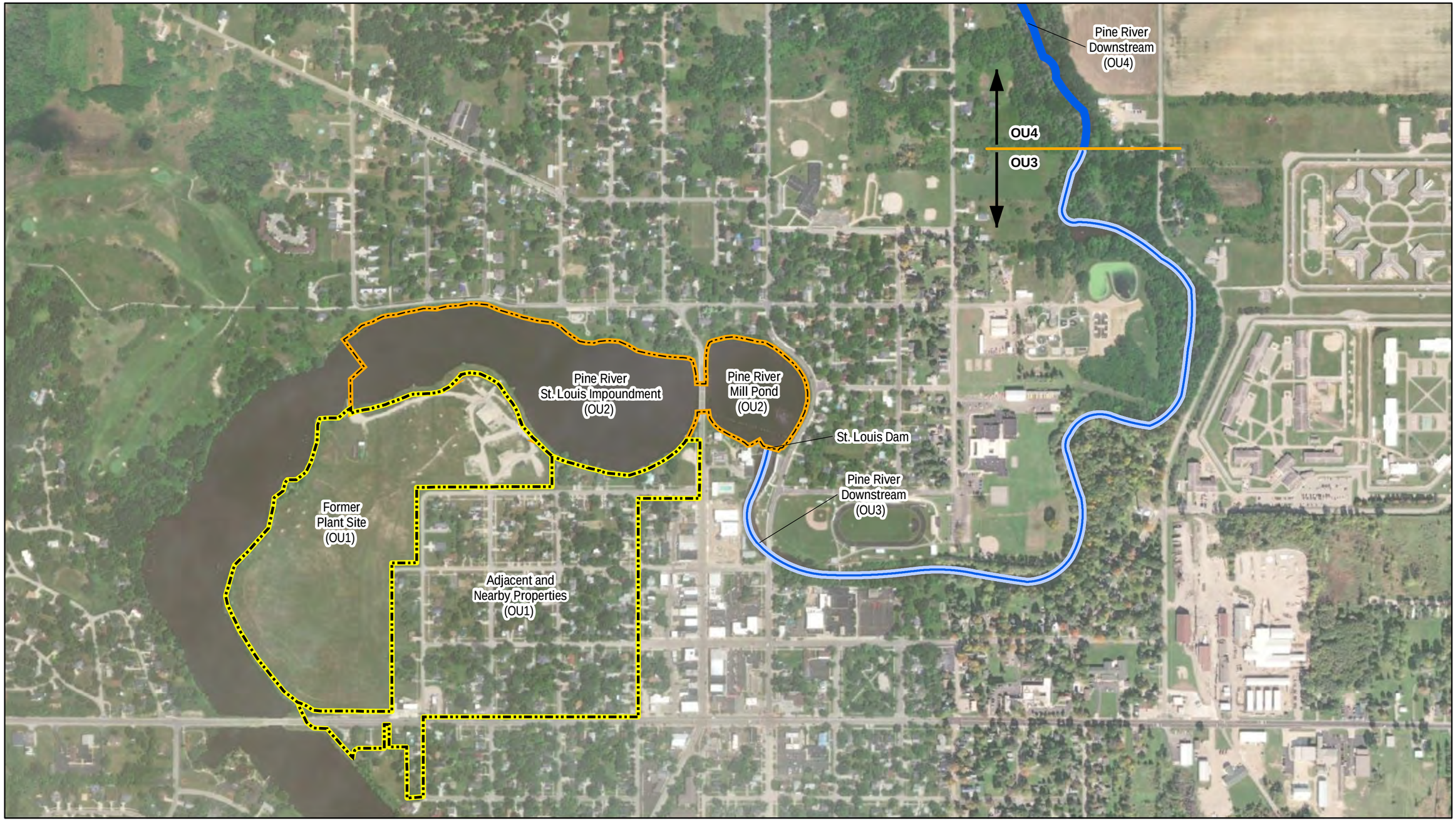
Figures



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1-1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Document Path - MKE - \\Hercules: \\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\Reports\2021\QAPP\MapFiles\Figure01_Study Areas and Operable Units.mxd User Name: mpetersh Date: 8/27/2021 Time: 3:47:13 PM

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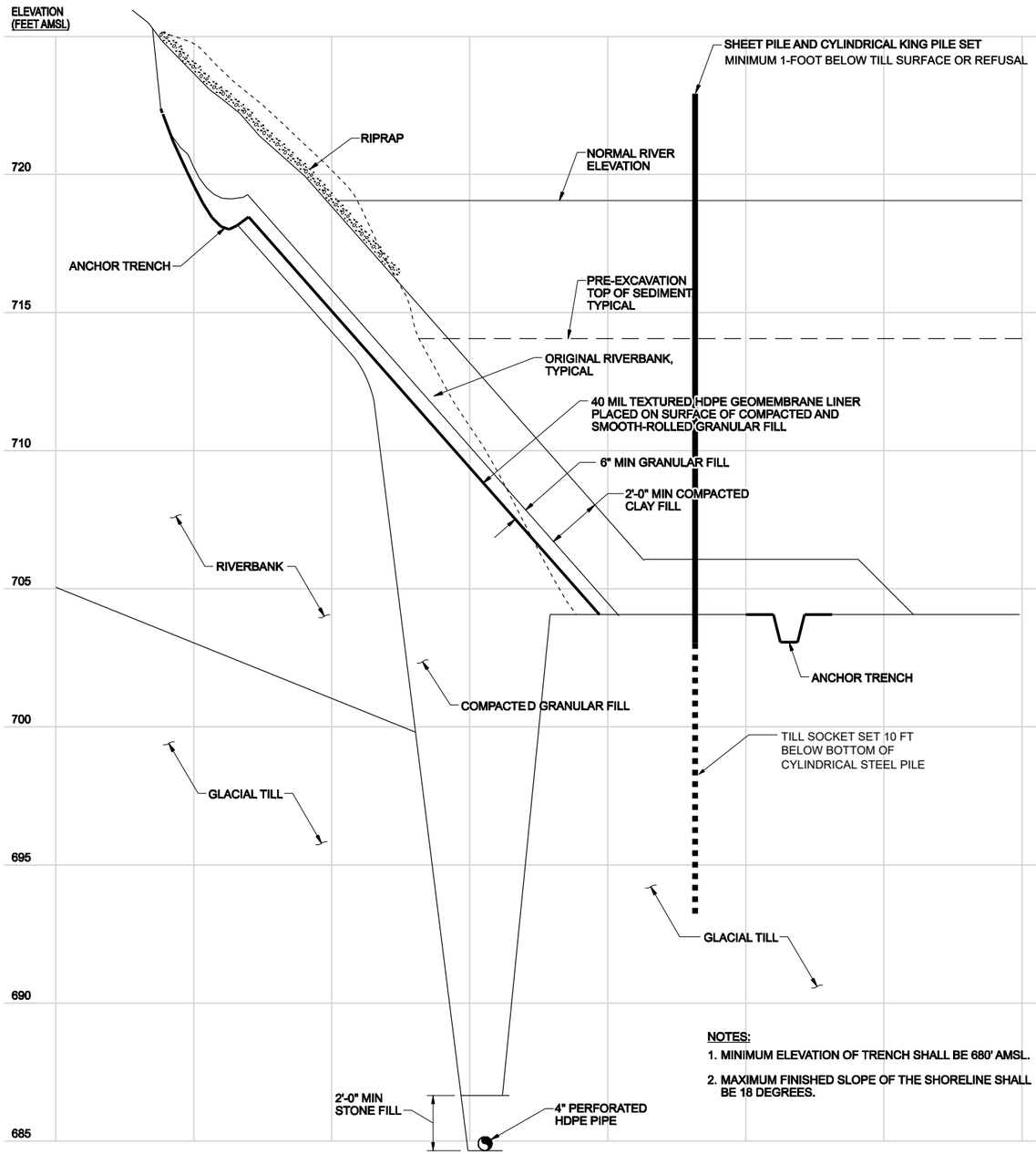
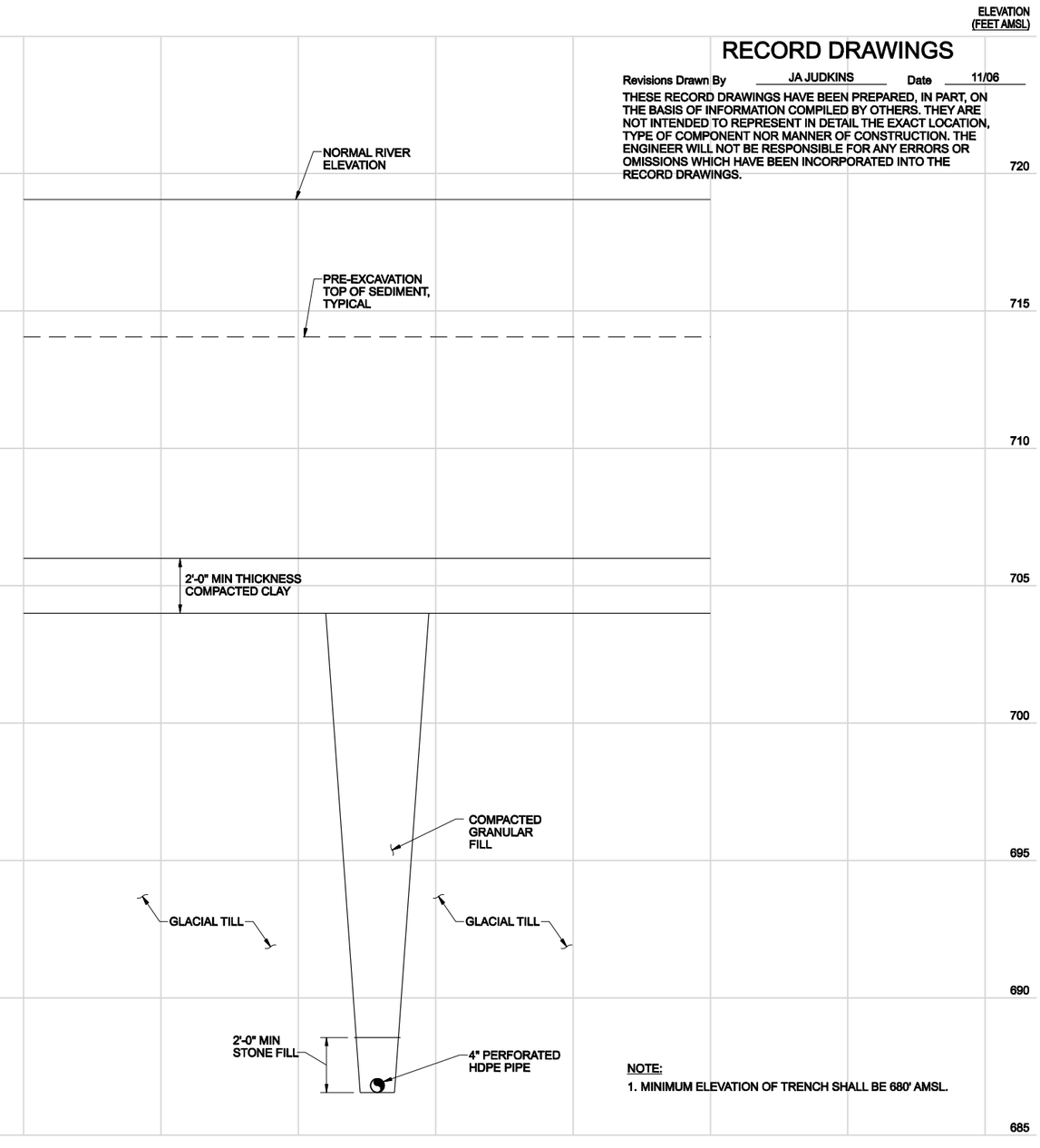


NOTES:

1. MINIMUM ELEVATION OF TRENCH SHALL BE 680' AMSL.
2. MAXIMUM FINISHED SLOPE OF THE SHORELINE SHALL BE 18 DEGREES.

DNAPL COLLECTION TRENCH AND CLAY CAPPING DETAIL

1"=10' HORIZONTAL
1"=2.5' VERTICAL



NOTE:

1. MINIMUM ELEVATION OF TRENCH SHALL BE 680' AMSL.

DNAPL COLLECTION TRENCH LATERAL AND CLAY CAPPING DETAIL

1"=10' HORIZONTAL
1"=2.5' VERTICAL

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

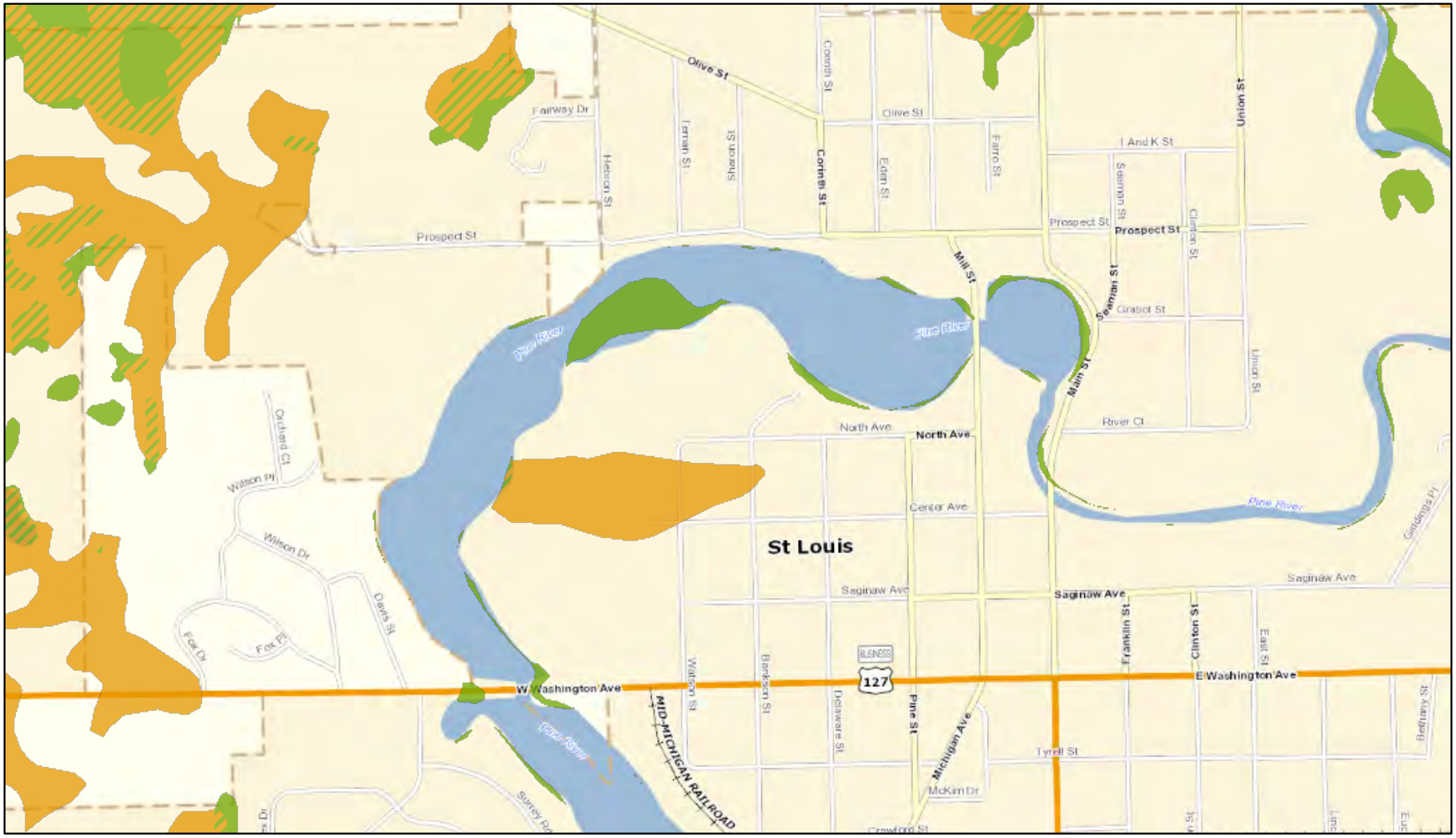
Top of till elevation is based on top of till elevations observed from river borings installed in 2002 during the NAPL Investigation (*NAPL Investigation Summary Report, Velsicol/Pine River Superfund Site, St. Louis, Michigan* [CH2M 2003]), top of till elevations observed during the geotechnical investigation performed in 2022 (*Draft Perimeter Drain and Geotechnical Predesign Investigation Technical Memorandum, Velsicol Chemical Corporation Superfund Site, Remedial Design* [CH2M 2023]), and the 2022 bathymetric survey results (*Hydrographic and Topographic Survey Results Summary, Velsicol Chemical Corporation/Pine River Superfund Site* [CH2M 2022]).

DNAPL/GWCS piping elevations are based on the DNAPL/GWCS as-built drawings (*2005 Sediment Remedial Action Groundwater Recovery System and DNAPL Collection Trench* [CH2M 2005]).

Source: 2005 Sediment Remedial Action Groundwater Recovery System and DNAPL Collection Trench (CH2M 2005)

Figure 3-1
DNAPL Collection Trench, Trench Lateral, and Clay Capping Details
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

ch2m



September 9, 2022

Part 303 Final Wetlands Inventory

- Wetlands as identified on NWI and MIRIS maps
- Soil areas, which include wetland soils
- Wetlands as identified on NWI and MIRIS maps and soil areas, which include wetland soils

1:9,364

0 0.07 0.15 0.3 mi

0 0.13 0.25 0.5 km

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Figure 6-1
Wetland Map as Illustrated on EGLE Wetlands Map Viewer
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Michigan Department of Environment, Great Lakes, and Energy Wetlands Map Viewer, https://www.mcgi.state.mi.us/wetlands/mcgiMap.html#. Accessed September 9, 2022.

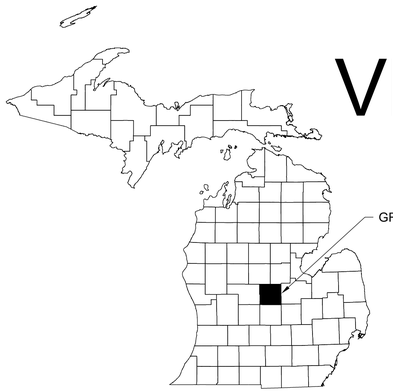
ch2m

Appendix A
Final Design Drawings

DOWNGRADIENT VERTICAL BARRIER WALL
OPERABLE UNIT 1
VELSICOL CHEMICAL SUPERFUND SITE

EPA SUPERFUND SITE
ST. LOUIS, MICHIGAN

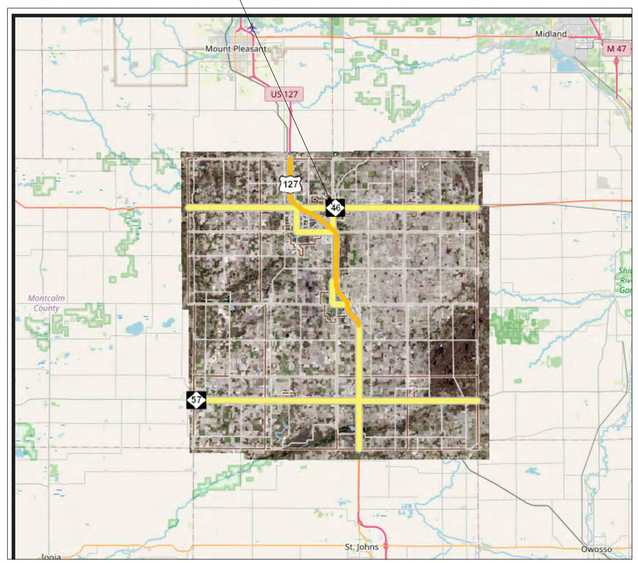
VOLUME II OF II



MICHIGAN
NTS

N

PROJECT LOCATION
CITY OF ST. LOUIS,
GRATIOT COUNTY



SOURCE: DOWNLOADED FROM GRATIOT COUNTY GIS AUTHORITY ON 10/13/2022

VICINITY MAP

N

CH2M INDEX TO DRAWINGS

SHEET NO.	DRAWING NO.	DESCRIPTION
GENERAL		
1	G-001	TITLE SHEET / VICINITY AND LOCATION MAPS / INDEX TO DRAWINGS
2	G-002	ABBREVIATIONS AND DESIGNATIONS LEGENDS
3	G-003	GENERAL SITE NOTES AND CIVIL LEGEND
CIVIL		
4	C-201	EXISTING CONDITIONS PLAN - NORTH
5	C-202	EXISTING CONDITIONS PLAN - SOUTH
6	C-203	SITE IMPROVEMENTS PLAN
7	C-204	SITE GRADING PLAN - NORTH
8	C-205	SITE GRADING PLAN - SOUTH
9	C-206	SITE RESTORATION PLAN
STRUCTURAL		
10	S-001	STRUCTURAL NOTES
11	S-201	VERTICAL BARRIER WALL PLAN AND PROFILE STA 0+00 TO STA 21+00
12	S-202	VERTICAL BARRIER WALL PLAN AND PROFILE STA 21+00 TO END
13	S-301	CROSS SECTIONS & DETAILS - 1 OF 5
14	S-302	CROSS SECTIONS & DETAILS - 2 OF 5
15	S-303	CROSS SECTIONS & DETAILS - 3 OF 5
16	S-304	CROSS SECTIONS & DETAILS - 4 OF 5
17	S-305	CROSS SECTIONS & DETAILS - 5 OF 5
DETAILS		
18	C-501	CIVIL DETAILS
19	S-501	STRUCTURAL DETAILS

PROJECT LOCATION
324 NORTH STREET
ST. LOUIS, MICHIGAN
48880

LOCATION MAP

N

STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD

DSGN R VAUGHAN | DR N LINDHOLM | CHK W ANDRAE | APVD J COLE

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

GENERAL
TITLE SHEET, VICINITY / LOCATION MAPS, AND INDEX TO DRAWINGS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	G-001
SHEET	1 of 19

FINAL DESIGN

ABBREVIATIONS

@	AT
ABDN	ABANDONED
ADDL	ADDITIONAL
ADJ	ADJACENT
AHR	ANCHOR
AL	ALUMINUM
ALTN	ALTERNATE
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
ARV	AIR RELEASE VALVE
AVG	AVERAGE
BETW	BETWEEN
BF	BOTTOM FACE
BGS	BELOW GROUND SURFACE
BLDG	BUILDING
BODR	BASIS OF DESIGN REPORT
BOT	BOTTOM
BRG	BEARING
BV	BUTTERFLY VALVE
C TO C	CENTER TO CENTER
CARV	COMBINATION AIR RELEASE VALVE
CHEM	CHEMICAL
CHK	CHECKED
CI	CAST IRON
CJ	CONSTRUCTION JOINT
CL	CENTER LINE
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT
CONC	CONCRETE
CONN	CONNECT / CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUED
COR	CORNER
CP	CONCRETE PIPE
CTR	CENTER
CU FT	CUBIC FEET
CU YD	CUBIC YARDS
DBCP	1,2-DIBROMO-3-CHLOROPROPANE
DBL	DOUBLE
DECON	DECONTAMINATION
DEG / °	DEGREE
DEMO	DEMOLISH / DEMOLITION
DET	DETAIL
DGVBW	DOWNGRADIENT VERTICAL BARRIER WALL
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DN	DOWN
DNAPL/GWCS	DENSE NONAQUEOUS PHASE LIQUID/ GROUNDWATER COLLECTION SYSTEM
DP	DISTRIBUTION PANEL
DSGN	DESIGNED
DWG	DRAWING
E	EAST
EA	EACH
EF	EACH FACE
EL	ELEVATION
ELB	ELBOW
ELEC	ELECTRICAL
EQL	EQUAL
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
EW	EACH WAY
EXST	EXISTING
EXT	EXTERNAL OR EXTERIOR
FACIL	FACILITY
FC	FIELD CLOSURE
FDN	FOUNDATION
FED	FEDERAL
FLEX	FLEXIBLE
FLGD	FLANGED
FLR	FLOOR
FNSH	FINISH
FT	FOOT / FEET
G	GAS
GAC	GRANULAR ACTIVATED CARBON
GAL	GALLON
GPD	GALLONS PER DAY
GV	GATE VALVE
GVL	GRAVEL
GW	GROUNDWATER
GWECT	GROUNDWATER ELEVATION CONTROL TILE
H OR HGT	HEIGHT
HDPE	HIGH DENSITY POLYETHYLINE
HORIZ	HORIZONTAL
HPT	HIGH POINT ELEVATION
HR	HOUR
HWL	HIGH WATER LEVEL
ID	INSIDE DIAMETER OR IDENTIFICATION
IE	INVERT ELEVATION
IN	INCHES
INSTL	INSTALL
INVT	INVERT
ISTT	IN SITU THERMAL TREATMENT
JT	JOINT
LB	POUND(S)
LF	LINEAR FEET
LG	LONG
LLDPE	LINEAR LOW DENSITY POLYETHYLENE
MATL	MATERIAL
MAX	MAXIMUM
MDOT	MICHIGAN DEPARTMENT OF TRANSPORTATION
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MG/L	MILLIGRAMS PER LITER
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MLC	MINI LOAD CENTER
MM	MILLIMETER
MON	MONUMENT
MTL	METAL
MTRG	METERING
N	NORTH
N.C.	NORMALLY CLOSED
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO.	NUMBER
NOM	NOMINAL
NORM	NORMAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OHWM	ORDINARY HIGH WATER MARK
OPNG	OPENING
OPP	OPPOSITE
PC	POINT OF CURVATURE
PERM	PERMANENT
PF	PROFILE
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
POC	POINT ON CURVE
POT	POINT ON TANGENT
PR	PAIR
PROJ	PROJECT
PROP	PROPERTY
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT OF TANGENCY
PVC	POINT OF VERTICAL CURVATURE OR POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QDRNT	QUADRANT
QTY	QUANTITY
QUAL	QUALITY
R	RISER
RAD	RADIUS
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RECP	ROLLED EROSION CONTROL PRODUCT
REINF	REINFORCE
RELOC	RELOCATED
REQD	REQUIRED
RMV	REMOVE
RR	RAILROAD
R&R	REMOVE AND REPLACE
R/W	RIGHT-OF-WAY
S	SOUTH
SCHED	SCHEDULE
SD	STORM DRAIN
SDR	STANDARD DIMENSION RATIO
SECT	SECTION
SF	SQUARE FEET
SH	SHEET
SIM	SIMILAR
SPECD	SPECIFIED
SPECS	SPECIFICATIONS
SPG	SPACING
SQ	SQUARE
ST	STREET
STA	STATION
STD	STANDARD
STL	STEEL
STOR	STORAGE
STR	STRAIGHT
STRUCT	STRUCTURE
SWD	SURFACE WATER DITCH
SYMM	SYMMETRICAL
TAN	TANGENT LENGTH
T&B	TOP AND BOTTOM
TC	TOP OF CONCRETE
THK	THICK
T.O.	TOP OF
TPD	TONS PER DAY
TRANSV	TRANSVERSE
TW	TOP OF WALL
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
V	VALVE
V.C.	VERTICAL CURVE
VB	VALVE BOX
VERT	VERTICAL
W	WEST OR WATER
W/	WITH
WL	WATER LINE
WS	WATER SURFACE
YR	YEAR

FILE NAMING CONVENTION

DRAWING NUMBER:

C - 2

DRAWING NUMBER

DISCIPLINE DESIGNATOR

DISCIPLINE LETTERS:

C	CIVIL
G	GENERAL
E	ELECTRICAL
S	STRUCTURAL

SECTION / DETAIL DESIGNATIONS

1 / C-2 — SHEET/DRAWING NUMBER WHERE SHOWN — ON DRAWING WHERE SECTION OR DETAIL IS TAKEN

B — SECTION — SCALE — ON DRAWING WHERE SECTION IS SHOWN

2 — DETAIL — SCALE — ON DRAWING WHERE DETAIL IS SHOWN

DRAWING TITLE — SCALE — ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)

B — SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

B / C-2 — SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

DESIGN DETAIL DESIGNATION

DESIGN DETAIL DESIGNATION (NUMERAL) — 1234-567

SHOWN ON DESIGN DETAIL DRAWING(S)

NOTES:

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3. THE DESIGN DETAILS REPRESENT THE CHARACTER AND NATURE OF THE WORK REQUIRED THROUGHOUT THE PROJECT. ALL ASSOCIATED WORK SHALL BE IN ACCORDANCE WITH THE DESIGN DETAILS SHOWN WHETHER THE DETAILS ARE SPECIFICALLY REFERENCED OR NOT.

MISCELLANEOUS SYMBOL DESIGNATIONS

1 — SHEET KEYNOTE

1 — REVISION NUMBER

N — NORTH ARROW

GENERAL NOTE:

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STATE OF MICHIGAN — JASON D COLE — ENGINEER — No. 6201063070 — LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD

DSGN R VAUGHAN | DR N LINDHOLM | CHK W ANDRAE | APVD J COLE

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

GENERAL

ABBREVIATIONS AND DESIGNATIONS LEGENDS

NTS

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	G-002
SHEET	2 of 19

FINAL DESIGN

GENERAL SITE NOTES:

1. SEAWORKS PERFORMED A HYDROGRAPHIC INVESTIGATION ALONG AND WITHIN THE PINE RIVER FROM THE WASHINGTON AVE. (M-46) OVERPASS TO THE N. MILL ST. BRIDGE FROM APRIL 4TH-9TH, 2022. TOPOGRAPHIC RIVERBANK, MULTIBEAM HYDROGRAPHIC RIVER DEPTH, SIDE-SCAN SONAR, AND MAGNETOMETER SURVEYS WERE PERFORMED.
2. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS FOR THE UPLAND MAIN PLANT SITE ARE BASE MAPS PROVIDED BY CITRIGEN, 2012 AND SPICER GROUP, 2015 AND 2017.
3. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. THE RA CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
4. SITE CONTROL:

ID:	EASTING:	NORTHING:	ELEVATION:
CP105004	13056697.64	695762.95	744.53
CP105005	13056900.74	696213.04	736.11

5. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED.
6. HORIZONTAL DATUM: MICHIGAN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE (2113), 1983 NORTH AMERICAN DATUM (NAD83), INTERNATIONAL FEET.
7. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM (NAVD88) GEOID12A, INTERNATIONAL FEET.
8. 100 YEAR FLOODPLAIN LIMITS WERE OBTAINED FROM THE FEMA NATIONAL FLOOD INSURANCE PROGRAM MAP (NO. 26057C0061C), PANEL 61 OF 500, GRATIOT COUNTY, MI, OCTOBER 18, 2011.
9. CRA GROUNDWATER ELEVATION CONTROL TILE MANHOLE, MANHOLE SUMPS, GRANULAR SUMPS, AND PIPING LOCATIONS ARE ALL APPROXIMATE. LOCATIONS ARE BASED ON SECUREMENT OF PLANT SITE, ST. LOUIS, MICHIGAN AS-BUILTS (CRA 1984)
10. RA CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION. EROSION CONTROL DEVICE (3125-165) IS THE MINIMUM REQUIRED.
11. RA CONTRACTOR SHALL TAKE MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE.

GENERAL YARD PIPING AND UTILITIES NOTES:

1. PROTECT EXISTING UTILITIES AND OTHER SITE FEATURES DURING CONSTRUCTION.
2. EXISTING PIPING AND EQUIPMENT ARE SHOWN SCREENED AND/OR LIGHT-LINED.
3. FOR SURFACE RESTORATION INCLUDING GRAVEL ROADS, SEE CIVIL DETAIL DRAWINGS.
4. EXISTING POTABLE WATER CONNECTION MAY BE AVAILABLE FOR USE BY RA CONTRACTOR. COORDINATE WITH ISTT CONTRACTOR AND CITY OF ST. LOUIS PRIOR TO USE.

FIELD OFFICE NOTES:

1. RA CONTRACTOR TO PROVIDE FIELD OFFICE TRAILER AND TEMPORARY UTILITIES FOR OWN USE.
2. PROVIDE SANITARY FACILITIES INCLUDING HAND WASHING STATION IN COMPLIANCE WITH STATE AND LOCAL HEALTH AUTHORITIES.

CONSTRUCTION SEQUENCE:

1. WORK PREPARATION
   - A. EQUIPMENT AND CREW MOBILIZATION
   - B. ESTABLISH SITE ACCESS
   - C. ESTABLISH HEALTH AND SAFETY INFRASTRUCTURE
   - D. ESTABLISH TEMPORARY FACILITIES AND CONTROLS
   - E. ESTABLISH MONITORING FOR VIBRATION AND IN-WATER TURBIDITY MEASUREMENTS
   - F. ESTABLISH STOCKPILE AREA(S)
   - G. ESTABLISH DEWATERING SYSTEM
   - H. ESTABLISH SITE SURVEY CONTROL AND PERFORM LAYOUT
   - I. OFF-SITE MATERIAL FABRICATION AND TESTING
   - J. BORROW SOURCE MATERIAL TESTING
2. DGVBW
   - A. INSTALL TURBIDITY CURTAIN IN THE PINE RIVER SURROUNDING THE WORK AREA
   - B. ALIGNMENT PREPARATION AND OBSTRUCTION REMOVAL
   - C. MATERIAL SHIPPING AND DELIVERY
   - D. INSTALL COMBINATION WALL
     - a. STAGE 1
       - i. DRIVE SHEET PILES AND CYLINDRICAL PILES IN SUCCESSIVE ORDER. SEALANT SHALL BE PRESENT IN INTERLOCKS AT TIME OF INSTALLATION. ELEVATIONS ARE APPROXIMATELY ONE FOOT INTO TILL. SHEET PILES AND CYLINDERICAL PILES CAN BE TERMINATED ONE FOOT INTO TILL, OR REFUSAL.
       - ii. DRILL A SOCKET INTO THE TILL THAT EXTENDS 10 FEET BELOW THE BOTTOM OF THE CYLINDRICAL PILE WITH NOMINAL DIAMETER NOT LESS THAN 5 INCHES LESS THAN THE INSIDE DIAMETER OF THE CYLINDRICAL PILE
       - iii. CLEAN OUT INSIDE OF CYLINDRICAL PILE OF SOIL AND DEBRIS WITH WIRE BRUSH ATTACHMENT OR EQUIVALENT. REMOVE ALL ACCUMULATED MATERIAL AT BOTTOM OF HOLE.
       - iv. PLACE REINFORCEMENT CAGE IN CLEANED OUT HOLE.
       - v. FILL SOCKET AND INSIDE OF CYLINDRICAL PILE WITH CONCRETE USING TREMIE METHODS.
       - vi. ALLOW FOR CONCRETE TO ATTAIN 100 PERCENT OF 28-DAY COMPRESSIVE STRENGTH.
     - b. STAGE 2
       - i. BACKFILL AREA BEHIND WALL WITH MATERIAL AS PER SPECIFICATION
       - ii. GRADE PROPOSED STORMWATER DITCHES AS PER STORMWATER DETAILS AND SPECIFICATIONS.
       - iii. COMPACT FILL VOLUME AS PER SPECIFICATION
       - iv. INSTALL COVER PLATE ON WALL
       - V. INSTALL RIP RAP TOE ON EXTERIOR OF WALL
     - c. STAGE 3 (FUTURE WORK BY OTHERS)
       - i. INSTALL ENGINEERED CAP

CIVIL LEGEND

EXISTING	THIS SUBCONTRACT	
× 757.7	⊗ 758.5	SPOT ELEVATION
745	745	CONTOUR LINE
	3:1	EMBANKMENT AND SLOPE
CB OR CB	CB OR CB	CATCH BASIN OR INLET
		TRENCH DRAIN
	OR	SIGN
D OR S	D OR S	MANHOLE
E	E	ELECTRICAL MANHOLE
H	H	ELECTRIC HANDHOLE
J	J	ELECTRIC JUNCTION BOX
		POST OR GUARD POST
		GUY ANCHOR
		FIRE HYDRANT
		GATE VALVE
		AIR RELIEF VALVE
		UTILITY POLE
		LIGHT POLE
BM		BENCH MARK
		SURVEY CONTROL POINT OR POINT OF INTERSECTION
		BRUSH/TREE LINE
		TREE
EL	EL	PROPERTY EASEMENT LINE
		CENTER LINE, BUILDING, ROAD, ETC.
		STAGING OR WORK AREA LIMITS
		AREA TO BE EXCAVATED
		AREA TO BE FILLED
OR	OR	DEMOLITION
OR	OR	STRUCTURE, BUILDING OR FACILITY
		GRAVEL SURFACING
		ASPHALT CONCRETE PAVEMENT
		SINGLE SWING GATE
		DOUBLE SWING GATE
X	X	CHAIN LINK FENCE AND PROPERTY LINE
		CULVERT
SD	SD	STORM SEWER
SS	SS	SANITARY SEWER
G	G	NATURAL GAS
W	W	WATER LINE
E-OVH	E-OVH	ABOVE GROUND ELECTRIC
E	E	UNDERGROUND ELECTRIC
W	W	UNDERGROUND WATER
C	C	ABOVE GROUND COMMUNICATION / INTERNET
CBR #		SOIL BORINGS
CMW MPZ CATW WMW GMW		WELL LOCATION AND NUMBER: CH2M MONITORING WELL MONITORING PIEZOMETER CH2M AQUIFER TEST WELL WESTON MONITORING WELL GROUNDWATER MONITORING WELL

EROSION CONTROL LEGEND

COVER PRACTICES	SYMBOL
TEMPORARY SEEDING	TS
MULCHING AND MATTING	MU
CLEAR PLASTIC COVERING	CPC
BUFFER ZONES	BZ
PERMANENT SEEDING AND PLANTING	PS
CONSTRUCTION ENTRANCE	
INTERCEPTOR DIKE	ID
INTERCEPTOR SWALE	IS
CHECK DAMS	
OUTLET PROTECTION / RIPRAP	
FILTER FENCE	
STRAW BALE BARRIER (BIOFILTER)	
SEDIMENT TRAP (OR SUMP)	
SEDIMENT POND OR BASIN	

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER
*****

NO.	DATE	REVISION	BY	APVD

DSGN R VAUGHAN | DR N LINDHOLM | CHK W ANDRAE | APVD J COLE

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

GENERAL
GENERAL SITE NOTES AND CIVIL LEGEND

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	G-003
SHEET	3 of 19

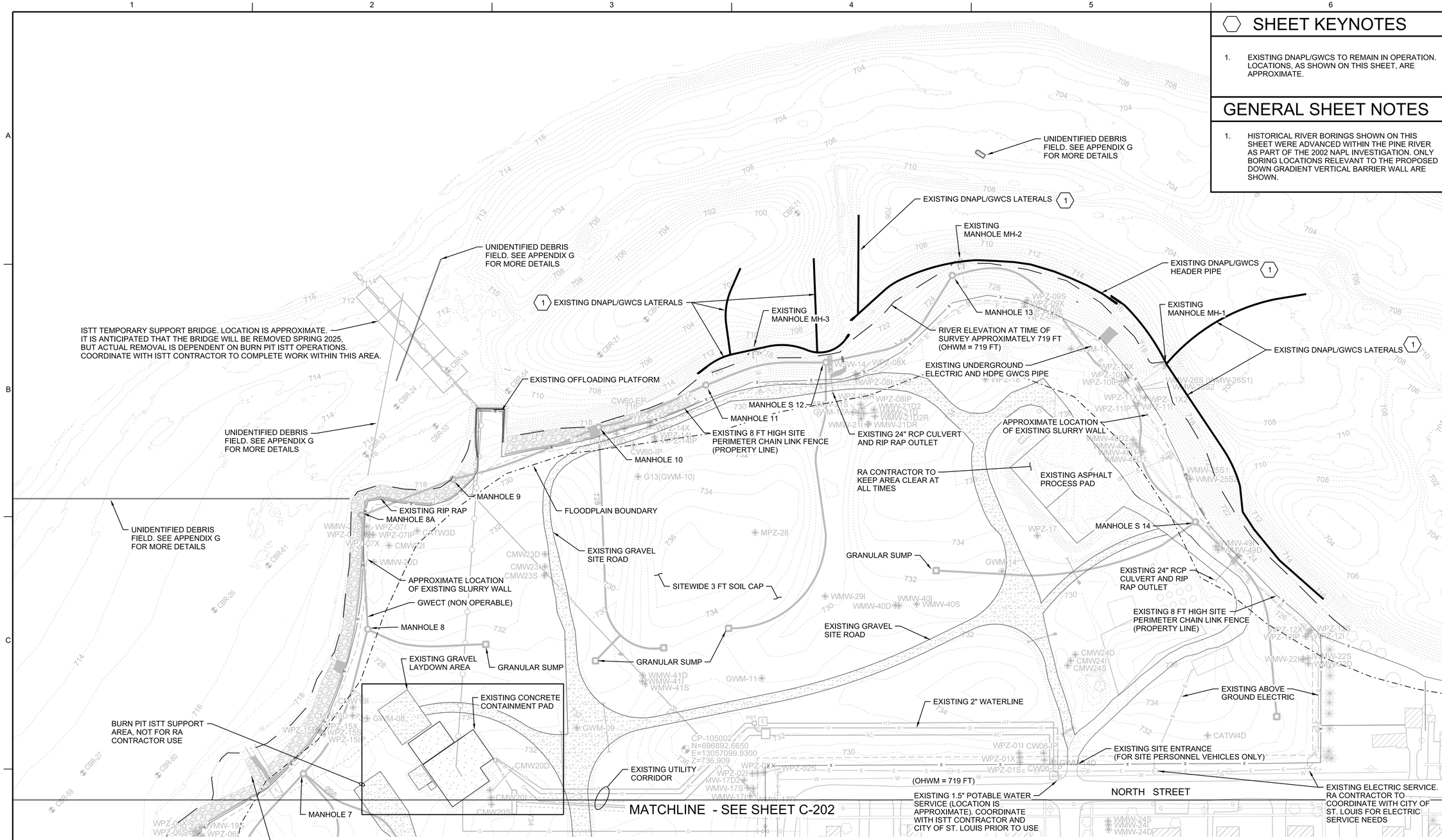
FINAL DESIGN

SHEET KEYNOTES

1. EXISTING DNAPL/GWCS TO REMAIN IN OPERATION. LOCATIONS, AS SHOWN ON THIS SHEET, ARE APPROXIMATE.

GENERAL SHEET NOTES

1. HISTORICAL RIVER BORINGS SHOWN ON THIS SHEET WERE ADVANCED WITHIN THE PINE RIVER AS PART OF THE 2002 NAPL INVESTIGATION. ONLY BORING LOCATIONS RELEVANT TO THE PROPOSED DOWN GRADIENT VERTICAL BARRIER WALL ARE SHOWN.



STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

CIVIL
EXISTING CONDITIONS PLAN - NORTH

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

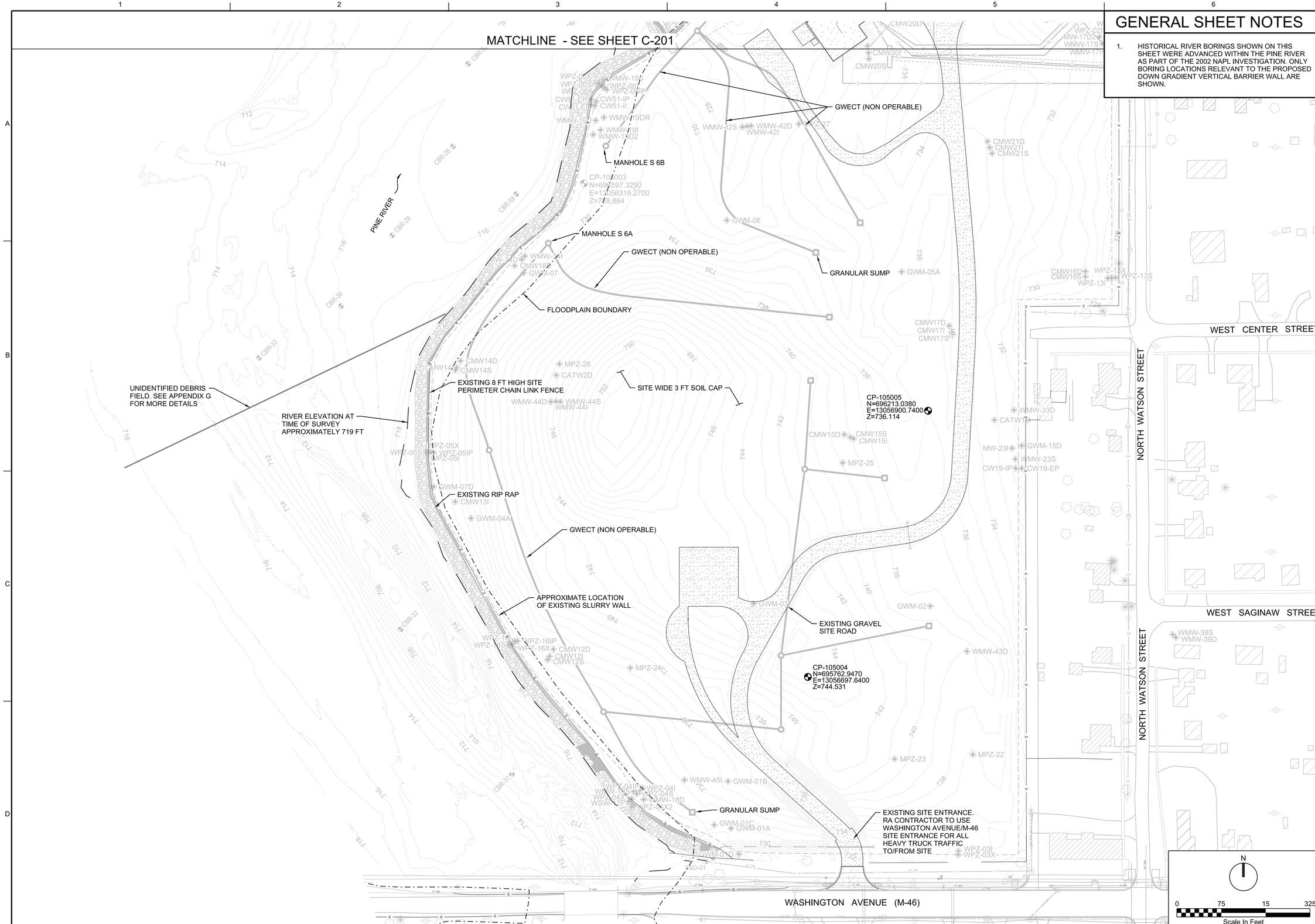
DATE	SEP 2023
PROJ	D3542500
DWG	C-201
SHEET	4 of 19

FINAL DESIGN

FILENAME: 005-C-201_D3542500.dgn PLOT DATE: 9/29/2023 PLOT TIME: 7:50:48 AM

GENERAL SHEET NOTES

1. HISTORICAL RIVER BORINGS SHOWN ON THIS SHEET WERE ADVANCED WITHIN THE PINE RIVER AS PART OF THE 2002 NAPL INVESTIGATION. ONLY BORING LOCATIONS RELEVANT TO THE PROPOSED DOWN GRADIENT VERTICAL BARRIER WALL ARE SHOWN.



STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD

DR: R VAUGHAN | CHK: N LINDHOLM | APVD: W ANDRAE | BY: J COLE

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

CIVIL
EXISTING CONDITIONS PLAN - SOUTH

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-202
SHEET	5 of 19

FINAL DESIGN

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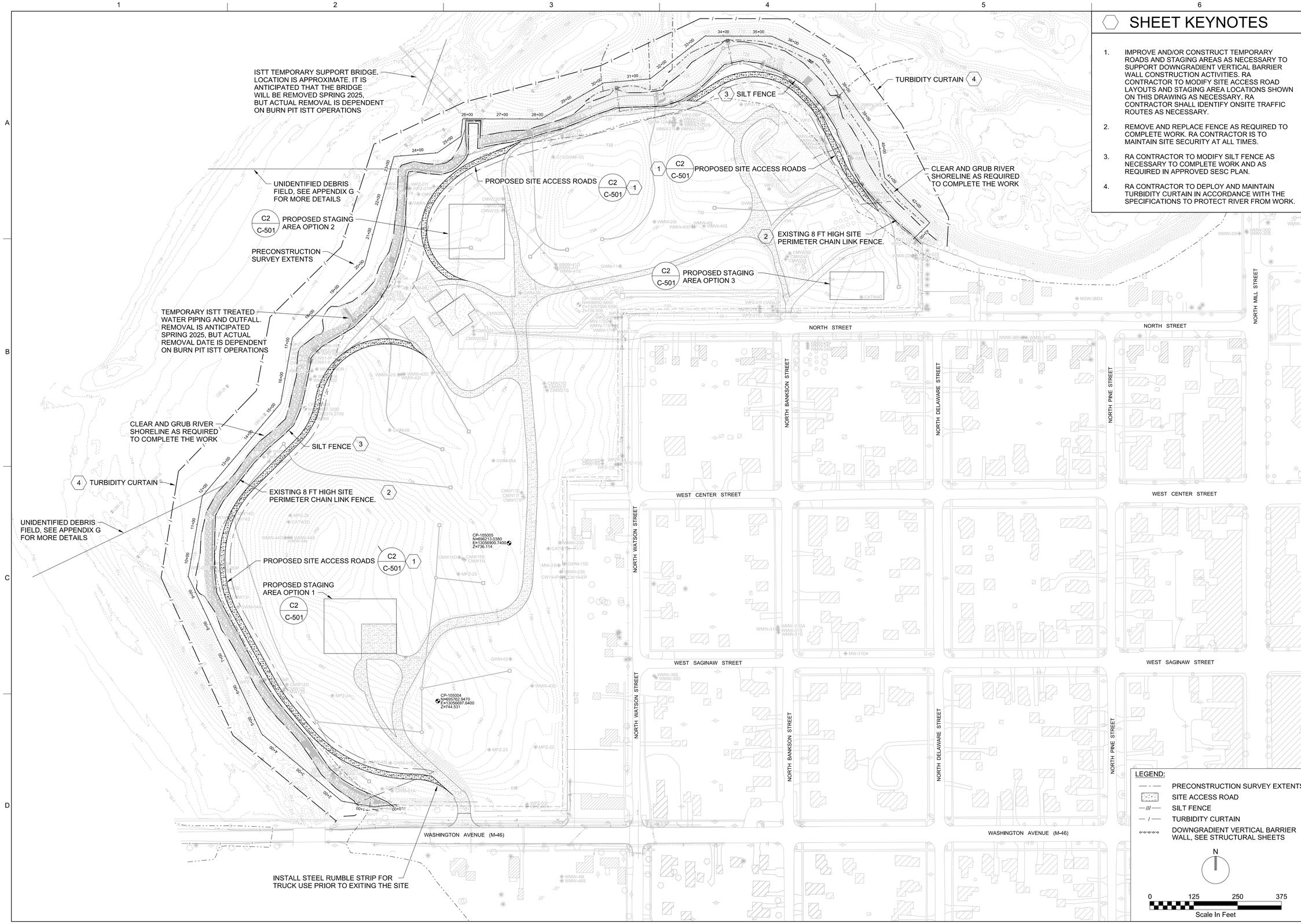

SHEET KEYNOTES

1. IMPROVE AND/OR CONSTRUCT TEMPORARY ROADS AND STAGING AREAS AS NECESSARY TO SUPPORT DOWNGRADIENT VERTICAL BARRIER WALL CONSTRUCTION ACTIVITIES. RA CONTRACTOR TO MODIFY SITE ACCESS ROAD LAYOUTS AND STAGING AREA LOCATIONS SHOWN ON THIS DRAWING AS NECESSARY. RA CONTRACTOR SHALL IDENTIFY ONSITE TRAFFIC ROUTES AS NECESSARY.
2. REMOVE AND REPLACE FENCE AS REQUIRED TO COMPLETE WORK. RA CONTRACTOR IS TO MAINTAIN SITE SECURITY AT ALL TIMES.
3. RA CONTRACTOR TO MODIFY SILT FENCE AS NECESSARY TO COMPLETE WORK AND AS REQUIRED IN APPROVED SESC PLAN.
4. RA CONTRACTOR TO DEPLOY AND MAINTAIN TURBIDITY CURTAIN IN ACCORDANCE WITH THE SPECIFICATIONS TO PROTECT RIVER FROM WORK.

LEGEND:

- PRECONSTRUCTION SURVEY EXTENTS
- SITE ACCESS ROAD
- SILT FENCE
- TURBIDITY CURTAIN
- DOWNGRADIENT VERTICAL BARRIER WALL, SEE STRUCTURAL SHEETS

N

0 125 250 375
Scale In Feet

STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER
*****

NO.	DATE	REVISION	BY	APVD

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
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ch2m

CIVIL

SITE IMPROVEMENTS PLAN

1"=100'

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-203
SHEET	6 of 19

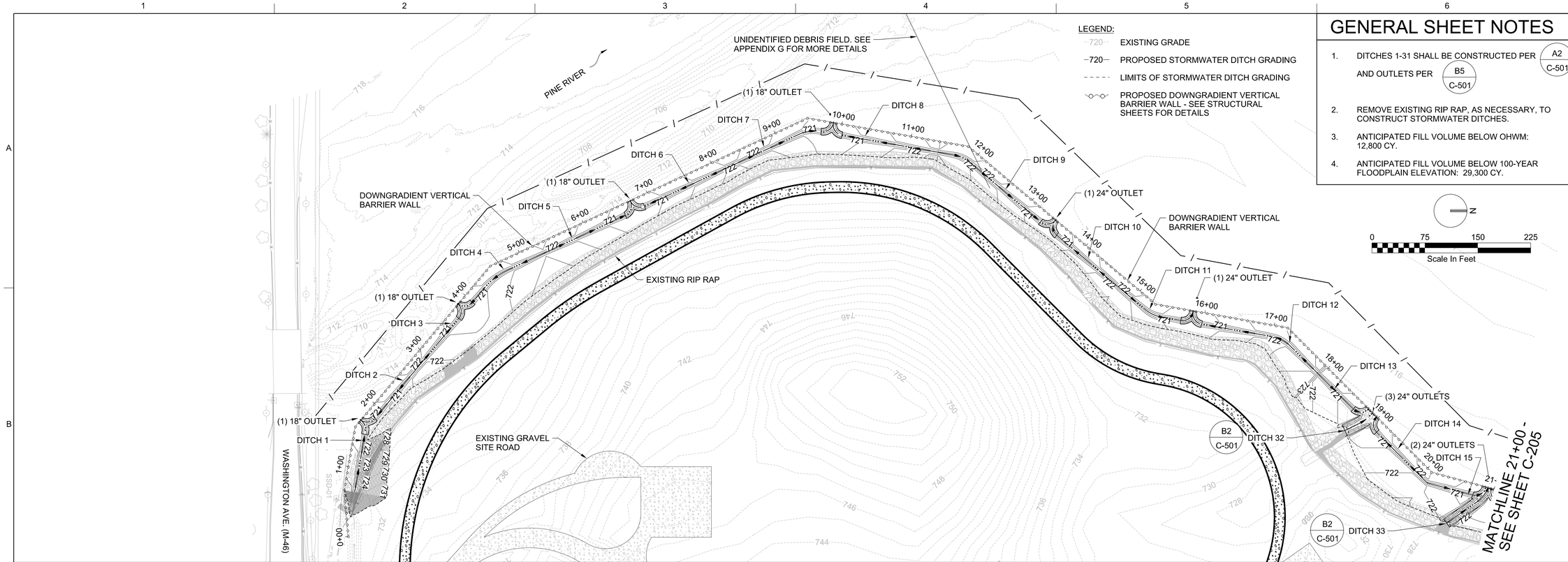
FINAL DESIGN

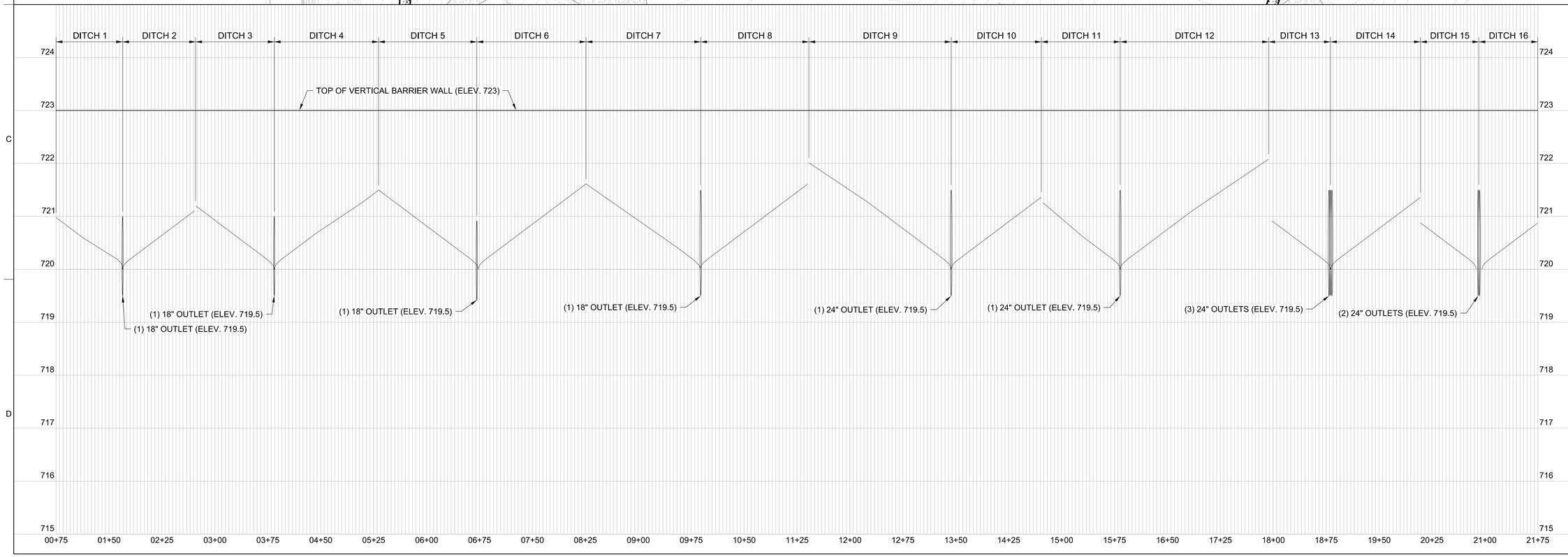
GENERAL SHEET NOTES

1. DITCHES 1-31 SHALL BE CONSTRUCTED PER A2 / C-501 AND OUTLETS PER B5 / C-501
2. REMOVE EXISTING RIP RAP, AS NECESSARY, TO CONSTRUCT STORMWATER DITCHES.
3. ANTICIPATED FILL VOLUME BELOW OHWM: 12,800 CY.
4. ANTICIPATED FILL VOLUME BELOW 100-YEAR FLOODPLAIN ELEVATION: 29,300 CY.

LEGEND:

- 720 EXISTING GRADE
- 720 PROPOSED STORMWATER DITCH GRADING
- LIMITS OF STORMWATER DITCH GRADING
- PROPOSED DOWNGRADIENT VERTICAL BARRIER WALL - SEE STRUCTURAL SHEETS FOR DETAILS





STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD
1	2/10/2025	PROFILE STATIONING	NL	JC

DSGN R VAUGHAN | DR N LINDHOLM | CHK W ANDRAE | APVD J COLE

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

CIVIL

SITE GRADING PLAN
STA 0+00 TO STA 21+00

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-204
SHEET	7 of 19

FINAL DESIGN

FILENAME: 005-C-204_D3542500.dgn PLOT DATE: 02\10\2025 PLOT TIME: 10:12:03 AM

SHEET KEYNOTES

1. ADD RISERS TO EXISTING MANHOLES SO THAT THE TOP OF THE MANHOLES IS ABOVE FINAL GRADE AND ACCESS IS MAINTAINED.

GENERAL SHEET NOTES

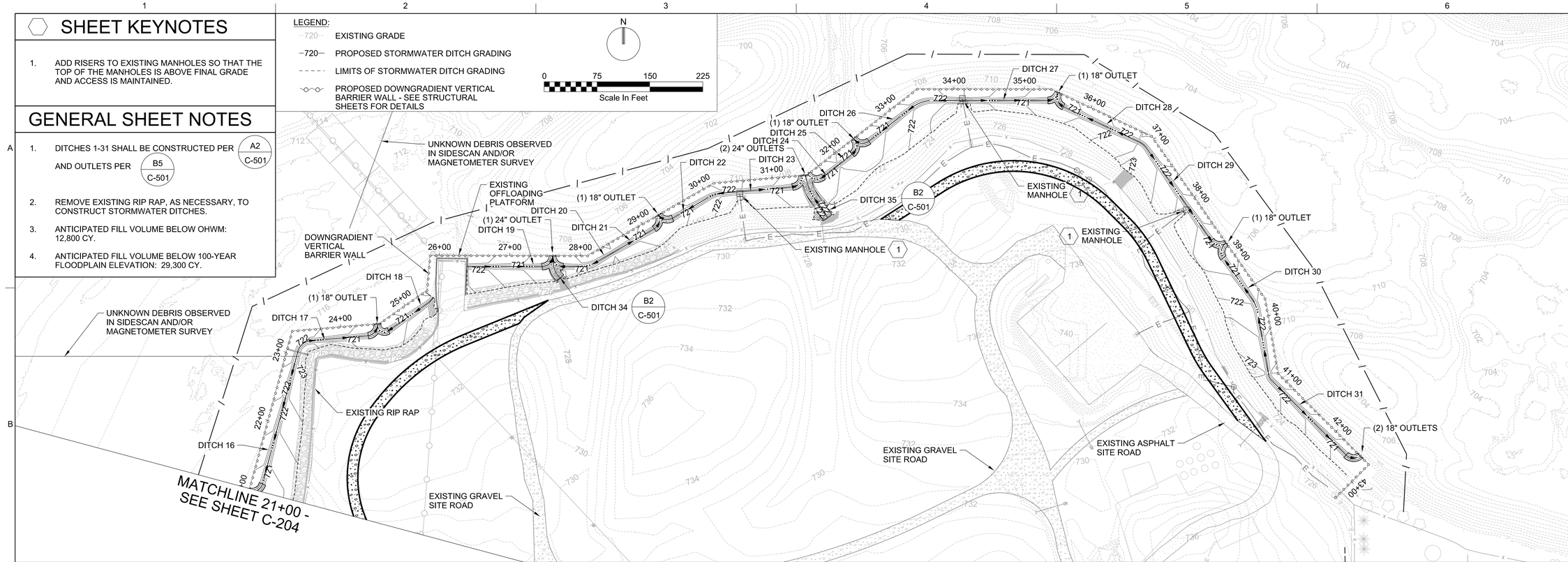
1. DITCHES 1-31 SHALL BE CONSTRUCTED PER A2 / C-501 AND OUTLETS PER B5 / C-501
2. REMOVE EXISTING RIP RAP, AS NECESSARY, TO CONSTRUCT STORMWATER DITCHES.
3. ANTICIPATED FILL VOLUME BELOW OHWM: 12,800 CY.
4. ANTICIPATED FILL VOLUME BELOW 100-YEAR FLOODPLAIN ELEVATION: 29,300 CY.

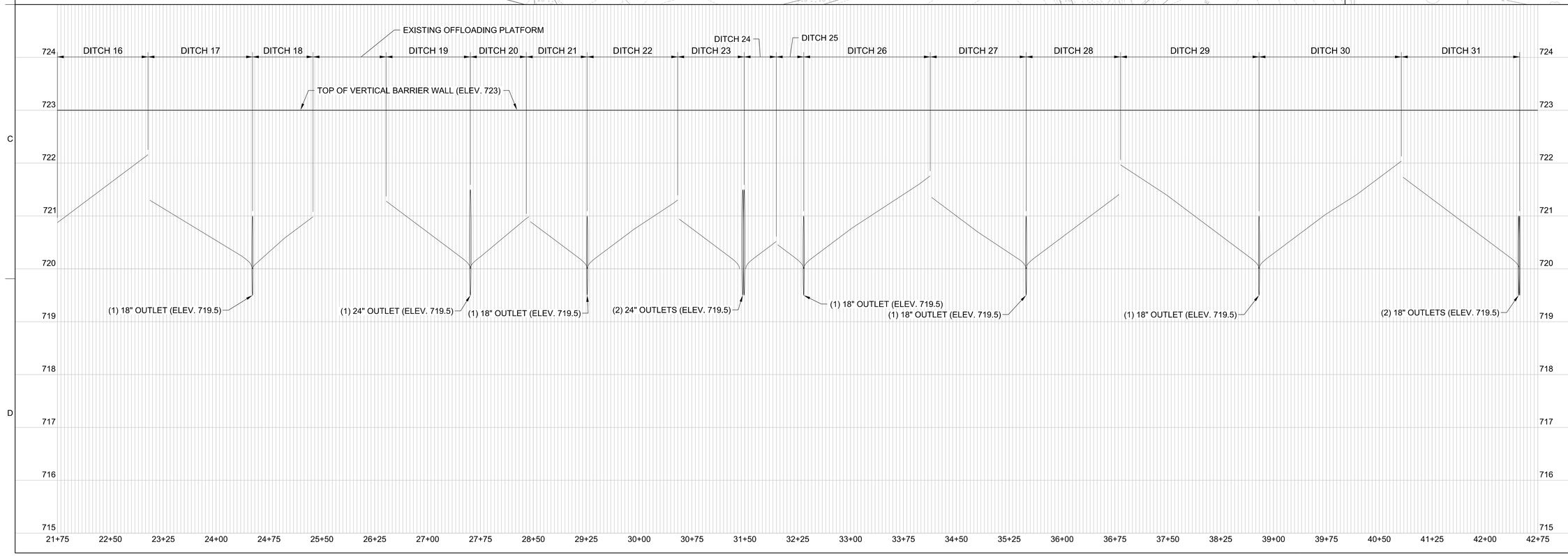
LEGEND:

- 720 EXISTING GRADE
- 720 PROPOSED STORMWATER DITCH GRADING
- LIMITS OF STORMWATER DITCH GRADING
- PROPOSED DOWNGRADIENT VERTICAL BARRIER WALL - SEE STRUCTURAL SHEETS FOR DETAILS

N

0 75 150 225
Scale In Feet





STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	APVD
1	2/10/2025	PROFILE STATIONING	NL	JC

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

CIVIL

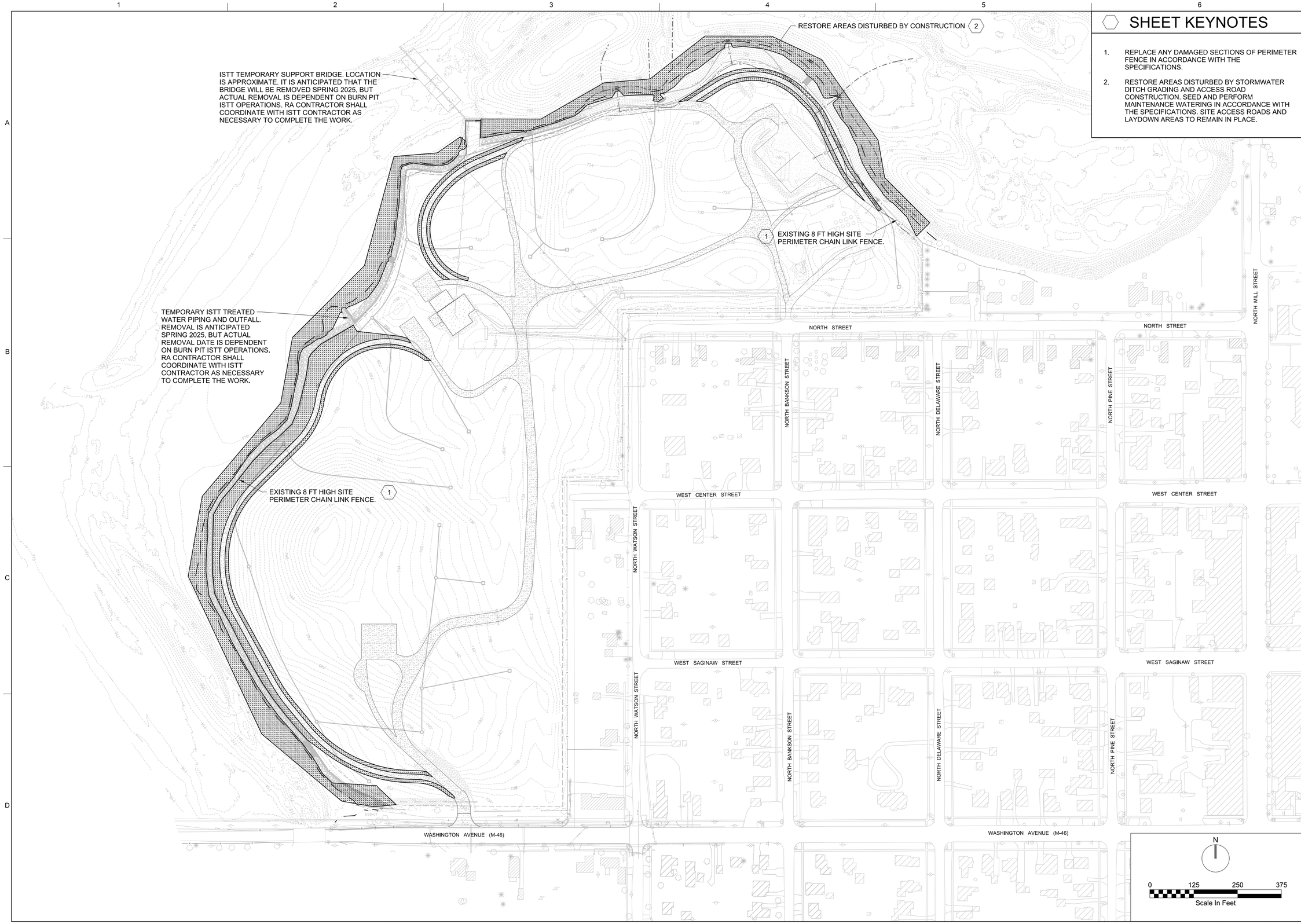
SITE GRADING PLAN
STA 21+00 TO STA END

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-205
SHEET	8 of 19

FINAL DESIGN

FILENAME: 005-C-205_D3542500.dgn PLOT DATE: 02\10\2025 PLOT TIME: 10:22:13 AM



SHEET KEYNOTES

1. REPLACE ANY DAMAGED SECTIONS OF PERIMETER FENCE IN ACCORDANCE WITH THE SPECIFICATIONS.
2. RESTORE AREAS DISTURBED BY STORMWATER DITCH GRADING AND ACCESS ROAD CONSTRUCTION. SEED AND PERFORM MAINTENANCE WATERING IN ACCORDANCE WITH THE SPECIFICATIONS. SITE ACCESS ROADS AND LAYDOWN AREAS TO REMAIN IN PLACE.

STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER
*****

NO.	DATE	REVISION	BY	APVD

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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CIVIL

SITE RESTORATION PLAN

1"=100'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-206
SHEET	9 of 19

FINAL DESIGN

GENERAL STRUCTURAL NOTES:

1. USE STRUCTURAL DRAWINGS (S-SERIES) IN CONJUNCTION WITH CIVIL DRAWINGS (C-SERIES) AND IN CONJUNCTION WITH ALL NOTES WITHIN THESE DRAWINGS.
2. REFER TO G-003 FOR CONSTRUCTION SEQUENCING.
3. MAKE NO DEVIATIONS FROM THE DOCUMENTS WITHOUT WRITTEN DIRECTION FROM THE OWNER.
4. VERIFY ALL DIMENSIONS IN THE FIELD. NOTIFY THE OWNER OF DISCREPANCIES BETWEEN THE NOTES, DRAWINGS, AND EXISTING CONDITIONS BEFORE PROCEEDING WITH AFFECTED PORTIONS OF THE WORK.
5. COORDINATE ALL WORK WITH THE OWNER TO MINIMIZE DISRUPTION TO OPERATIONS, AND PROTECT EXISTING FACILITIES, STRUCTURES AND UTILITIES TO REMAIN IN PLACE FROM DISRUPTION AND DAMAGE.
6. THE DGVBW SYSTEM IS DESIGNED TO BE SELF SUPPORTING AND STABLE ONLY AFTER THE STRUCTURAL WORK CONTAINED IN THE DRAWINGS IS COMPLETE. DESIGN SHOWN DOES NOT INCLUDE THE NECESSARY COMPONENTS OR EQUIPMENT FOR STABILITY OF THE STRUCTURES DURING CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR ALL WORK RELATING TO CONSTRUCTION ERECTION METHODS, SHORING, BRACING, TEMPLATE, RIGGING, GUYS, SCAFFOLDING, AND OTHER WORK AIDS REQUIRED TO SAFELY PERFORM THE WORK SHOWN.
7. SUBMIT COMPLETE SHOP DRAWINGS FOR ALL PARTS OF THE STRUCTURAL WORK, INCLUDING DESCRIPTIONS OF TEMPORARY SHORING, GUIDE/FALSE WORK FRAMING, CONSTRUCTION METHODS AND SEQUENCING, WHERE APPLICABLE. NO PERFORMANCE OF THE WORK SHALL COMMENCE WITHOUT REVIEW OF THE SHOP DRAWINGS BY THE OWNER.
8. ADHERE TO ALL APPLICABLE FEDERAL, STATE, AND MUNICIPAL LAWS, RULES, REGULATIONS, AND ORDINANCES.
9. ALL HOLES IN STEEL COMPONENTS SHALL BE DRILLED AND FABRICATED OFF-SITE.
10. ALL WELDING SHALL BE PERFORMED IN ACCORDANCE WITH AMERICAN WELDING STANDARDS (AWS) D1.1.
11. CONTRACTOR SHALL CONDUCT PERFORMANCE AND/OR QUALITY CONTROL TESTING OF ALL SEALING MATERIALS IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
12. SHEET PILES AND CYLINDRICAL PILES SHALL BE INSTALLED IN A CONTINUOUS FASHION, EITHER FROM ONE END OF THE ALIGNMENT TO THE OTHER OR STARTING FROM AN INTERMEDIATE POINT.

DESIGN CRITERIA:

1. DESIGN CODES AND SPECIFICATIONS:
   - A. 2021 INTERNATIONAL BUILDING CODE (IBC)
   - B. AISC, STEEL CONSTRUCTION MANUAL, 15TH EDITION
   - C. ASCE 7-16, MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES
   - D. AWS D1.1/D1.1M (2020), STRUCTURAL WELDING CODE - STEEL, AMERICAN WELDING SOCIETY
2. DESIGN LOADS:
   - A. PERMANENT SURCHARGE LOADS: 100 POUNDS PER SQUARE FOOT (PSF)

MATERIALS:

1. MATERIALS SHALL CONFORM TO THE FOLLOWING:
   - A. INTERLOCKED STEEL SHEET PILE NZ-14, OR EQUIVALENT WITH SIMILAR WIDTH. ASTM-A572 STRUCTURAL STEEL, HOT ROLLED - GRADE 50 FY = 50 KSI.
   - B. CYLINDRICAL PILES: STEEL OPEN-ENDED PIPE PILE, 36-INCH OUTSIDE DIAMETER, 0.5-INCH WALL, ASTM A252 GR3 WITH PHYSICAL AND CHEMICAL REQUIREMENTS THAT MEET ASTM A572 GR50.
   - C. CONNECTORS: ASTM A572, GRADE 50 FY = 50 KSI.
   - D. STEELANT (OR APPROVED EQUAL) INTERLOCK SEALANT SHALL BE SUPPLIED AND APPLIED BY THE RA CONTRACTOR. RA CONTRACTOR SHALL MAKE REPAIRS NEEDED TO ENSURE WATERTIGHTNESS PRIOR TO BACKFILLING.
   - E. REINFORCING STEEL: ASTM A615, GRADE 60, UNCOATED.
   - F. CONCRETE 28-DAY COMPRESSIVE STRENGTH = 4,000 PSI.
2. STRUCTURAL STEEL SHALL BE FABRICATED AND ERECTED IN CONFORMANCE WITH THE AISC MANUAL OF STEEL CONSTRUCTION, CURRENT EDITION, AND CURRENT OSHA STANDARDS.
3. NO HOLES OTHER THAN THOSE SPECIFICALLY DETAILED SHALL BE ALLOWED THROUGH STRUCTURAL STEEL MEMBERS. NO CUTTING OR BURNING OF STRUCTURAL STEEL IS PERMITTED WITHOUT APPROVAL OF ENGINEER.
4. FABRICATION AND PLACEMENT OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH CRSI MSP-1 "MANUAL OF STANDARD PRACTICE" AND ACI "SPECIFICATIONS FOR STRUCTURAL CONCRETE."

WELDING

1. WELDS SHALL CONFORM TO AMERICAN WELDING SOCIETY (AWS), LATEST EDITION:
   D1.1, STRUCTURAL WELDING CODE – STEEL
   D3.6M, UNDERWATER WELDING CODE
2. REPAIR WELDS FOUND DEFECTIVE IN ACCORDANCE WITH AWS D1.1 SECTION 5.26.
3. WELDS SHALL BE CORROSION-RESISTANT AND COMPATIBLE WITH IAW CURRENT AWS STANDARDS.

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

STRUCTURAL
STRUCTURAL NOTES

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-001
SHEET	10 of 19

FINAL DESIGN

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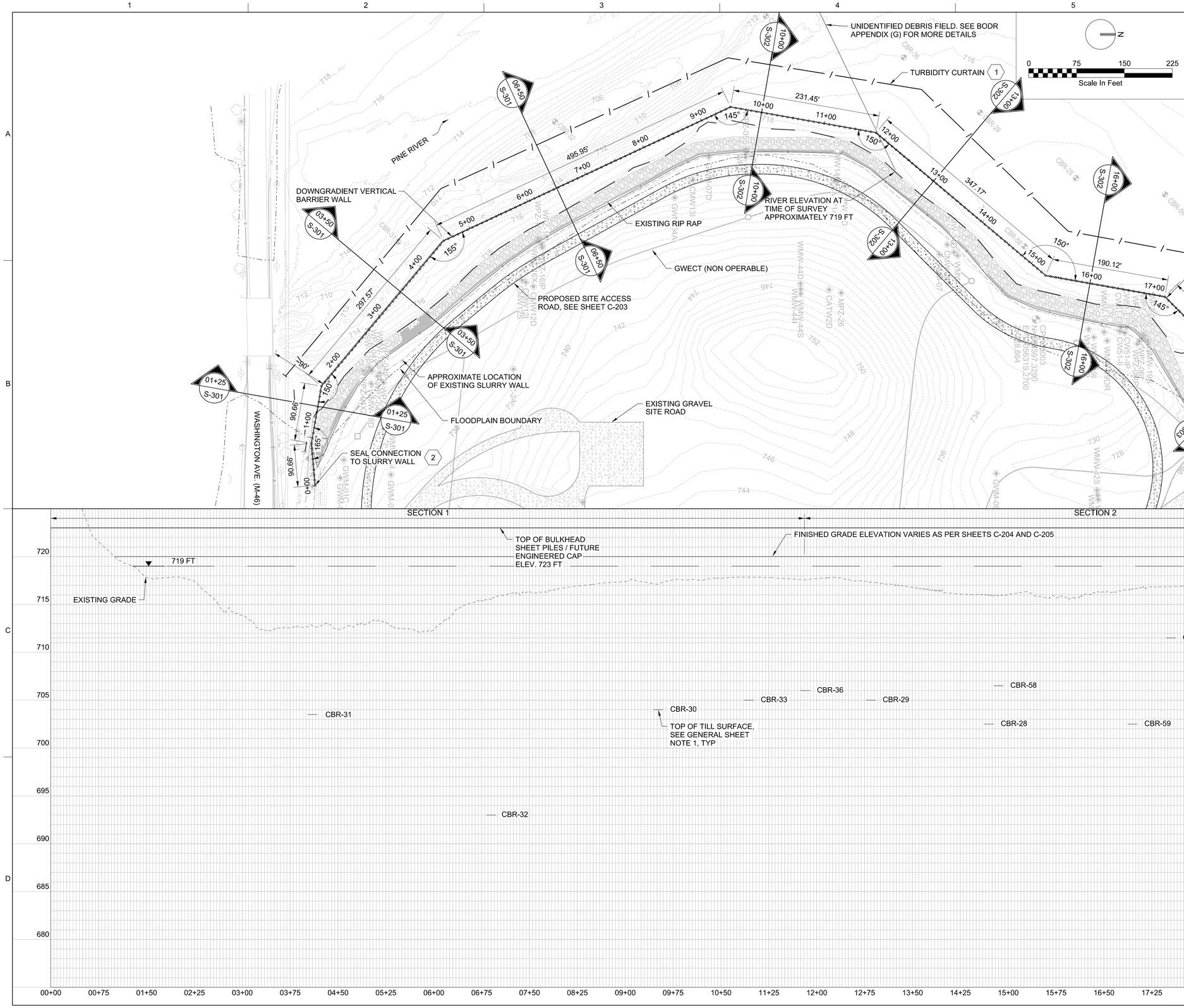

SHEET KEYNOTES

1. RA CONTRACTOR TO MODIFY SILT FENCE AS NECESSARY TO COMPLETE WORK AND AS REQUIRED IN APPROVED SESC PLAN.
2. ENDS OF WALLS TO INTERSECT EXISTING SLURRY WALL. THESE PENETRATIONS SHALL BE REPAIRED USING A MINIMUM 36-INCH-DIAMETER COLUMN OF ATTAPULGITE CLAY SLURRY MIX EXTENDING THE FULL DEPTH OF THE SHEET PILE.

GENERAL SHEET NOTES

1. TOP OF TILL ELEVATIONS PROVIDED ARE BASED ON INFORMATION FROM RIVER BORINGS ADVANCED WITHIN THE PINE RIVER AS PART OF THE 2002 NAPL INVESTIGATION. THE TOP OF TILL ELEVATIONS SHOWN DO NOT REPRESENT THE EXACT ELEVATION ALONG THE DGVBW ALIGNMENT, BUT ARE FROM THE RIVER BORINGS NEAREST THE DGVBW STATIONS SHOWN. THE TOP OF TILL ELEVATIONS SHOWN ARE APPROXIMATE AND SHALL ONLY BE USED AS GUIDANCE.

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

STRUCTURAL

VERTICAL BARRIER WALL PLAN AND PROFILE STA 00+00 TO STA 21+00

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-201
SHEET	11 of 19

FINAL DESIGN

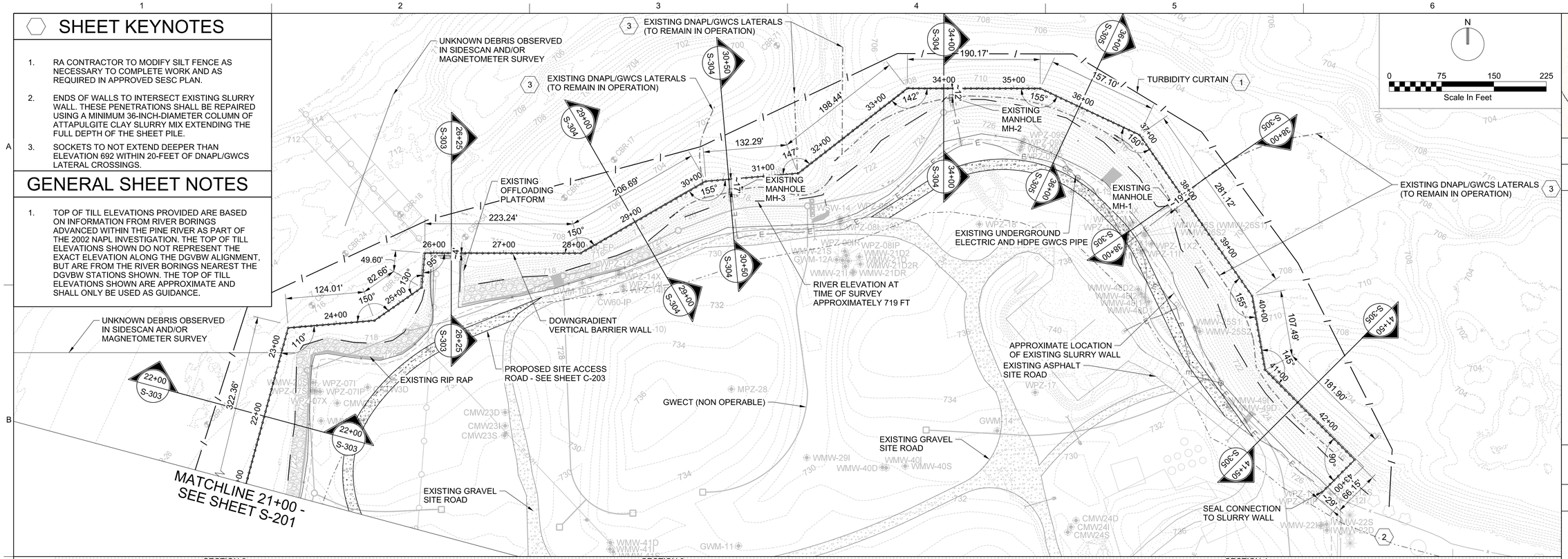
FILENAME: 005-S-201_D3542500.dgn PLOT DATE: 09\29\2023 PLOT TIME: 12:06:14 PM

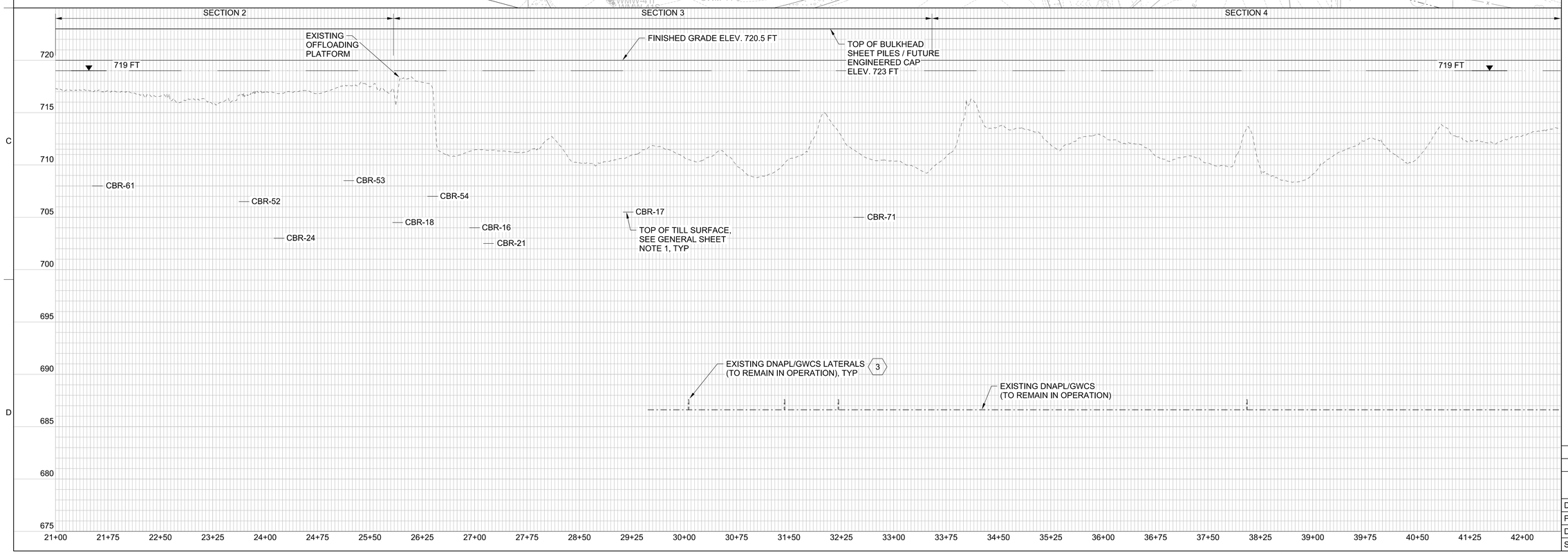
SHEET KEYNOTES

1. RA CONTRACTOR TO MODIFY SILT FENCE AS NECESSARY TO COMPLETE WORK AND AS REQUIRED IN APPROVED SESC PLAN.
2. ENDS OF WALLS TO INTERSECT EXISTING SLURRY WALL. THESE PENETRATIONS SHALL BE REPAIRED USING A MINIMUM 36-INCH-DIAMETER COLUMN OF ATTAPULGITE CLAY SLURRY MIX EXTENDING THE FULL DEPTH OF THE SHEET PILE.
3. SOCKETS TO NOT EXTEND DEEPER THAN ELEVATION 692 WITHIN 20-FEET OF DNAPL/GWCS LATERAL CROSSINGS.

GENERAL SHEET NOTES

1. TOP OF TILL ELEVATIONS PROVIDED ARE BASED ON INFORMATION FROM RIVER BORINGS ADVANCED WITHIN THE PINE RIVER AS PART OF THE 2002 NAPL INVESTIGATION. THE TOP OF TILL ELEVATIONS SHOWN DO NOT REPRESENT THE EXACT ELEVATION ALONG THE DGVBW ALIGNMENT, BUT ARE FROM THE RIVER BORINGS NEAREST THE DGVBW STATIONS SHOWN. THE TOP OF TILL ELEVATIONS SHOWN ARE APPROXIMATE AND SHALL ONLY BE USED AS GUIDANCE.





STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

STRUCTURAL
VERTICAL BARRIER WALL PLAN AND PROFILE
STA 21+00 TO STA 42+00

1"=75'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-202
SHEET	12 of 19

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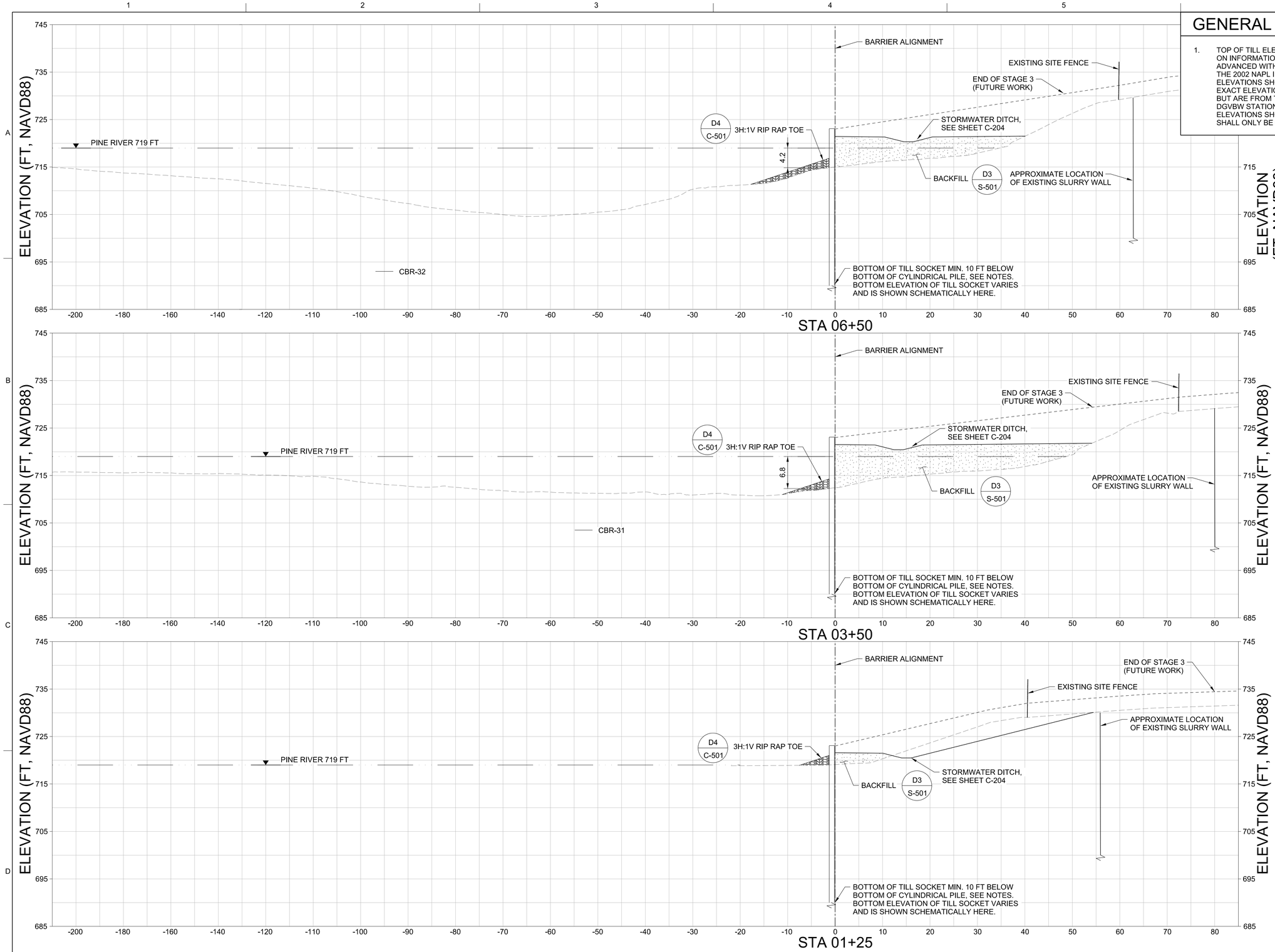

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN	D PETERSON	DR	N LINDHOLM	CHK	W ANDRAE	APVD	C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

STRUCTURAL
CROSS SECTIONS
SHEET 1 OF 5

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-301
SHEET	13 of 19

FINAL DESIGN

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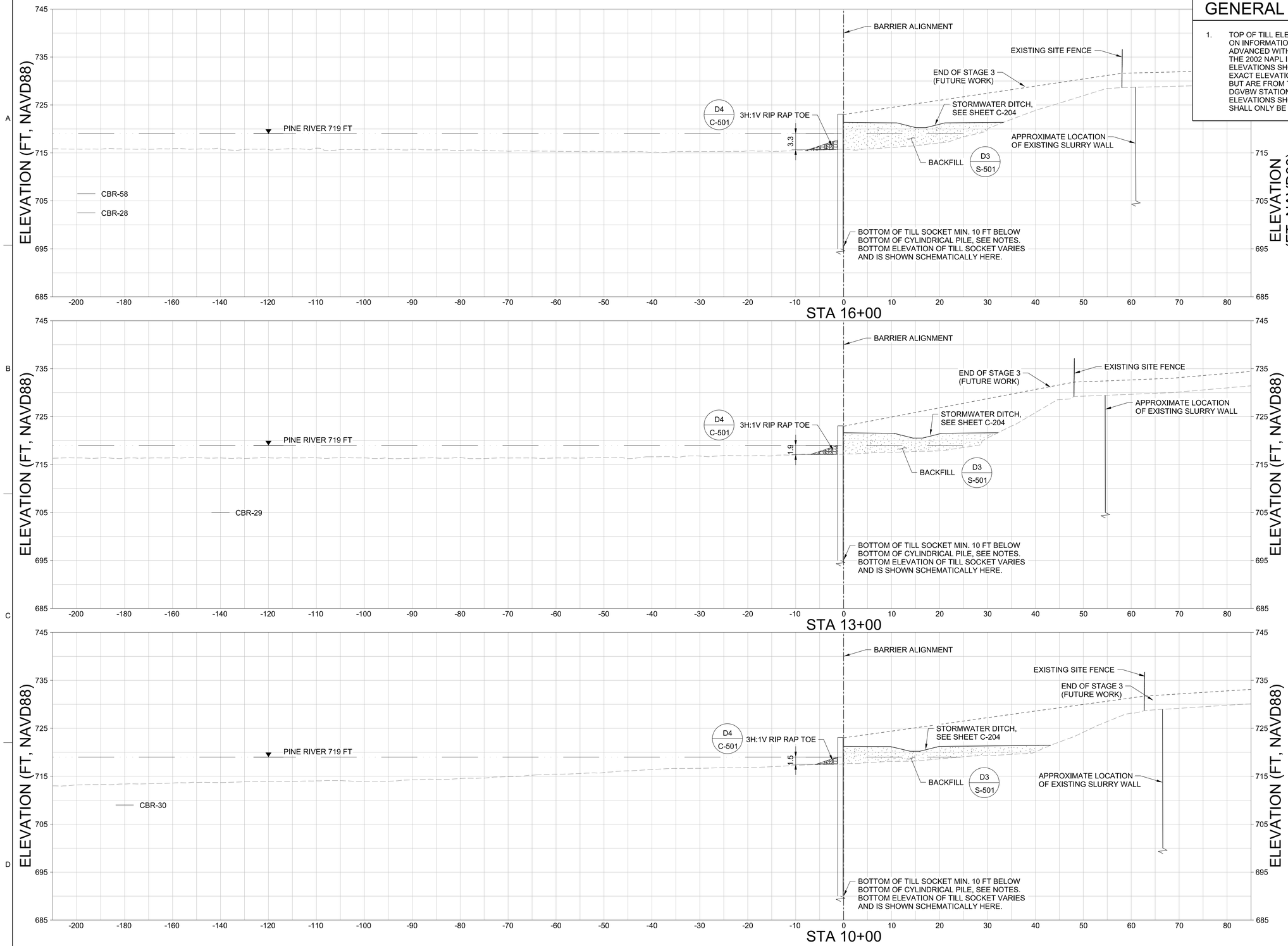

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

STRUCTURAL
CROSS SECTIONS
SHEET 2 OF 5

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-302
SHEET	14 of 19

FINAL DESIGN

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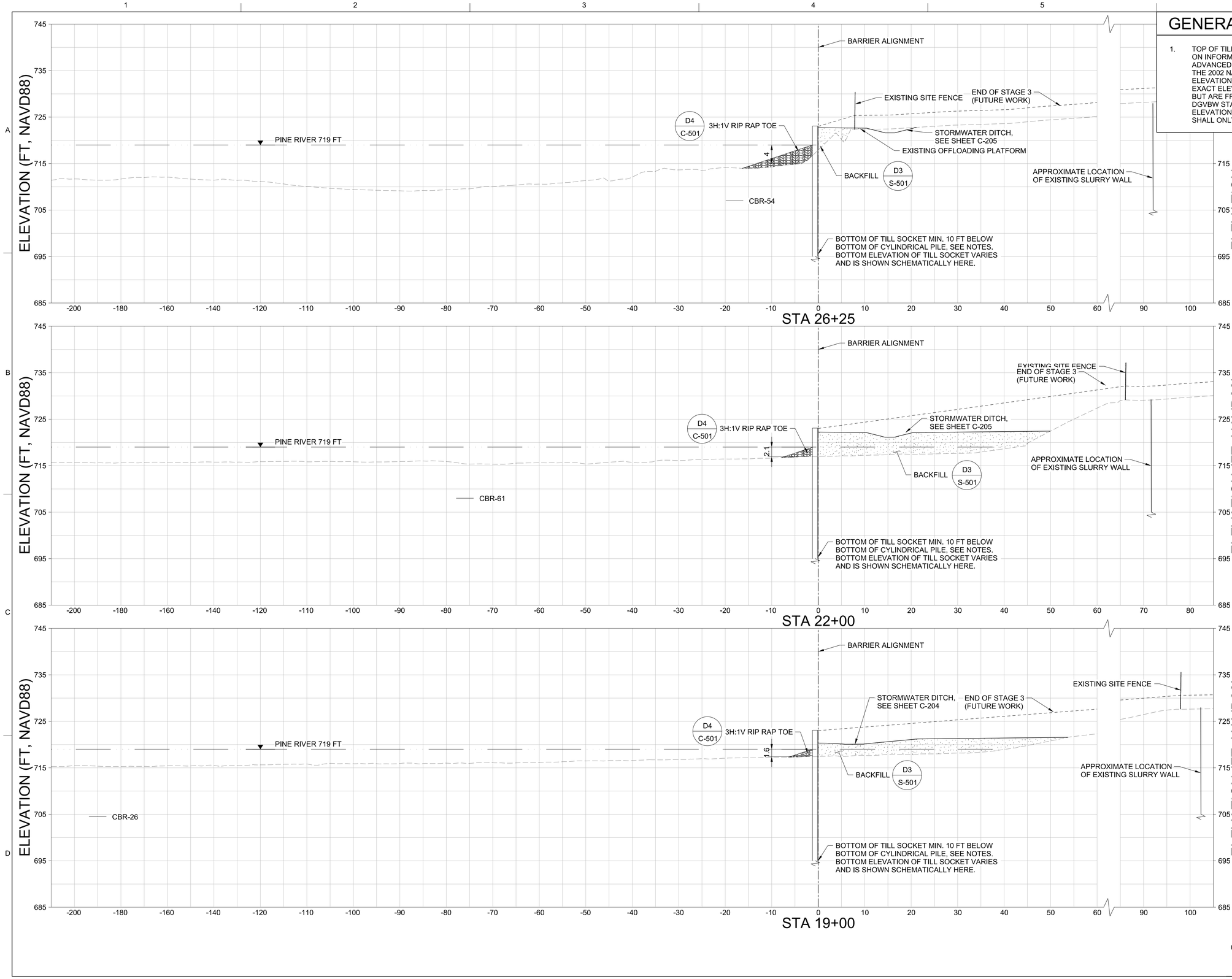
STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023



NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

STRUCTURAL
CROSS SECTIONS
SHEET 3 OF 5

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-303
SHEET	15 of 19

FINAL DESIGN

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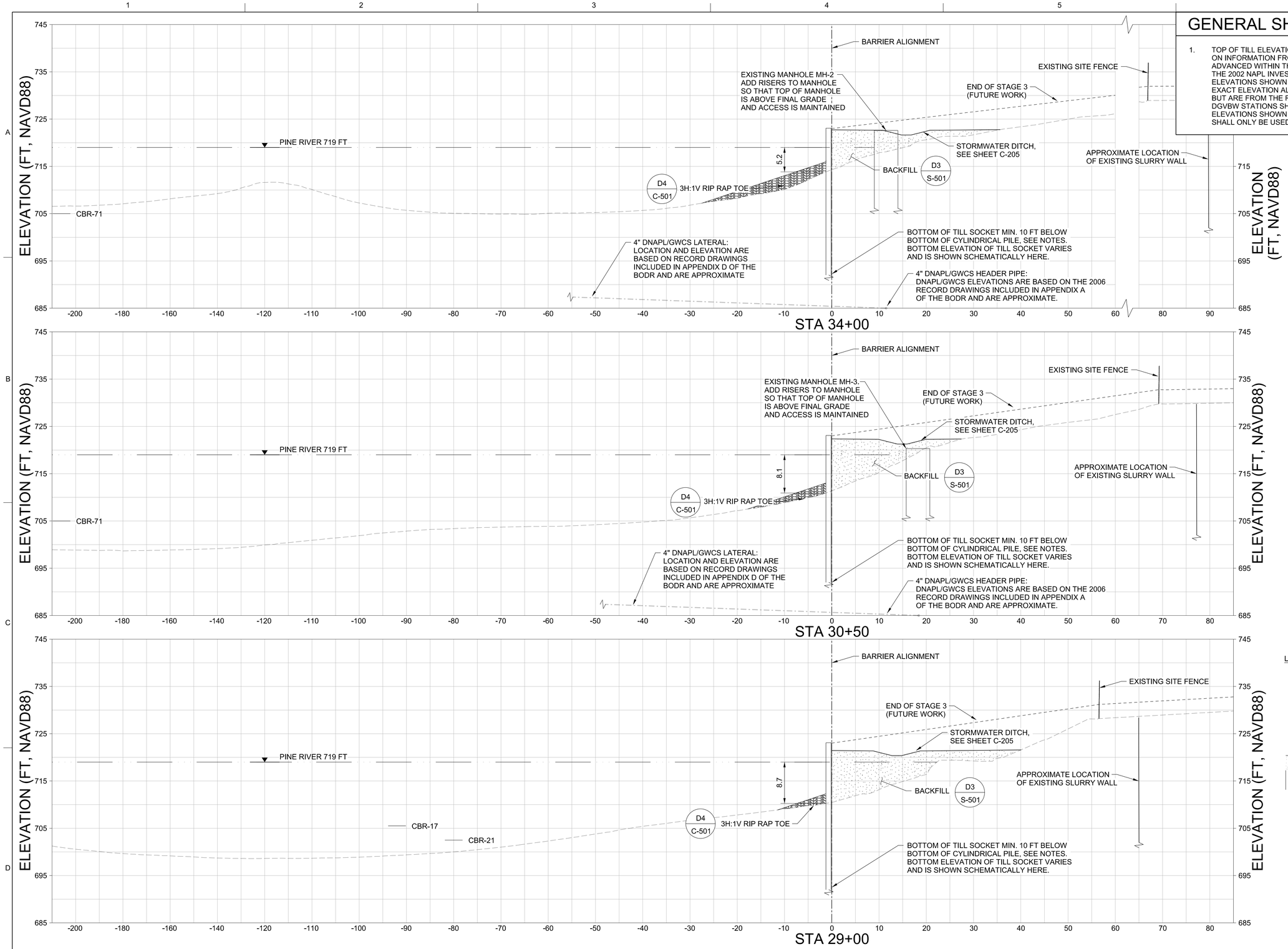
STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023



NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

ch2m

STRUCTURAL
CROSS SECTIONS
SHEET 4 OF 5

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-304
SHEET	16 of 19

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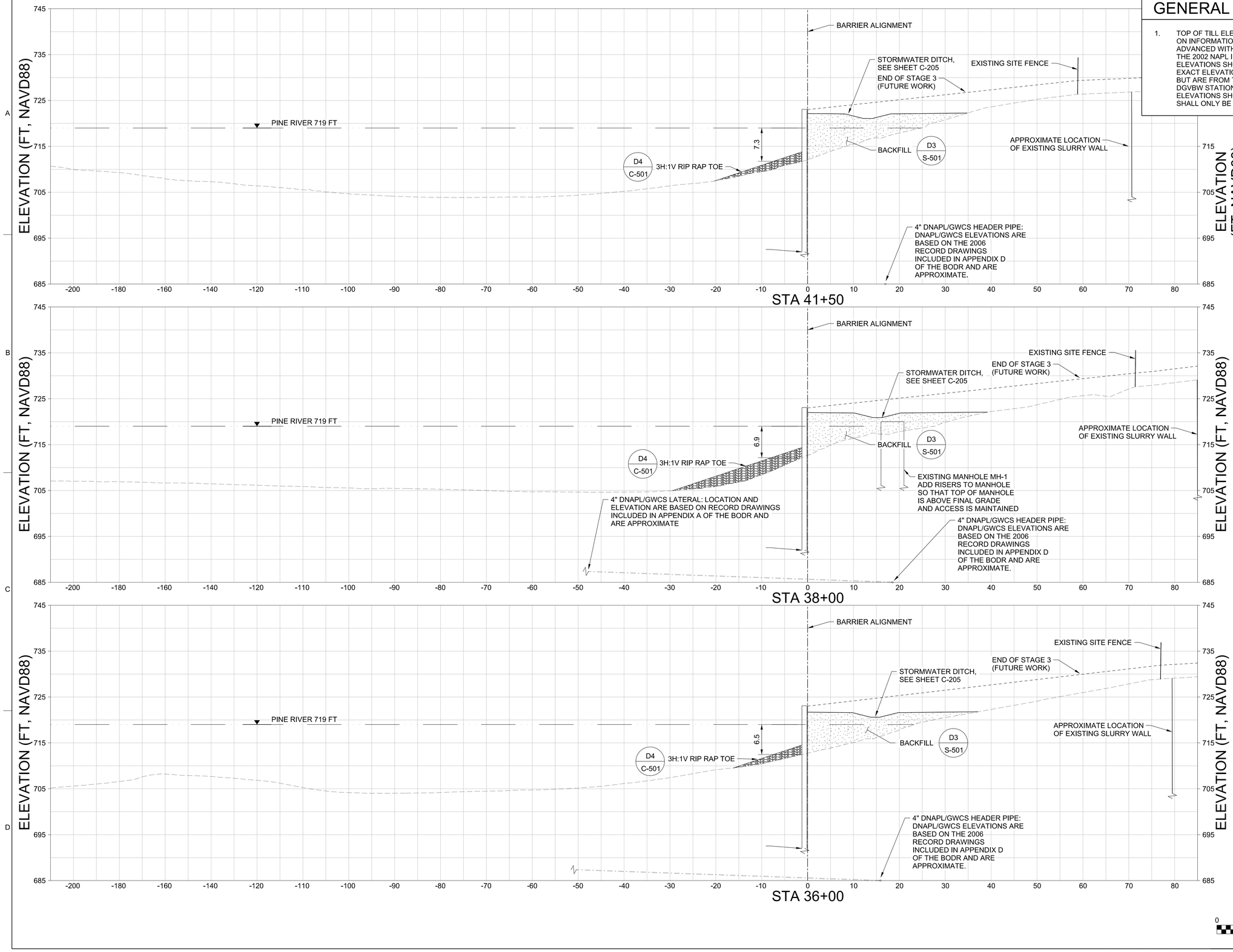

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

STRUCTURAL
CROSS SECTIONS
SHEET 5 OF 5

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-305
SHEET	17 of 19

FINAL DESIGN

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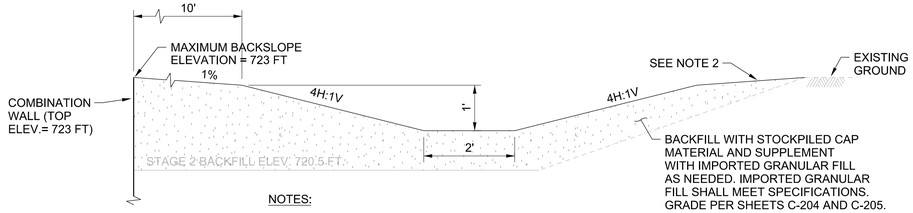


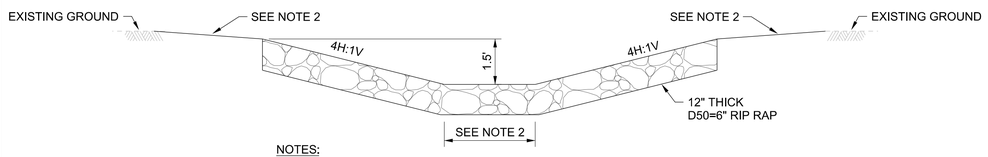
NOTES:

1. DITCHES SHALL BE SLOPED AT 1% TOWARDS OUTLET. OUTLET ELEVATION IS 719.5 FT. (1)
2. DITCHES SHALL BE TRAPEZOIDAL WITH 1 FT MINIMUM DEPTH, 2' BOTTOM WIDTH AND 4H:1V SIDESLOPES. CATCH SLOPES SHALL BE SLOPED AT MINIMUM 1% AND MAXIMUM 4H:1V TO MEET EXISTING GROUND ELEVATION.
3. PLACE 12" THICK D50=6" RIPRAP AT OUTLETS.

A2 TYPICAL STORMWATER CONVEYANCE DITCH

NTS

C-204, C-205



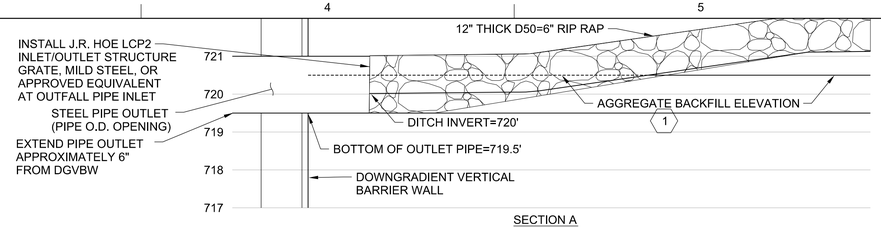
NOTES:

1. DITCHES 32 AND 34 SHALL BE SLOPED AT 1% AND DITCHES 33 AND 35 SHALL BE SLOPED AT 2% TOWARDS OUTLET. OUTLET ELEVATION IS 719.5 FT.
2. DITCHES SHALL BE TRAPEZOIDAL WITH 1.5 FT MINIMUM DEPTH, 2' BOTTOM WIDTH (DITCH 32 SHALL HAVE 6' BOTTOM WIDTH), AND 4H:1V SIDESLOPES. CATCH SLOPES SHALL BE SLOPED AT MINIMUM 1% AND MAXIMUM 4H:1V TO MEET EXISTING GROUND ELEVATION.

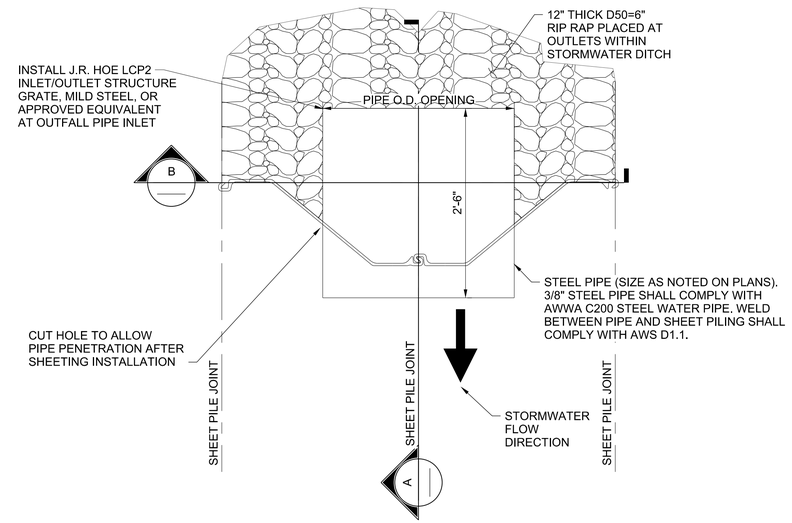
B2 STORMWATER DITCH AT EXISTING CULVERTS

NTS

C-204, C-205



SECTION A

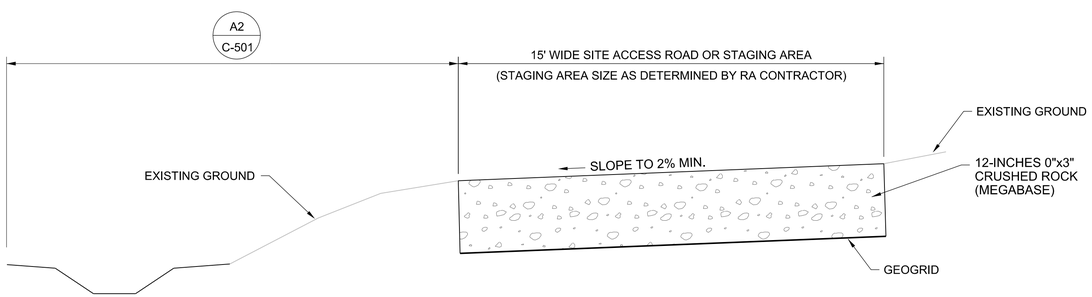


PLAN

B5 OUTLET AT DOWNGRADIENT VERTICAL BARRIER WALL

NTS

C-204, C-205



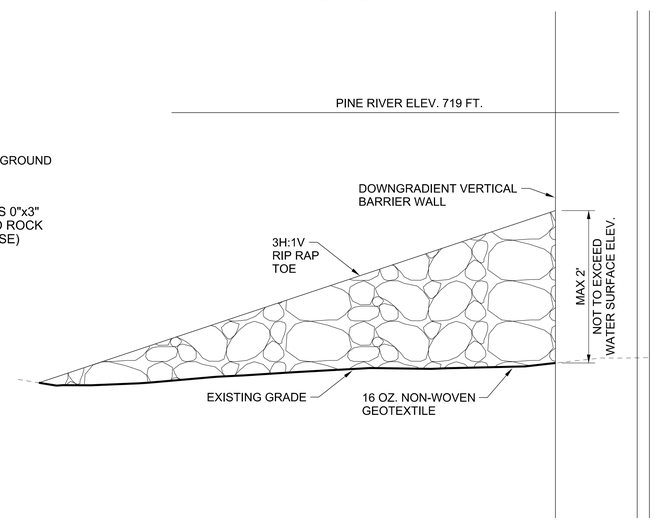
NOTES:

1. PREPARE SUBGRADE BY STRIPPING THE EXISTING 6" OF TOPSOIL AND 6" OF CLAY CAP MATERIAL. STOCKPILE TOPSOIL AND CLAY CAP MATERIAL SEPARATELY FOR REUSE.
2. PLACE GEOGRID IN ACCORDANCE WITH THE SPECIFICATIONS.
3. SPREAD CRUSHED ROCK EVENLY AND COMPACT. COMPACTION TESTING IS NOT REQUIRED, BUT A FIRM, NON-YIELDING SURFACE SHALL BE PROVIDED TO ALLOW SUPPORT VEHICLES AND EQUIPMENT SAFE ACCESS ALONG THE ENTIRE LENGTH AND WIDTH OF THE SITE ACCESS ROAD OR STAGING AREA.

C2 SITE ACCESS ROAD AND STAGING AREA

NTS

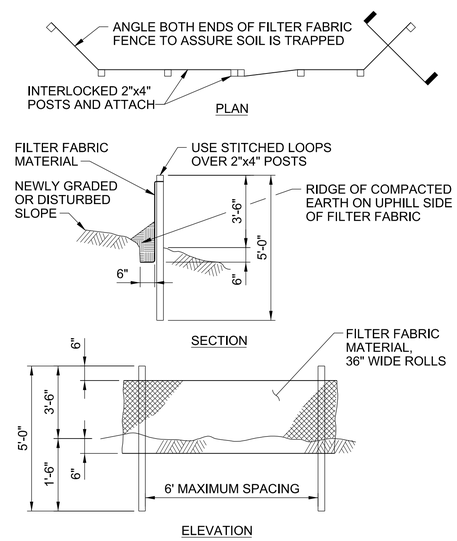
C-203



D4 RIP RAP TOE

NTS

S-301, S-302, S-303, S-304



NOTES:

1. BURY BOTTOM OF FILTER FABRIC 6" VERTICALLY BELOW FINISHED GRADE.
2. 2"x4" DOUGLAS FIR OR STEEL FENCE POSTS.
3. STITCHED LOOPS TO BE INSTALLED DOWNHILL SIDE OF SLOPE.
4. COMPACT ALL AREAS OF FILTER FABRIC TRENCH.

SEDIMENT FENCE

NTS

3125-165

SHEET KEYNOTES

1. STONE FILL AND AGGREGATE FILL SHALL BE REMOVED AT OUTLET TO ALLOW FOR STORMWATER DITCH AND OUTLET INSTALLATION TO ELEVATION 720.5 FT AND 719.5 FT RESPECTIVELY.

STATE OF MICHIGAN
JASON D COLE
ENGINEER
No. 6201063070
LICENSED PROFESSIONAL ENGINEER
*****

NO.	DATE	REVISION	BY	APVD

DSGN R VAUGHAN | DR N LINDHOLM | CHK W ANDRAE | APVD J COLE

DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

STANDARD DETAILS

CIVIL DETAILS

NTS
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	C-501
SHEET	18 of 19

FINAL DESIGN

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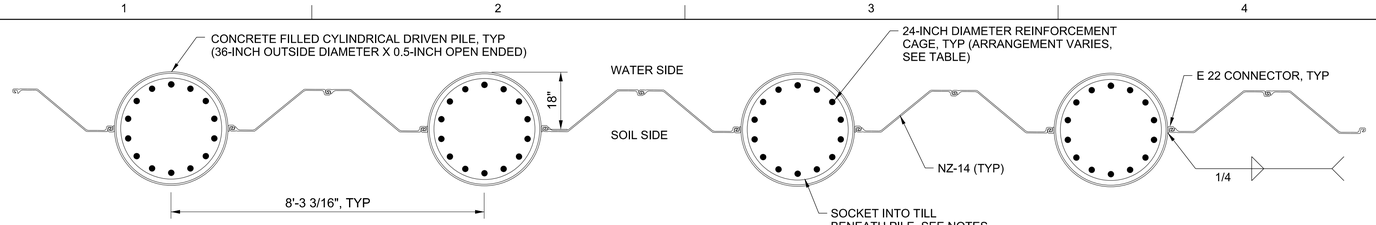
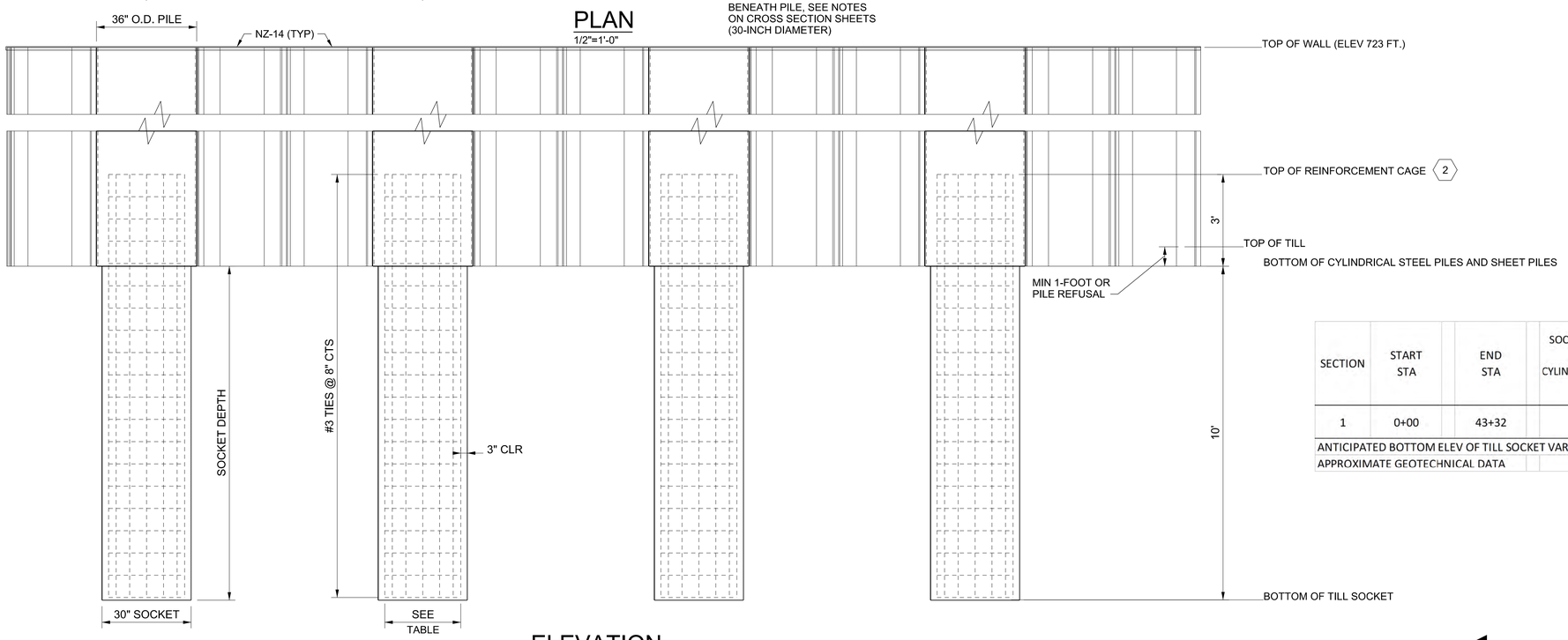


PLAN

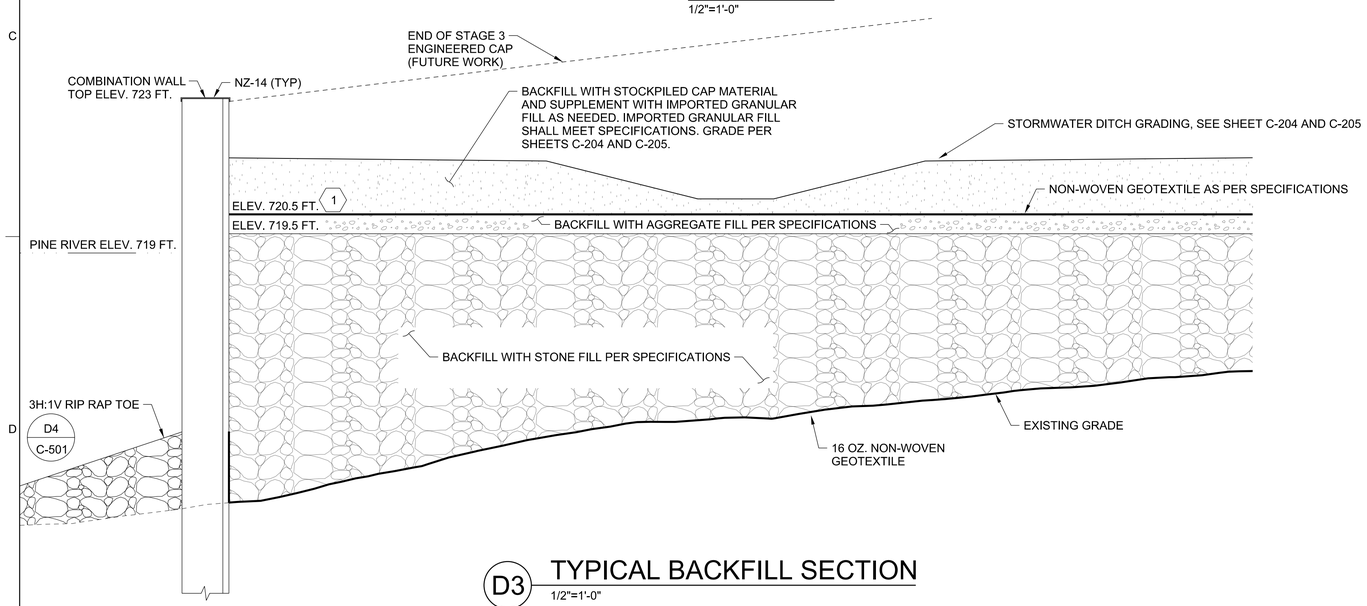
1/2"=1'-0"



ELEVATION

1/2"=1'-0"

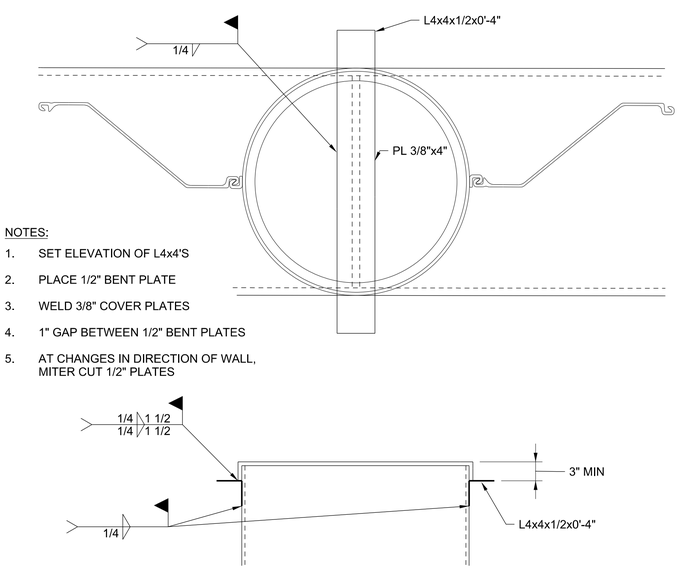
SECTION	START STA	END STA	SOCKET DEPTH BELOW BOTTOM OF CYLINDERICAL STEEL PILES FEET	REBAR	LENGTH OF REBAR CAGE FEET	
1	0+00	43+32	10	9 - #10 long, #3 ties @ 8" sp	13	2
ANTICIPATED BOTTOM ELEV OF TILL SOCKET VARIES, SEE STRUCTURAL SHEETS THAT REFERENCE						
APPROXIMATE GEOTECHNICAL DATA						



D3 TYPICAL BACKFILL SECTION

1/2"=1'-0"

S-301, S-302, S-303, S-304, S-305



NOTES:

1. SET ELEVATION OF L4x4'S
2. PLACE 1/2" BENT PLATE
3. WELD 3/8" COVER PLATES
4. 1" GAP BETWEEN 1/2" BENT PLATES
5. AT CHANGES IN DIRECTION OF WALL, MITER CUT 1/2" PLATES

D6 COVER PLATE

1"=1'

SHEET KEYNOTES

1. SEE SHEET C-501 FOR STORMWATER DITCH OUTLET INSTALLATION ELEVATION.
2. THERMAL INTEGRITY PROFILER (TIP) TESTING REQUIRED ON EVERY THIRD CYLINDERICAL PILE. IN TIP-EQUIPPED PILES FOUR (4) LONGITUDINAL REBARS TO EXTEND TO THE TOP OF THE SHAFT TO FACILITATE CORRECT PLACEMENT OF THERMAL WIRE CABLES.

GENERAL SHEET NOTES

1. REFER TO SHEET G-003 FOR CONSTRUCTION SEQUENCING.
2. TIE BAR ANCHORAGE SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF ARTICLE 25.7.2.4.1 OF ACI 318-19.

STATE OF MICHIGAN
CHARLES WINTER
ENGINEER
No. 6201066290
LICENSED PROFESSIONAL ENGINEER
9-29-2023

NO.	DATE	REVISION	BY	APVD

DSGN D PETERSON | DR N LINDHOLM | CHK W ANDRAE | APVD C WINTER

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DOWNGRADIENT VERTICAL BARRIER WALL
VELSICOL CHEMICAL SUPERFUND SITE
US ENVIRONMENTAL PROTECTION AGENCY
ST. LOUIS, MICHIGAN

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ch2m

STANDARD DETAILS

STRUCTURAL DETAILS

1"=10'
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEP 2023
PROJ	D3542500
DWG	S-501
SHEET	19 of 19

FINAL DESIGN

Appendix B
Final Specifications

Final Design Documents

Downgradient Vertical Barrier Wall Remedial Design

Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan

Volume I of II

Specifications

September 2023

Prepared By:

Jacobs

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END OF SECTION

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY RA CONTRACT DOCUMENTS

Work of this contract includes installing approximately 4,300 linear feet of a combination steel sheet pile wall to construct the downgradient vertical barrier wall (DGVBW) for the Velsicol Chemical Corporation Superfund Site (Site), located in St. Louis, Michigan. Sheet piles, cylindrical piles, and appurtenant hardware shall be provided and installed by the RA Contractor. The Work includes environmental controls, relocation of existing outfalls, installation and drilling of cylindrical piles, installation of sheet pile, joint sealant, and appurtenant hardware, backfilling, site security, site grading, and restoration. The Work will be performed at the Former Plant Site (FPS), within Operable Unit (OU) 1 of the Velsicol Chemical Corporation Superfund Site. The activities for satisfying the performance requirements for this project are summarized as follows:

1. Management of all Subcontractors and vendor activities onsite during the execution of this Work.
2. Coordination with other Contractors and Subcontractors, including the Burn Pit RA Contractor and its subcontractors.
3. Preconstruction activities, including preparation of site-specific plans and preconstruction submittals, borrow source identification, and coordination with City of St. Louis, Michigan Department of Environment, Great Lakes, and Energy (EGLE), and United States Army Corps of Engineers (USACE).
4. Mobilization, including transportation of equipment, materials, and personnel to the site and assembly of equipment.
5. Site preparation, including installation of temporary facilities and controls as identified in Section 01 50 00, Temporary Facilities and Controls, utility locates, installation of erosion and sediment controls as identified in Section 01 57 13, Temporary Erosion and Sediment Control, clearing and grubbing, preparation of decontamination, storage and staging area(s), installation of temporary support roads, establishment of site security, and documentation of existing property conditions.
6. Surveying activities, as described in Section 01 31 13, Project Coordination.

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7. Installation of the DGVBW, including sheet and cylindrical piles installation, drilling and water management activities, turbidity monitoring and management, noise and vibration monitoring, grading, backfilling, and compaction activities.
8. Transportation and offsite disposal of material, as required.
9. Restoration of work areas.
10. Demobilization and post-construction documentation.
11. Specific Tasks Not Mentioned: Specific tasks not mentioned or completely detailed in this Summary of Work that are necessary or normally required as part of the Work described will be performed by the RA Contractor as incidental Work without extra costs to the Owner, as if fully detailed. The expense for such Work will be included in the applicable lump sum and unit prices for the Work described.

B. Drawings—That part of the Remedial Action (RA) Contract Documents prepared by Engineer which graphically shows the scope, extent, and character of the Work to be performed by RA Contractor. Shop Drawings and other RA Contractor submittals are not Drawings as so defined.

C. Owner: U.S. Environmental Protection Agency, Region 5 (USEPA), or another federal agency representing USEPA.

D. Owner's Representative: The company retained by the Owner to provide onsite oversight of the construction activities.

E. Engineer: Firm contracted by the USEPA to complete the remedial design (CH2M).

F. Project Site: Velsicol Chemical Corporation Superfund Site, as shown on the Drawings.

G. Project Area: Lands or areas indicated in the RA Contract Documents where the Work is to be performed, including rights-of-way and easements for access.

H. CERCLA: Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as "Superfund". CERCLA is the regulatory driver for this scope of remediation work.

I. Successful Bidder: The Bidder selected for the RA Contract award prior to award of RA Contract.

J. RA Contract: The entire and integrated written agreement between the Owner and RA Contractor concerning the Work. The RA Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

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K. RA Contract Documents: Those items so designated in the Agreement. Approved Shop Drawings, other RA Contractor submittals, and the reports and drawings of subsurface and physical conditions are not RA Contract Documents.

L. RA Contractor: The successful bidder of the solicitation. The RA Contractor is responsible for completing the Work described in these Specifications and as shown on Drawings.

M. Subcontractor: A subcontractor retained by the RA Contractor.

N. Burn Pit RA Contractor: The RA Contractor responsible for in situ thermal treatment at the Burn Pit, including construction and operation of an in situ thermal treatment system. The RA Contractor may need to coordinate with the Burn Pit RA Contractor during the Work, as Burn Pit ISTT activities may be performed concurrent with DGVBW construction activities.

O. Shop Drawings: All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for RA Contractor and submitted by RA Contractor to illustrate some portion of the Work.

P. Specifications: That part of the RA Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

Q. Substantial Completion: The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Owner, the Work (or a specified part thereof) is sufficiently complete, in accordance with the RA Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.

R. The words “perform” or “provide”. When used in connection with services, materials or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.

S. When “furnish”, “install”, “perform”, or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of the RA Contractor, provide is implied.

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T. Work: The entire construction or the various separately identifiable parts thereof required to be provided under the RA Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the RA Contract Documents. Work includes installation of the DGVBW in the Pine River to surround the downgradient perimeter of the Former Plant Site (FPS) described herein, which the RA Contractor and/or Subcontractor(s) retained by the RA Contractor will perform.

1.02 QUALIFICATIONS

A. The RA Contractor will be licensed, insured, and bonded to operate in the state of Michigan and will comply with all applicable federal, state, county, and local laws and regulations. All Subcontractors will also be appropriately licensed and insured in the state of Michigan. In the event of conflict, the most stringent of these regulations will apply.

1.03 ENVIRONMENTAL CONTAMINANTS

A. Extensive soil and groundwater contamination is present in the FPS. A slurry wall is present around the perimeter of the FPS, containing wastes and debris historically associated with former operations and demolition activities performed on the site. Soil within the containment area is known to be contaminated by volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls, pesticides, specialty chemicals, and inorganic constituents, consistent with materials, manufacturing, and disposal activities performed onsite. Previous site investigations have indicated the slurry wall does not meet design specifications along its entirety, and that contaminants may be present outside of the slurry wall boundary.

B. Potential exposure may occur during the drilling out of the cylindrical piles and management of water associated filling the cylindrical piles with concrete.

1.04 PROJECT PERMITS

A. CERCLA projects are generally exempt from requirements to obtain environmental permits for onsite work under CERCLA 121(e); however, compliance with all substantive requirements is required.

B. Coverage under the Michigan National Pollutant Discharge Elimination System Construction Stormwater Permit-by-Rule (Mich. Admin. Code R 323-2190) is not required. However, Project will be conducted compliant with all substantive aspects of the Rule, and as indicated in the Basis of Design document.

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C. Onsite work shall comply with substantive requirements of all Federal, State, and local regulations, and with the latest edition of applicable sections of the following regulations, standards, and codes:

1. Federal:
   a. Joint EGLE and U.S. Army Corps of Engineers Permit:
      1) Clean Water Act-Section 404.
      2) Clean Water Act – Section 401 Water Quality Certification.
      3) Section 10 Rivers and Harbors Act.
      4) Section 408 Navigation and Navigable Waters.
   b. U.S. Fish and Wildlife Service-East Lansing Ecological Services Field Office:
      1) Endangered Species Act
      2) Migratory Bird Treaty Act
      3) Fish and Wildlife Coordination Act
2. State:
   a. State of Michigan Natural Resources and Environmental Protection Act 451:
      1) Part 31, Water Resources Protection.
      2) Part 301, Inland Lakes and Streams.
      3) Part 303, Wetland Protection.
      4) Part 365, Endangered Species Protection.
      5) Part 303 Wetland Protection
      6) Part 323 Shoreline Protection and Management.
      7) Part 111 Hazardous Waste Management.
      8) Part 115 Solid Waste Management.
      9) Part 91 Soil Erosion and Sedimentation Control
      10) Part 5, Spillage of Oil and Polluting Materials
      11) Part 55, Control of Fugitive Dust
   b. Natural Features Inventory Information Consultation.
   c. National Pollutant Discharge Elimination System (NPDES) Permit-Operation.
   d. EGLE approval of the following:
      1) NWP 38 Substantive Requirements Document.
      2) 401/404 Joint Permit Application.

D. Non-environmental permits and permits related to offsite activities must be obtained, and both administrative and substantive requirements apply to offsite activities. The RA Contractor will obtain any non-environmental permits or permits related to offsite activities. RA Contractor is responsible for obtaining all construction permits necessary for the performance of the work of these Contract Documents.

E. RA Contractor will comply with and execute requirements in all permits.

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1.05 SUBMITTALS PRIOR TO AWARD

A. Prior to RA Contract award, the RA Contractor will be required to submit a certificate of insurance naming Owner as additional insured and waivers of subrogation against Owner in accordance with the RA Contract. All certificates of insurance, as well as bonds, will be either executed by or countersigned by a licensed resident agent of the surety or insurance company having its place of business in the State of Michigan. Further, the said surety or insurance company must be duly licensed and qualified to do business in the State of Michigan.

B. Prior to RA Contract award, the RA Contractor will be required to submit the following:

1. Completed certification of compliant drug policy.
2. Proof of training and medical monitoring programs.
3. Copies of RA Contractor's and business licenses as required by state and local statutes.
4. Michigan Department of Environment, Great Lakes, and Energy (EGLE) or USEPA National Environmental Laboratory Accreditation Program (NELAP) certification of laboratory for all required analyses.
5. Completed Waste Subcontractor Qualification Form.
6. Transporter's valid U.S. DOT Number, and as appropriate, Michigan registration and permits.
7. Transporter's valid EPA ID# (for hazardous waste transport).
8. Transporter's Certificate of Insurance.
9. Intended disposal facilities required for each waste stream, for Owner's approval. For waste disposal facilities, provide written evidence of USEPA approval under Offsite Rule of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (40 CFR 300.440); and a summary of violations (formal and informal) and how they were resolved in the last 5 years.
10. Table describing potential borrow sources and a site drawing identifying the location(s) of borrow areas, and of any samples with respect to the specific borrow area at the borrow source.
11. A schedule for completing the Work should be submitted as part of the Bid proposal and should be updated prior to RA Contract award, if necessary. The schedule is to comply with all Specification requirement including any work timing restrictions to protect natural resources and species.

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1.06 SUBMITTALS AFTER AWARD

A. The selected RA Contractor will provide the following for review by the Owner before the commencement of any Work onsite:

1. Safety Data Sheets (SDSs)

B. The RA Contractor will provide the following for review and approval by the Owner before the commencement of any Work onsite:

1. Preliminary Progress Schedule updates in accordance with RA Contract Agreement and 01 32 00, Construction Progress Documentation.
2. RA Contractor's site-specific health and safety plan (HASP) and Activity Hazard Analysis (AHA) worksheets.
3. Current hazardous waste site training and medical surveillance documentation for all field personnel, as necessary.
4. Project schedule and schedule narrative of RA Contractor's approach in performing the Work. The narrative will identify equipment, labor resources, crews and subcontracts. The narrative will also discuss Project coordination.
5. RA Contractor Quality Control Plan, as described in Section 01 45 16.13, RA Contractor Quality Control.
6. Work Plan. The Work Plan narrative will identify equipment, labor resources, crews and subcontracts, including scope of services supplied by each. The narrative will also discuss Project schedule, Project coordination and lines of communication, mobilization, site preparation, access roads, storage and staging area plans (including maps), haul routes, the means and methods to complete the Work, how site security will be maintained during execution of the Work, and demobilization.
   a. List Subcontractors (i.e. Surveying, Analytical, Geotechnical Testing, Transportation and Disposal, etc.)
   b. Methods, work sequence, and equipment.
   c. Products proposed for use.
   d. Coordination with the Owner.
7. Additional plans to be included as sections within the Work Plan include:
   a. Dust Control Plan that describes the management of stockpiles and transport of bulk material to minimize dust emissions. Include water supply sources proposed for dust control. The Dust Control Plan shall also outline methods for dust monitoring, including equipment that will be used, monitoring locations, alarm, and action limits. Dust monitoring data shall be evaluated against the EPA National Ambient Air Quality Standards for PM_{10} of 150 micrograms per cubic meter. The Dust Control Plan shall also describe what action(s) the RA Contractor will take if the action limits are exceeded.

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b. Spill Prevention and Countermeasures Plan. If onsite storage capacity for petroleum products will exceed 1,320 gallons, a Spill Prevention, Control and Countermeasures Plan per 40 CFR 112 is also required. All containers with a capacity of 55 gallons or greater will be included in determining onsite capacity. This threshold does not include mobile refueling tanks if they do not remain onsite overnight. The Spill Prevention and Countermeasures Plan should include the following, at a minimum:
   1) Fuel and oil storage requirements.
   2) Preplanning for spill control and spill control measures, including potential spills of decontamination rinsate, contaminated soils, vehicle fuel, and hydraulic oil.
   3) Spill and fire control materials and equipment.
   4) Drum, container, and tank handling and moving procedures.

c. Noise Control Plan, which will provide information to mitigate construction noise, including method of construction, operating procedures, equipment to be used, noise monitoring, and acoustical treatments to minimize disturbance to the community and comply with applicable local noise regulations and ordinances.

d. Survey Plan including:
   1) Type of survey to be used.
   2) Proposed Surveyor's relevant qualifications.
   3) Approximate number of survey points within a given area.
   4) Precision of the equipment.
   5) Accuracy of the survey.
   6) The reporting format to meet the specifications.

e. Waste Management Plan including:
   1) Identify all waste streams being generated and describe their proper management both onsite and offsite.
   2) Describe the stockpiling and management of construction debris generated during the site work.
   3) Describe waste inspection, management, characterization, labeling, transportation, and disposal.
      a) Waste tanks and containers will be inspected by the RA Contractor upon arrival at the site for signs of disrepair or contamination, and to verify that the tanks and containers are empty and clean. If the tank or container arrives in poor condition, is contaminated, or is not empty, it will be immediately rejected and documented. Upon arrival of the tanks and containers, if existing damage (for example, dings, significant paint scratches, or broken wheels) does not warrant rejection, tank and container conditions will be documented using photos and field book entries.

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b) Upon filling, the tanks and containers will be labeled with the site name, media (that is, soil, liquid, or PPE), date generated, generator contact information, and container number. Waste will be labeled as analysis pending depending on the origin of the waste stream. Tanks and containers will be inspected weekly by the RA Contractor, and information will be documented on the waste inventory log. The waste inventory log will be reviewed weekly to ensure proper inspections are performed and information is recorded properly.

c) The RA Contractor will be responsible for solid and liquid waste characterization sampling, analysis, and profiling, as required by the disposal facilities. The EPA will review and approve the waste profiles before disposal activities are scheduled. Remediation waste may be subject to land disposal restrictions.

f. A Transportation and Disposal Plan including:

1) Proposed offsite disposal location for each waste stream identified in the Waste Management Plan.
2) Proposed transporters.
3) Sequences of construction affecting use of roadways, time required and phasing of operations to limit traffic on the residential roads.
4) The sequence of moving, handling and loading of trucks.
5) Describe signage and protective measures for vehicular traffic on streets.
6) Information for intended haul routes to and from the FPS and approved disposal facility. Routes to and from the site will generally be shortest route available.
7) Provisions for sampling and disposing of decontamination liquids and also disposal of used personal protective equipment or other work-derived wastes generated.
8) Plans for transporting and disposing of contaminated soil and existing on-site materials scheduled for demolition and removal and importing materials from approved borrow sources.
9) Preparation of waste characterization profiles, proof of disposal facility approval under the CERCLA Offsite Rule, set forth in the National Contingency Plan, at 40 Code of Federal Regulations 300.440, and proof of disposal facility acceptance.
10) Provisions for street cleaning and equipment decontamination.

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11) Manifesting and other shipping documentation requirements for transportation of contaminated materials.
12) Identification of all waste streams.
13) Waste and container management, storage, labeling, and marking.
14) Spill response and reporting (for potential spills related to transportation of materials).
15) Records and reporting.

8. Waste disposal documentation. The RA Contractor will prepare all disposal paperwork required for transportation or offsite disposal of waste. The Generator of this waste is USEPA Region 5.
   a. Include the following:
      1) Waste characterization profiles and supporting analytical results.
      2) Proof of disposal facility approval under the CERCLA Offsite Rule, set forth in the National Contingency Plan, at 40 Code of Federal Regulations 300.440.
      3) Proof of disposal facility acceptance.
      4) Pre-printed manifests and labels, as applicable.
   b. Upon satisfactory completion of all documentation by the RA Contractor, the waste profile will be reviewed and signed by the Owner. Once the waste profile is signed, the Owner will provide the signed profile back to the RA Contractor for submittal to the disposal facility.
9. Soil Erosion and Sedimentation Control Plan (SESC Plan) as indicated in Section 01 57 13, Temporary Erosion and Sediment Control.
10. Turbidity and Resuspension Management Plan, as indicated in 02 40 00, Sediment Resuspension Control.

C. Provide the following submittals during execution of the Work:

1. Daily Reports (RA Contractor production report, RA Contractor quality control report [CQC Report] as described in Section 01 45 16.13 RA Contractor Quality Control, AHAs, field testing results, equipment inspections, sheet pile installation, soil excavation/backfill, waste disposal log for soil and liquid waste, weight tickets, etc.) during the field operations period.
   a. The Daily Report will describe each calendar day's activities (12 a.m. to 11:59 p.m.) beginning with mobilization to the site and ending with demobilization from the site.
   b. Daily Reports will be submitted to the Owner no later than 12:00 noon on the day following the work reported.
   c. At a minimum, Daily Reports will include:
      1) Project name, day, and date.

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2) Weather conditions for the site, including high and low temperature, precipitation levels, maximum and average wind velocity and direction, and sky conditions.
3) Location of Work performed for the day with a figure to illustrate the area, if necessary.
4) Include active Work times, time when Work was not conducted due to maintenance of equipment, time and reason for downtime due to delays by others.
5) Description of Work performed, including approximate linear footage of sheet piling installed, soil excavated, backfill placed, etc.
6) Debris type, approximate volume, location encountered, and location placed.
7) Health and safety reporting to include accidents, spills, and near-misses, and actions taken to contain and correct each incident with the name of the individual reporting the event.
8) Safety topics, images of day's activities, meeting or inspections with applicable decisions, and/or miscellaneous notes appropriate to the day's activities.
9) Equipment summary.
10) Labor hours.
11) Certificates of destruction/disposal.
12) Haul tickets.
13) Completed waste manifests.
14) Details to include in the Daily Reports are further outlined in the Construction Quality Assurance Plan (CQAP).

2. Summary of remedial actions completed each day, including any deviations from the specified SOW.
3. Weekly updated schedule of values showing cumulative amounts for the billing period and cumulative Project to date are to be submitted no later than 9:00 a.m. on Tuesday for each week in which Work is completed for the Project.
4. Detailed progress schedule update and narrative report.
5. Three Phases of Control Preparatory Phase Reports, as needed, prior to the initiation of a new definable feature of work.
6. As-built redline drawings of all permanent features constructed. Beginning and ending elevation of backfill areas will be confirmed and documented using a survey. Stormwater management features and final elevation of the top of the DGVBW and deadman will also be documented. As-built redlines must be submitted to Owner after completion of the Work.
7. A table documenting information on wastes managed, including quantities generated and disposition of wastes.

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8. Disposal: The RA Contractor will provide a copy of the approved profile or letter of approval for each waste stream. The Owner will coordinate with the RA Contractor for the transport and disposal of wastes, as necessary.
9. Fully completed manifests or delivery tickets for all waste streams documenting ultimate disposal, as necessary.
    a. Manifesting: A manifest for each load of waste will be created before leaving the Site. At a minimum, the manifest form will include the following information:
        1) Generator information, including name, address, contact, and phone number, and EPA ID number.
        2) Transporter information, including name and EPA ID number.
        3) Designated facility information, including name, address, phone number, and EPA ID number.
        4) Site name, including street and mailing address.
        5) DOT proper shipping name.
        6) Type and number of container(s).
        7) Quantity of waste (volumetric estimate).
        8) Task order or job number.
        9) Profile number.
        10) 24-hour emergency phone number. Number must be answered 24 hours per day, 7 days per week (i.e. no voicemail).
    b. Post-disposal: The RA Contractor will provide fully executed manifests (with transporter and facility signatures), weight tickets, and Certificates of Disposal/Destruction (CD) as applicable. Originals will be sent directly to the Owner via a means of traceable mail such as Federal Express or UPS or hand-delivered with a signature receipt. <u>Original facility-signed manifests will not be attached to invoices.</u> All original hazardous waste manifests must be returned to the Owner within 25 calendar days.

D. Additional action and informational submittals required by the technical specifications.

1.07 APPLICABLE REGULATIONS

A. General: Work will comply with all Federal, State and local regulations, and with the latest edition of applicable sections of the following regulations, standards, and codes:

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).

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3. Building Code of America.
4. National Electric Code (NEC).
5. National Electrical Manufacturer's Association (NEMA) Code.
6. National Fire Protection Association (NFPA) Standards.
7. Occupational Safety and Health Act.
8. Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120.
9. Michigan Occupational Safety and Health Administration (MIOSHA).
10. Michigan Vehicle Code (MCL Section 257.722).
11. Underwriter's Laboratory (UL).
12. St. Louis Code of Ordinances.
13. Michigan Department of Transportation (MDOT).
14. Michigan Department of Environment, Great Lakes, and Energy (EGLE).
15. United States Environmental Protection Agency (USEPA).
16. Other applicable state and local codes and regulations.

B. Regulatory Framework:

1. This Work is part of the USEPA's Superfund Program and is governed by CERCLA. CERCLA projects are generally exempt from requirements to obtain environmental permits for onsite work under CERCLA 121(e); however, compliance with all substantive requirements is required. Non-environmental permits and permits related to offsite activities must be obtained, and both administrative and substantive requirements apply to offsite activities.
2. A SESC Plan will be required for this Work. The RA Contractor will be required to prepare the SESC Plan for approval and implement erosion control measures as best management practices for controlling erosion, regardless of other requirements.
3. The actions described in this Summary of Work are not likely to result in any atmospheric discharges that would require either notification or permitting under the Clean Air Act (CAA). Under the CAA, temporary sources are not considered stationary sources and therefore are not regulated by the provision set forth in the act; however, any emission or escape into the open air can be declared a public nuisance. To avoid the nuisance rule, best management practices (i.e., periodic wetting of the area) will be implemented by the RA Contractor during the Work.

1.08 HEALTH AND SAFETY

A. The RA Contractor is required to follow the most recent version of U.S. Army Corps of Engineers Engineering Manual 385-1-1.

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B. The RA Contractor will provide its health and safety procedures for the performance of its activities in a HASP. The HASP must meet the requirements given in the General Terms and Conditions. The primary chemicals of concern for this Project are summarized in Article Environmental Contaminants, and may be contained within the soil and/or groundwater within the Work area. The RA Contractor is responsible for the health and safety of its own personnel and any of its Subcontractors' personnel at the Project Site, and will provide, for all its own personnel and any of its Subcontractors' personnel, all health and safety equipment required to comply with the RA Contractor's safety procedures and that are necessary to complete the Work.

C. Failure to comply with the appropriate health and safety procedures outlined in the RA Contractor's HASP and the safety procedures, as determined by Owner, will be considered grounds for a Stop Work Order. The RA Contractor will remedy failure of compliance, as directed and approved by Owner, before resuming Work. The RA Contractor will not be paid for the time occurring after notice of Stop Work Order and before resuming Work and may be responsible for Owner costs during the downtime.

D. Responsibilities:

1. The RA Contractor is responsible for the health and safety of their employees. Each company will designate one site employee as the "Designated Safety Coordinator" (DSC). The DSC must have a minimum of 5 years of construction and safety experience.
2. The Health and Safety Program has three objectives: 1) to protect personnel onsite, 2) to comply with applicable (federal, state, and local) health and safety regulations and 3) minimize health and safety liabilities.
3. All employees shall follow, as a minimum, the requirements of OSHA 29 CFR 1910 and 29 CFR 1926 and MIOSHA Parts 194 and Parts 301-591.

E. Minimum Requirements:

1. Personal Protective Equipment:
   a. General Requirements:
      1) Responsibilities (29 CFR 1910.132):
         a) Employees must use all personal protective equipment (PPE) that maintains their exposure within acceptable limits as defined in the HASP.
         b) Employers must ensure that employees receive training in and have knowledge of the use and maintenance of all PPE that is required to maintain their exposure within acceptable limits.

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2) Employees must be physically able and medically determined qualified to use the PPE and safety equipment that may be required in their job duties.
3) PPE and safety equipment must be tested, inspected, and maintained in serviceable and sanitary condition.
   a) Defective equipment will not be used.
   b) Records of any tests or inspection will be available for inspection by Owner.
4) For hazardous waste operations, RA Contractor must abide by 29 CFR 1910.120, Appendix B.

b. Minimum Requirements for Appropriate Personal Protective Equipment: As described in the RA Contractor's approved HASP.

c. Minimum Requirements for Site Safety:
   1) Safety color code for marking physical hazards (29 CFR 1910.144) will include the following:
      a) Caution tape shall be at a minimum of 3 inches wide, yellow, and the words "CAUTION" spelled out legibly in black.
      b) Safety cans or other portable containers of flammable liquids must be in compliance.
   2) All signs and tags must be in compliance with 29 CFR 1910.145.
   3) Fencing will be required around per 29 CFR 1926.501.

2. Outline for the Site-specific HASP:
   a. Activity Hazard Analysis (AHA):
      1) All definable features of Work will be addressed with an AHA prior to beginning each activity. This chart looks at principal steps of the operation, potential safety/health hazards for each step, and recommended controls for each hazard. In addition, a listing of equipment to be used onsite, inspection requirements, and training requirements for operation of equipment will be included.
      2) Analyses will define the activities being performed, identify the sequences of Work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level.
      3) Work will not begin until the hazard analysis for each Work activity has been reviewed and accepted by Owner.
      4) During the daily safety meeting, the RA Contractor's supervisor will brief their Work crew on the AHA, which will include the day's planned tasks, tools, equipment, and materials that will be used, along with hazards posed and required hazard control procedures for each day's planned activities.

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b. Training requirements are as follows (29 CFR 1910.120.(e)):
   1) 40-hour hazardous waste training.
   2) 8-hour hazardous waste refresher training within the last 12 months.
   3) Site-specific training including names of personnel and alternates responsible for site safety and health; safety, health, and other hazards identified in the AHA; use of PPE; Work practices to minimize risks from hazards; medical surveillance requirements and recognition of symptoms and signs which might indicate overexposure to hazards; and decontamination procedures.
   4) Surveyors: 24-hour hazardous waste training plus 8-hour hazardous waste refresher training within the last 12 months.
      a) No hazardous waste training is required, if there is no potential for surveyor to come in contact with contaminants as determined by the RA Contractor and Owner.

c. Personal Protective Equipment: A specific list of PPE to be used by RA Contractor employees for each site task and operation plus the assigned level of protection and criteria for upgrading or downgrading a task will be included.

d. Medical Surveillance:
   1) As a minimum, list the requirements for annual and any site-specific physical requirements for contaminants of concern on the site.
   2) Provide name, route map, and contact number for emergency medical services available in case of a suspected exposure or emergency.
   3) 5-panel drug testing will be completed for any RA Contractor and Subcontractor onsite employees within 30 days prior to arrival whom will participate directly with any HAZWOPER-related activities. A certified letter stating the 5-panel drug testing was completed for applicable employees will suffice as a submittal.

e. Site Control: Implement appropriate site controls to isolate areas with hazardous substances or physical hazards before Work begins. Establish Work zones, use of the “buddy” system, site communications including emergency signals, and identification of standard operating procedures.

f. Heat and cold stress monitoring plan for all RA Contractor and Subcontractor employees must be implemented in the field, where necessary. This should be clearly defined in the RA Contractor’s HASP.

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g. Decontamination:
   1) Written procedures will be developed and implemented before and during site activities based upon actual site conditions. Decontamination for hand tools, light equipment and personnel will be described in the RA Contractor's AHAs. Decontamination for heavy equipment and trucks will be described in the RA Contractor's Work Plan.
   2) All trucks or other equipment entering the exclusion zones must be decontaminated prior to exiting the exclusion zones. This includes, but is not limited to, trucks transporting contaminated soil from excavation areas to the waste stabilization area (if needed), trucks transporting equipment to and from the exclusion zone(s), trucks transporting contaminated soil from the excavation areas to the landfill(s), and trucks transporting liquids for offsite treatment/disposal. The RA Contractor is responsible for conducting all truck decontamination and management of decontamination wastes.
   3) All equipment leaving the site must be decontaminated and decontamination wastes must be managed, contained and disposed of by the RA Contractor in a manner approved by the Owner in the appropriate plans.

h. Spill Control:
   1) Onsite Spills: Requirements for spill containment procedures will be detailed in the Spill Prevention and Countermeasures Plan. A general description of these procedures will be described in the RA Contractor's HASP.
   2) Offsite Spills: Describe procedures for containment of offsite spills in detail in the Transportation and Disposal Plan; a general description of these procedures will be described in the RA Contractor's HASP.
   3) All personnel leaving the exclusion area will perform the required decontamination. The RA Contractor DSC will observe these operations and ensure proper decontamination procedures are being followed. These procedures will be followed every time personnel leave the Site.
   4) PPE will be cleaned or disposed of in a method specified in the RA Contractor's HASP.

i. Emergency response plan will include the following:
   1) Pre-emergency planning including designation of personnel roles, responsibilities, emergency recognition, safe places of refuge or gathering, evacuation routes, emergency decontamination procedures, alerting procedure, and availability of first aid and medical treatment.

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2) Site emergency equipment including first aid kits, 15-minute eyewash, 20-pound fire extinguishers, bloodborne pathogen kit, emergency map, designated emergency vehicle, and listing of trained first aid and CPR personnel.
3) Procedures for reporting incidents, emergency communications, and testing of the site emergency notification system.
4) Post-emergency evaluation, an evaluation looking at how resources came into play, response of outside sources, and steps to improve the process.

j. Confined Space Entry, if Required by Site Activities: This includes the specific procedure following 29 CFR 1910.146, including training, site isolation, permit procedures, air monitoring, and emergency rescue.

k. Spill Containment Program:
1) Written spill containment program that is targeted at the quantities and types of material brought to the Site by the RA Contractor or as a result of stockpiling or tankage of site materials.
2) Spill control materials in adequate quantities to control solid or liquid spills.
3) Drums or containers for recovery of spilled material or rapidly available local resources to provide these materials.

3. References:
a. CH2M Health and Safety Program Plan.
b. U.S. Army Corps of Engineers Engineering Manual EM 385-1-1.
c. OSHA 29 CFR 1910, General Industry Standards.
d. OSHA 29 CFR 1926, Construction Industry Standards.

1.09 WORK SCHEDULE

A. The RA Contractor will complete Work in accordance with Owner-approved work schedule.

B. RA Contractor will comply with local ordinances governing acceptable work hours or obtain approvals if alternate work hours are required.

1.10 ORDER OF PRECEDENCE

A. In the event of a conflict in the execution of work, the following order of precedence will apply if the order is not specified in the General Terms and Conditions of the RA Contract.

1. Technical Specifications.
2. RA Contract Drawing Details.

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3. RA Contract Drawing Sections or Elevations.
4. RA Contract Drawing Plan Views.

1.11 GREEN AND SUSTAINABLE

A. Green and sustainable materials and practices will be utilized to the extent practicable that they provide a reasonable value to the Owner and meet RA Contract Documents.

1.12 RA CONTRACT TIME

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the RA Contract Documents.

B. Substantial Completion:

1. Substantial Completion will occur when preliminary punch list Work has been completed and the Post-Construction Meeting is conducted with the Owner.
2. The Work is to be performed in 1 mobilization. Project Substantial Completion will occur when DGVBW installation, backfill activities, and site restoration is complete, as shown in the Drawings, and punch list work is complete.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values: Submit on RA Contractor's standard form.
2. Schedule of Estimated Progress Payments:
   a. Submit with initially acceptable Schedule of Values.
   b. Submit adjustments thereto with Application for Payment.
3. Application for Payment.
4. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. On a weekly basis, the RA Contractor will provide an updated Schedule of Values (SOV) as described in Section 01 11 00, Summary of Work.

B. The Schedule of Values will be reviewed weekly during each weekly progress meeting with the Owner. Based on the weekly review, the SOV will be revised, if needed.

C. Upon request of Owner, provide documentation to support the accuracy of the Schedule of Values.

D. The Schedule of Values will correspond to the compensation schedule.

E. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

F. Lump Sum Work:

1. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
2. Break down by Division 02 through 49 with appropriate subdivision of each specification.

G. An unbalanced or front-end loaded schedule will not be acceptable.

H. Summation of the complete Schedule of Values representing all the Work shall equal the RA Contract Price.

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1.03 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

A. Show estimated payment requests throughout RA Contract Times aggregating initial RA Contract Price.

B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and RA Contract Price as reflected by modifications to the RA Contract Documents.

1.04 APPLICATION FOR PAYMENT

A. The Task Order will contain details on making payments through the federal Invoice Processing Platform (IPP). In the event of a conflict between this specification section and the Task Order, the Task Order will take precedence over this specification section.

B. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of RA Contractor.

C. Use detailed Application for Payment Form provided by Owner or other Owner-approved format.

D. Provide separate form for each schedule as applicable.

E. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

F. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Owner.

G. Preparation:

1. Report values to nearest cent.
2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Owner.

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1.05 MEASUREMENT—GENERAL

A. Weighing, surveying, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, the weight or load slip shall be obtained from weigher using properly certified scales and delivered to Owner as documentation.

C. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Owner. Each vehicle shall bear a plainly legible identification mark.

D. Haul materials that are specified for measurement by the cubic yard measured in the vehicle in transport vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Load vehicles to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

E. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction by the RA Contractor will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

F. Units of measure shown on Bid Form shall be as follows, unless specified otherwise.

Item	Method of Measurement
AC	Acre—Field Measure by survey
CY	Cubic Yard—Field Measure by survey within limits specified or shown
CY-VM	Cubic Yard—Measured in Vehicle by Volume
DY	Day
EA	Each—Field Count by RA Contractor
GAL	Gallon—Field Measure by RA Contractor

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Item	Method of Measurement
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by survey
SF	Square Foot – Field Measure by survey
SY	Square Yard – Field Measure by survey
TON	Ton—Weight Measure by Scale (2,000 pounds)

1.06 PAYMENT

A. General:

1. Progress payments will be made in accordance with the RA Contract documents.
2. The date for RA Contractor's submission of monthly Application for Payment will be established at the Preconstruction Conference.

B. Payment for all Lump Sum Work shown or specified in RA Contract Documents is included in the RA Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.

C. Payment for Lump Sum Work covers all Work specified or shown within the limits or Specification sections as shown in Table 1, Lump Sum Price Items, attached as a supplement to this section.

D. Payment for unit price items covers all the labor, materials, and services necessary to furnish and install the items shown in Table 2, Unit Price Items, attached as a supplement to this section.

1.07 PAYMENT FOR WORK COMPLETED

A. Payment for work completed will be made only after the Owner has reviewed the payment application and confirms that the work has been completed satisfactorily according to the specifications and in accordance with the 3-phase quality control process, as discussed in the RA Contractor's Quality Control Plan.

1.08 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.

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2. Quantities of material wasted or disposed of in manner not called for under RA Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of RA Contractor to conform to provisions of RA Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.
7. Miscellaneous Crew or Standby time not approved in writing and in advance by the Owner.

1.09 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored. Payment will be made only for materials incorporated in Work.

1.10 SUPPLEMENTS

A. The supplements listed below, following “End of Section”, are part of this Specification.

1. Table 1, Lump Sum Price Items.
2. Table 2, Unit Price Items.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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TABLE 1

Lump Sum Items

Item	Description
Performance/Payment Bonds and Taxes	Includes the cost for required performance and payment bonds and taxes as required in General Terms & Conditions.
Insurance	Includes the cost for insurance as required to complete the project.
Onsite Preconstruction Meeting	Includes all necessary labor and expenses for all of the RA Contractor's personnel to attend an onsite preconstruction meeting with Owner to introduce project staff and review the project scope and schedule.
Preconstruction Activities	Premobilization submittals development and revisions until approval is obtained, performing borrow source sampling, and participating in preconstruction meetings with EPA and stakeholders, as required.
Permitting	Includes all necessary labor, expenses, and materials to obtain necessary substantive requirement documents required to complete the Work.
Mobilization	Labor, equipment, materials, taxes, and fees to mobilize and setup equipment and mobilize materials to site (excluding king pile and sheet pile materials and delivery, which are covered under separate line items) and prepare staging areas. Includes documenting existing conditions of haul routes with photos and videos, coordination meeting with EPA, EGLE, City of St. Louis, and other onsite contractors.
Third Party Utility Locates	Labor, equipment, materials, taxes and fees to perform third party utility locates and document the results.
Temporary Facilities and Laydown Areas	Labor, equipment, materials, taxes and fees to install temporary utilities, site trailers, site security and fencing, stockpile, staging, and parking areas. Includes costs for separate trailer, furniture, and utilities for USACE. Staging area location(s) subject to approval by the EPA. Payment will be based on the overall percent complete of the project.
Temporary Road Construction	Labor, equipment, materials, taxes and fees, to install temporary roads to support construction activities. Includes installation of culverts, as needed, to maintain site drainage. Includes material testing, placement of material, compaction, and compaction testing. Includes maintenance. Quantity will be determined by survey.
Turbidity Control Feature Installation and Removal	Labor, equipment, materials, taxes, and fees to install and maintain turbidity control and monitoring equipment. For bidding purposes, assume three monitoring locations within the Pine River. Also includes labor, equipment, and materials necessary to remove turbidity control and monitoring equipment when project is complete.

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TABLE 1

Lump Sum Items

Item	Description
Surveys	Includes all necessary labor, equipment, and materials, taxes and fees necessary to perform preconstruction survey, DGBVW installation survey, backfill surveys, and an as-built survey by a Michigan-licensed surveyor. Includes preparation of survey deliverables.
Demobilization and Contract Closeout	Labor, equipment, and materials to remove personnel and equipment from the site after completion of activities. Includes decontamination of equipment prior to demobilization. Also includes completion of final project close-out activities, including providing any remaining as-built drawings and field documentation and preparation of a Remedial Action Completion Report.
Second Mobilization (Optional)	Labor, equipment, materials, taxes, and fees to perform a second mobilization to mobilize equipment, personnel, and materials to site and prepare staging areas if work cannot be completed in one construction season. Document existing condition of haul routes with photos and videos. Line item is to be used only at the written direction of EPA.
Second Demobilization (Optional)	Labor, equipment, and materials to remove personnel and equipment from the site after completion of construction activities completed during second mobilization/construction season. Includes decontamination of equipment prior to demobilization. Also includes completion of final project close-out activities, including providing any remaining as-built drawings, field documentation, and reporting. Line item is to be used only at the written direction of EPA.

END OF SECTION

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
Clearing and Grubbing	Labor, equipment, materials, taxes, and fees required to perform clearing & grubbing of trees, shrubs, grasses and root systems and other vegetation within the work areas. Assumes tree trunks, shrubs, and other vegetation will be chipped and spread onsite.	AC
Erosion Control	Includes all labor, equipment, materials, taxes and fees required to install and maintain erosion controls (i.e. silt fencing, storm water drain protection, and other best management practices) as shown on the drawings. Includes costs for inspections, repairs, and replacement throughout the duration of the project.	LF
King Pile Material Costs	Includes labor, equipment, taxes, and fees to deliver king pile materials to the site and place them in staging area(s).	TN
Sheet Pile Material Costs	Includes labor, equipment, taxes, and fees to deliver sheet pile materials to the site and place them in staging area(s).	TN
Sheet Pile Installation	Includes all labor, equipment, materials, taxes and fees to install sheet piles.	LF
King Pile Installation	Includes all labor, equipment, materials, taxes and fees to install cylindrical steel king piles into the till.	EA
King Pile Embedment Drilling	Includes all labor, equipment, and materials, taxes and fees to drill king pile sockets 10 feet below bottom of cylindrical king pile. Includes costs for managing and solidifying drilling waste and for offsite disposal of drilling waste. Includes costs for analytical sampling for waste profile, preparation of manifests and distribution of signed manifests and certificates of disposal. Assumes drilling waste material will be nonhazardous.	EA

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
King Pile Cleanout	Includes all labor, equipment, and materials, taxes and fees to clean out king piles after king pile and socket installation, prior to placement of rebar and concrete.	EA
King Pile Rebar	Includes all labor, equipment, materials, taxes and fees to deliver, construct, and install king pile rebar cages into king piles..	EA
King Pile Concrete	Includes all labor, equipment, materials, taxes and fees to deliver and place concrete into king piles.	EA
Toe Stone Placement	Includes all labor, equipment, and materials to install geotextile and toe stone at the base of the combination wall.	TON
Dust Monitoring	Includes all labor, equipment, materials, taxes, and fees for dust monitoring throughout preconstruction activities (for background data collection) and DGVBW construction activities. Assumes three monitoring locations.	DAY
Dewatering and Liquid Waste Management	Includes all labor, equipment, materials, taxes, and fees to perform dewatering and liquid management activities throughout DGVBW installation and construction activities. Includes management of displaced river water, stormwater, contact water, and decontamination water. Assumes liquid will be treated and discharged to Pine River under a SRD. Includes sample collection, analytical testing, and reporting required by SRD.	GAL
Backfill-Import Stone Fill	Includes all labor, equipment, materials, taxes, and fees to purchase and transport imported borrow source material to the site. Includes gradation testing. Quantity will be determined by delivery tickets.	CY

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
Backfill - Place Stone Fill	Includes all labor, equipment, materials, taxes, and fees to place and compact backfill material. Includes proof rolling per specifications. Quantity will be determined after compaction, by survey.	CY
Backfill - Import Aggregate Fill	I Includes all labor, equipment, materials, taxes, and fees to purchase and transport imported borrow source material to the site. Includes gradation testing. Quantity will be determined by delivery tickets.	CY
Backfill - Place Aggregate Fill	Includes all labor, equipment, materials, taxes, and fees to place and compact backfill material. Includes proof rolling per specifications. Quantity will be determined after compaction, by survey.	CY
Backfill - Import Granular Fill	Includes all labor, equipment, materials, taxes, and fees to purchase and transport imported borrow source material to the site. Includes QA/QC compliance sampling and gradation and proctor analysis per specifications. Quantity will be determined by delivery tickets.	CY
Backfill - Place Granular Fill	Includes all labor, equipment, materials, taxes, and fees to place and compact backfill material. Includes compaction testing. Quantity will be determined after compaction, by survey.	CY
Backfill – Place Stockpiled Clay Cap Material	Includes all labor, equipment, materials, taxes, and fees to place, and compact stockpiled clay cap material removed for construction of site roads, laydown, and support areas. Quantity will be determined after compaction, by survey.	CY
Backfill – Place Stockpiled Topsoil Material	Includes all labor, equipment, materials, taxes, and fees to place stockpiled topsoil material removed for construction of site roads, laydown, and support areas. Quantity will be determined by survey.	CY

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
Backfill – Import Topsoil	Includes all labor, equipment, materials, taxes, and fees to purchase and transport imported borrow source material to the site. Includes QA/QC compliance sampling and gradation analysis per specifications. Quantity will be determined by delivery tickets.	CY
Backfill – Place Imported Topsoil	Includes all labor, equipment, materials, taxes, and fees to place topsoil. Quantity will be determined by survey.	CY
Geotextile (non-woven) – Supply & Place	Includes all labor, equipment, materials, taxes, and fees to purchase, deliver, and place geotextile between native material and stone fill and also between aggregate fill and granular fill. Quantity will be determined after placement	SF
Ditch Construction	Includes all labor, equipment, materials, taxes and fees to purchase, deliver and place rip rap for ditch construction at existing culverts and stormwater outlets. Includes gradation testing. Quantity will be determined by survey..	CY
Site Restoration	Includes all necessary labor, equipment, materials, taxes, and fees for hydroseeding, watering, and maintenance of disturbed areas from construction activities. Assumes temporary access roads and support facilities will remain in place.	SF
Turbidity Monitoring	Includes all necessary labor, equipment, materials, taxes, and fees to perform turbidity monitoring. For bidding purposes, assume three monitoring locations within the Pine River. Includes monitoring during preconstruction activities (for background data collection) and DGVBW construction activities. Also includes labor equipment, and materials necessary to relocate turbidity control features throughout the project, as required.	DY

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
Transportation and Disposal of Materials Offsite – Nonhazardous Solid Waste	Includes all necessary labor, equipment, materials, taxes, and fees to dispose of clearing and grubbing material that cannot be chipped and spread onsite, miscellaneous debris generated during construction, etc. Includes analytical sampling for waste profile, preparation of manifests and distribution of signed manifests and certificates of disposal. Assumes all material will be nonhazardous. Measurement shall be based on landfill weigh tickets.	TON
Transportation and Disposal of Materials Offsite – Hazardous Solid Waste (Optional)	Includes all necessary labor, equipment, materials, taxes, and fees to dispose of hazardous solid waste. Measurement shall be based on landfill weigh tickets. Includes analytical sampling for waste profile, preparation of manifests and distribution of signed manifests and certificates of disposal.	TON
Transportation and Disposal of Materials Offsite – Hazardous Liquid Waste (Optional)	Includes all necessary labor, equipment, materials, taxes, and fees to dispose of hazardous liquid waste. Includes costs for transporting all accumulated liquids to an offsite disposal facility, and disposal costs. Includes analytical sampling for waste profile, preparation of manifests and distribution of signed manifests and certificates of disposal.	GAL
Transportation and Disposal of Materials Offsite – Nonhazardous Liquid Waste (Optional)	Includes all necessary labor, equipment, materials, taxes, and fees to dispose of nonhazardous liquid waste. Includes costs for transporting all accumulated liquids to an offsite disposal facility, and disposal costs. Includes analytical sampling for waste profile, preparation of manifests and distribution of signed manifests and certificates of disposal.	GAL

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TABLE 2
Unit Price Items

Item	Description	Unit of Measure
Hourly Standby Time (Optional)	Includes all necessary labor, material, and equipment costs for operation shutdown with less than a 12-hr. advance notification from Owner. Applicable for the first 24-hrs following the notification from Owner. Standby time does not cover downtime as a result of RA Contractor's actions that would prevent continued operations, including, but not limited to, RA Contractor equipment failure or relocation, or not meeting other contract requirements nor force-majeure.	CREW HR

END OF SECTION

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SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational:

1. Statement of Qualification (SOQ) for land surveyor.
2. Utility locate tickets:
   a. Documentation of completed utility locates for both MISS DIG and 3rd party.
   b. Submit one copy, within 2 days prior to beginning intrusive activities.
3. Photographs:
   a. Digital Images: Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
   b. Copies of videos and photographs taken by RA Contractor.

B. Action:

1. Survey Documentation:
   a. Pre-Construction Survey: Submit drawings documenting coordinates for DGVBW alignment shown on Drawings and existing topography for area shown on Drawings to support backfill quantity calculations.
   b. DGVBW Installation Surveys: Submit electronic files and coordinates with top of sheet pile and king pile elevations.
   c. Post-Backfill Surveys: Submit electronic files and coordinates with post-backfill grades and calculated backfill volumes for each layer of backfill material placed.
   d. Post-Construction Survey: Submit Drawings documenting coordinates and elevations for top of the DGVBW, stormwater features (including invert elevations), and final surface grades.
   e. Submit electronic files in MicroStation V8i SELECT Series 10 or other compatible format.

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1.02 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these RA Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
2. Coordinate the Work of these RA Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

1.03 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate utility clearance through the local one-call system (MISS DIG). Verify that utilities have been identified and marked prior to beginning excavation and protect the utilities from damage during construction.

B. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

1. Electricity: City of St. Louis
   a. Contact Person: Mike Parsons.
   b. Telephone: 989-681-3351.
2. Telephone/Internet Company: Charter Spectrum.
   a. Telephone: 844-777-3691.
3. Water Department: City of St. Louis
   a. Contact Person: Keith Risdon.
   b. Telephone: 989-681-2137 ext. 1010.
4. 4. Gas Department: Consumers Energy.
   a. Contact Person: Ben Lewis.
   b. Telephone: 517-581-1424.

C. Third Party Utility Locator:

1. The RA Contractor will provide a third-party utility locate subcontractor to perform an independent utility locate search that will help define the location of existing utilities in the work area. The RA Contractor will investigate areas where subsurface work will be performed. The utility locating task will include the following:
   a. Verify the presence or absence of underground utilities in the proposed work areas shown on Drawings.

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b. Methods used to locate underground utilities and anomalies will include ground penetrating radar and electromagnetic/magnetometer.
c. Underground utilities will be marked as appropriate for each utility (e.g. electrical, gas, or water). Utilities must be clearly marked with spray paint and flags capable of withstanding inclement weather and normal abuse in accordance with American Public Works Association (APWA) uniform color codes.
d. All utilities in the area will be delineated and clearly marked.

2. The results of the locate effort will be submitted to the Owner.

1.04 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Task Order Award and before Notice to Proceed, RA Contractor, Owner, and affected nearby property owners (if applicable) and utility owners will make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination will be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs.
2. Upon receipt, and Owner approval, one record copy of documentation to RA Contractor to be kept on file in field office.
3. Such documentation will be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of RA Contractor's operations, and is for the protection of adjacent property owners, RA Contractor, and Owner.

1.05 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases and areas of the Project including pre-construction, construction progress, and post-construction.
2. Owner will have right to select subject matter and vantage point from which photographs are to be taken.

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3. Digital Images: No post-session electronic editing of images is allowed. Stored image will be actual image as captured without cropping or other edits.

B. Pre-Construction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take photographs of Site and facilities and properties adjacent to perimeter of Site.
2. Particular emphasis will be directed to structures both inside and outside the Site.
3. Format: Digital, minimum resolution of 1,832 by 3,264 pixels and 24 bit, millions of color.

C. Construction Progress Photos:

1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent facilities and properties.
2. Weekly: Take photographs using digital, minimum resolution of 1,832 by 3,264 pixels and 24 bit, millions of color.

D. Documentation:

1. Digital Images:
   a. Electronic image will have date taken embedded into image.
   b. Archive using a commercially available photo management system that provides listing of photographs including date and keyword description.
   c. Label file folders or database records with Project and Owner's name, and month and year images were produced.

1.06 PROJECT MILESTONES

A. General: Include the Milestones specified herein as a part of the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.

1.07 REFERENCE POINTS AND SURVEYS

A. All survey work must be completed under the direct supervision of a Professional Land Surveyor licensed and in good standing with the State of Michigan.

B. Location and elevation of bench marks are shown on Drawings.

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C. RA Contractor's Responsibilities:

1. Complete survey work in accordance with Exhibit 1 of this specification.
2. Establish benchmarks convenient to Work and at each king pile along the DGVBW alignment.
3. Establish horizontal reference points or coordinate system with benchmarks and reference points for RA Contractor's use as necessary to lay out Work.
4. Provide additional survey and layout required to layout the Work.
5. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
6. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
7. Retain professional land surveyor or civil engineer registered in state of Michigan who shall perform or supervise engineering surveying necessary for additional construction staking and layout.
8. Maintain complete accurate log of survey work as it progresses as a Record Document.
9. On request of Owner, submit documentation.
10. Provide competent employee(s), tools, stakes, and other equipment and materials required to:
    a. Establish control points, lines, and easement boundaries.
    b. Check layout, survey, and measurement work performed by others.
    c. Measure quantities for payment purposes.
11. Establish clearing limits and set benchmarks convenient for use as necessary to establish basic layout of the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including piping, conduit, and other utilities as specified and as shown on Drawings.

C. Remove specimens of installed Work for testing when requested by Owner.

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3.02 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this specification.

1. Exhibit 1 – Standard Survey Specification.

END OF SECTION

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Draft Standard Survey Specification

1.1 General

- All work must be performed by or under the direction of a currently registered Michigan Licensed Land Surveyor who is licensed and in good standing with the State of Michigan licensing agency (surveyor).
- All documents submitted must bear the surveyor's stamped, dated, and signed seal and a certification that all work was completed under the Surveyor's supervision and that all information contained in the delivered documents are true and accurately shown.
- The surveyor is responsible for obtaining all permits and access permissions required for this work, will take all reasonable precautions to prevent damage to public and private property, and will restore the properties to the condition existing prior to the surveyor's entry.
- All work will be completed under the direction of the surveyor using equipment, personnel, and procedures that will ensure compliance with the accuracy standards as defined herein. It is the responsibility of the supervising land surveyor to ensure that all work under this agreement complies with all federal, state, and local regulations. All documents submitted will bear the surveyor's seal, signature, and a certificate that all work was done under the surveyor's supervision and that all information contained in the document is true and is accurately shown.
- The surveyor is responsible for quality assurance for the survey work performed on this project, which will include but is not limited to fieldwork checks, equipment calibration, office calculations, drawings, and a final peer review. Obtain and report survey check shots to document quality assurance/quality control (QA/QC) measures and to document horizontal and vertical survey accuracies. Post-processing reports will be provided where the global positioning system (GPS) is used. The surveyor will provide documentation of QA and QC completed upon request and at the time of the surveyor's report final deliverable.
- All data and deliverables prepared for this survey are the property of the Owner. The surveyor also understands and agrees that the Owner may reproduce the drawings and use all or part of the information provided on the drawings. This includes any reports prepared in connection with the investigative work for this site without incurring obligation for additional compensation to the surveyor. The original drawings, copies of field notes, and any required survey reports will be and will remain the property of the Owner. All required documents and copies of field notes will be submitted to the Owner upon completion of the work or upon request.
- Daily information will be recorded in hard copy field notebook format, and any data collector information will also be provided to the Owner. Electronic field notes alone are not acceptable. In addition, QA/QC checks and other measurement information will be included in the field notes. The field notes will include the following: the date, names of the crew, weather conditions, barometric pressure, and all collected survey data information. The field notes will contain enough sketches and other information to clearly show the work performed, including control monuments used and set. The field notes will be complete enough for retracement of the surveys by others.

- Where practical, traverses and level loops will include and verify two different permanent control monuments. Where not practical, they will be closed to the starting point control monument, and the closure error recorded. If the error is above the standards outlined above, then the surveyor will re-run the horizontal and/or vertical traverses until the errors are reduced to within the acceptable range.
- All surveyed features will be incorporated into the base mapping. The Owner will be onsite to confirm the exact survey area.

1.2 Specifications of Work

- The surveyor will perform and provide data for the following surveys, at a minimum:
  - Control Surveys – Recover and confirm existing control suitable for the work described herein. Establish control onsite to complete the work specified herein. Recover and tie-in control established for previous surveys.
  - Pre-construction survey, including horizontal and vertical extents of work areas, and horizontal and vertical extents of site access roads, laydown and storage areas, and utilities.
  - DGVBW Installation Surveys documenting horizontal extents of the DGVBW alignment and top elevations of each king pile.
  - Post-backfill survey documenting horizontal and vertical extents of backfill materials. A post-backfill survey will be performed after completion of general fill placement and after completion of topsoil placement (to be within 0.1 foot of elevations shown on grading plan) to calculate volumes of materials placed between the shoreline and DGVBW.
  - Post-construction survey, including horizontal and vertical extents of Work.
- The objective of this task is the delivery of a 1”=20-feet scale, one-half foot contour interval accuracy planimetric and topographic mapping to the accuracies specified in this document, and to deliver a one-half-foot contour interval accuracy DTM file to be used for volume calculations.
- Accuracy of Control: The surveyor will recover or establish horizontal and vertical control monuments for the site. The horizontal accuracy of the control will be Third Order Class I, (1:10,000) or better, and the vertical accuracy will be Third Order, (0.05√m) as outlined in the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards, Part 4: Standards for Architecture, Engineering, Constructions (A/E/C) and Facility Management.

  Prior to using GPS survey methods to establish onsite control, the surveyor will describe their planned method and provide the Owner with their determination of the horizontal and vertical accuracy they can achieve based on their planned GPS methodology and baseline lengths and how they plan to document achievement of the attained accuracy. GPS cannot be used until the accuracy determination is provided by the surveyor and is approved by the Owner.
- If GPS is allowed for establishing onsite horizontal control, then the surveyor will also perform and document direct field measurement checks between the monuments established using GPS.
- If GPS is allowed for establishing vertical control, then the surveyor will also perform and document direct differential level loop closure checks between the monuments established using GPS.

- Accuracy of all Other Field Surveys: Other than the control surveys, field survey mapping will comply with FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for A/E/C, and facility management with relative accuracy tolerances of ±0.25 foot for the horizontal and ±0.07 foot for the vertical on all hard surfaces (including compacted ground surfaces) and ±0.10 foot for the vertical on soft or natural ground surfaces.
- The surveyor will provide coordinates of all points X, Y, and Z to the nearest 0.01 foot, except ground control coordinates will be reported to three decimal places.
- Where practical, all differential level and horizontal traverses will be closed to a second benchmark or control monument and the errors recorded. If the errors are above the standards outlined above, then the survey will re-run the horizontal and vertical traverses until the errors are eliminated within the acceptable range.
- The surveyor will research, recover, and confirm the existing past project horizontal and vertical control networks found on or near the properties. The surveyor will confirm that the horizontal and vertical coordinate system and datum(s) specified herein (including adjustments) are consistent with the coordinate system and datum(s) currently in use on the properties. If the surveyor determines that the past systems are different than those specified herein, then the surveyor will explain the differences and will work with the Owner to decide which systems to use for the work identified in this document. Unless otherwise agreed to in writing, the horizontal coordinate system and horizontal and vertical datum(s) will be as follows:
  - The project horizontal coordinate system and datum will be the Michigan State Plane Coordinates System, South Zone, North American Datum of 1983 (NAD83) most current adjustment.
  - The project vertical datum will be the North American Vertical Datum of 1988, most current adjustment.
- The unit of measure will be the International Foot.

1.3 Standards and Delivery Formats

Survey Accuracy Standard –
FGDC Geospatial Positioning Accuracy Standards, Part 4: Standards for A/E/C, and Facility Management.

Map Accuracy Standard –
ASPRS (Map) Accuracy Standards – Class 1 for the required map scale and contour interval, except the X, Y, and Z positions for all surveyed points shown in the mapping will comply with the survey accuracy standards cited in this scope of work.

CAD Standard –
National CAD Standards (NCS), as published for the National Institute of Building Sciences.

Geographic Information System (GIS) Standard –
Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE), version 2.6.

GIS Format –
GIS deliverables will be provided in either ESRI's shape file (.shp) or geodatabase (.gdb) format, along with an accompanying map document (.mxd) in ArcMap Version 10.2 or newer. All shape files and/or geodatabases must adhere to the Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE), version 2.6. At a minimum, the naming convention of SDSFIE must be followed and relevant attribute information populated. Should the surveyor be unable to provide the information in the SDSFIE format, the surveyor will provide to the Owner (via the RA Contractor) information to define the GIS format proposed for use and obtain acceptance from the Owner prior to use.

CAD Format –
CAD deliverables will be provided in a native current version of MicroStation or AutoCAD electronic format. All electronic drawing symbology must conform to the CAD Standards identified above.

Minimum Content of the Map/Drawing Deliverables –

Construction staking Record Map: Scale to be proposed by the surveyor for approval by the Owner.

As-Built Survey Base Mapping: For plotting at 1 inch = 20 feet horizontal scale.

Minimum Content Requirements		
Title block	North arrow	Scale (Bar) and contour interval
Date of survey	Legend with symbols and abbreviations	Coordinate system and datum – horizontal and vertical
Grid Ticks – A minimum of four labeled grid ticks	Grid Values – Coordinate system values for the grid ticks	All survey control monuments found and set
Surveyor's Certificate – Which certifies that all work complies with the accuracy requirements and with federal, state, laws, codes, ordinances, rules, and regulations.	Surveyor's stamped, dated, and signed seal	

Coordinate Listing of Surveyed Points –
A Microsoft Excel spreadsheet file containing ALL survey shots/points will be provided in the following format:

- Point number/name, northing, easting, elevation, field code, and point description.
- Control point northings and eastings and elevations will be reported to 3 decimal places.
- The northing, easting, and elevation for all points, other than control points, will be reported to 2 decimal places.
- All field-collected data will have unique point numbers/names assigned and point numbers/names will not be re-used in subsequent field surveys for the project.

1.4 Detailed Scope of Services by Task

1.4.1 Control Surveys

If existing horizontal control monuments are not recovered very near the survey areas, then two inter-visible pair (three semi-permanent) control monuments will be set (e.g., 30-inch or longer, #5 rebar or larger, or equivalent, driven to refusal and appropriately capped and marked). These monuments will be set at ground level and will achieve the accuracies stated herein.

If existing vertical monuments are not recovered very near the survey areas, then two pairs of semi-permanent vertical benchmark control monuments (three benchmarks) will be set. These monuments can be the same points as the horizontal control monuments if there are no existing features or structures available that would provide more stability for vertical control monuments (e.g., bridge headwalls, building foundation, sidewalks, curbs, etc. where a chiseled square could be generated).

Construction activities will be performed within the survey/mapping area; therefore, the horizontal and vertical control monuments will be set nearby but outside of the survey area in an area that will be undisturbed by construction activities.

When control is established, regardless of the techniques used (e.g., GPS or conventional Total Station survey) the surveyor will conduct direct conventional field measurements to confirm the accuracy of the new control points and will report the results. The surveyor will base all surveys, horizontal and vertical, on the survey control monuments recovered or established as the project control monuments.

Control Surveys will include the following:

1. Recovered or established NAD83 State Plane Coordinate System horizontal control monuments.
2. Recovered or established Project North American Vertical Datum of 1988 benchmark monuments.
3. Data sheets, descriptions, to-reach descriptions, photographs, and coordinate listings of all found and set control monuments.
4. All other information described in the scope of work regarding the control will be included as part of the surveyor's report and/or base mapping deliverables.

1.4.2 Preconstruction Survey

This task includes planimetric and topographic mapping, DTM development and contour mapping of the preconstruction condition of the Work area shown in the Drawings. Conduct Total Station and GPS field surveys as necessary to generate topographic and planimetric base mapping in the areas shown on the Drawings. The objective for this task is the delivery of 1"=50-feet scale, one-half foot contour interval accuracy planimetric and topographic mapping to the accuracies specified in this document for "Other Field Surveys" and to deliver a one-half-foot contour interval accuracy DTM file to be used for engineering design and volume calculations.

Deliverables –
The deliverables for this task include the following:

1. DTM model in either INROADS or CIVIL3D format, and in an ESRI TIN format together with the base 3D DTM input data (obscured areas, break lines, and spot elevations in CAD and GIS format). In addition to the DTM format files the 3D triangle surfaces and/or triangle edges shall be delivered.
2. Planimetric and topographic base mapping, including one-half-foot contours interpolated from the DTM. Labeling of features and contours shall be provided for 50-scale plotted output. Plotted output shall be on a 22" by 34" sheet size. The base mapping shall include all control monuments found and set and shall contain the minimum content requirements described in the Minimum Content of Map/Drawing Deliverables Section. The base mapping deliverables shall be delivered in ESRI ArcMap GIS format including .mxd map document in ArcMap10.2.1 or higher and associated shape files or a personal geodatabase. If the Surveyor does not have ESRI GIS capabilities the CAD deliverables shall be delivered in a manner that can be easily converted to GIS. The ease of conversion to GIS shall be demonstrated as part of the delivery.

1.4.3 DGVBW Installation Survey

This task includes the collection of horizontal and vertical positions for the top of each constructed king pile along the DGVBW alignment. The objective for this task is the delivery of 1"=50-feet scale mapping that shows the final locations and elevations of the king piles to verify construction to design elevation.

Deliverables –
The deliverables for this task shall include the following:

1. Base mapping showing the locations and final elevations of all king piles. Labeling of features and contours shall be provided for 50-scale plotted output. Plotted output shall be on a 22" by 34" sheet size. The base mapping shall include all control monuments found and set and shall contain the minimum content requirements described in the Minimum Content of Map/Drawing Deliverables Section. The base mapping deliverables shall be delivered in ESRI ArcMap GIS format including .mxd map document in ArcMap10.2.1 or higher and associated shape files or a personal geodatabase. If the Surveyor does not have ESRI GIS capabilities the CAD deliverables shall be delivered in a manner that can be easily converted to GIS. The ease of conversion to GIS shall be demonstrated as part of the delivery.

1.4.4 Post Backfill Surveys

This task includes planimetric and topographic mapping, DTM development and contour mapping of the backfill areas for quantity calculations and confirmation that backfill material is placed in accordance with the grading plan. Conduct Total Station and GPS field surveys as necessary to generate topographic and planimetric base mapping and to provide quantity calculations in the areas requiring backfill, for each type of backfill material placed. The objective for this task is the delivery of 1"=50-feet scale, one-half foot contour interval accuracy planimetric and topographic mapping to the accuracies specified in this document for "Other Field Surveys" and to deliver a one-half-foot contour interval accuracy DTM file to be used for engineering design and volume calculations.

Deliverables –
The deliverables for this task include the following:

1. DTM model in either INROADS or CIVIL3D format, and in an ESRI TIN format together with the base 3D DTM input data (obscured areas, break lines, and spot elevations in CAD and GIS format). In addition to the DTM format files the 3D triangle surfaces and/or triangle edges shall be delivered.

Planimetric and topographic base mapping, including one-half-foot contours interpolated from the DTM. Labeling of features and contours shall be provided for 50-scale plotted output. Plotted output shall be on a 22" by 34" sheet size. The base mapping shall include all control monuments found and set and shall contain the minimum content requirements described in the Minimum Content of Map/Drawing Deliverables Section. The base mapping deliverables shall be delivered in ESRI ArcMap GIS format including .mxd map document in ArcMap10.2.1 or higher and associated shape files or a personal geodatabase. If the Surveyor does not have ESRI GIS capabilities the CAD deliverables shall be delivered in a manner that can be easily converted to GIS. The ease of conversion to GIS shall be demonstrated as part of the delivery.

1.4.5 Post Construction Survey

This task includes planimetric and topographic mapping, DTM development and contour mapping of the final grades and locations of permanent features (such as stormwater features and invert elevations) within the Work area. Conduct Total Station and GPS field surveys as necessary to generate topographic and planimetric base mapping for as-built documentation. The objective for this task is the delivery of 1"=50-feet scale, one-half foot contour interval accuracy planimetric and topographic mapping to the accuracies specified in this document for "Other Field Surveys" and to deliver a one-half-foot contour interval accuracy DTM file to be used for as-built documentation.

Deliverables –
The deliverables for this task include the following:

1. DTM model in either INROADS or CIVIL3D format, and in an ESRI TIN format together with the base 3D DTM input data (obscured areas, break lines, and spot elevations in CAD and GIS format). In addition to the DTM format files the 3D triangle surfaces and/or triangle edges shall be delivered.

Planimetric and topographic base mapping, including one-half-foot contours interpolated from the DTM. Labeling of features and contours shall be provided for 50-scale plotted output. Plotted output shall be on a 22" by 34"sheet size. The base mapping shall include all control monuments found and set and shall contain the minimum content requirements described in the Minimum Content of Map/Drawing Deliverables Section. The base mapping deliverables shall be delivered in ESRI ArcMap GIS format including .mxd map document in ArcMap10.2.1 or higher and associated shape files or a personal geodatabase. If the Surveyor does not have ESRI GIS capabilities the CAD deliverables shall be delivered in a manner that can be easily converted to GIS. The ease of conversion to GIS shall be demonstrated as part of the delivery.

1.4.6 Surveyor's Report

Surveyor's Report will include the following:

1. A survey report will be prepared and delivered addressing all survey fieldwork and mapping performed. The survey report will include the following:
    a. Copies of all field notes, manual, and electronic.
    b. Documentation of the horizontal coordinate system and horizontal and vertical datum(s) and adjustments.
    c. The control monuments recovered and set, and those used as the basis for the surveys.
    d. The surveyor's report will describe the equipment and methodology used to perform the work and will also describe the results of the survey and accuracies attained.
    e. Documentation of the QC procedures and checks performed and their results.
    f. The report will contain a coordinate point listing for all points field surveyed provided in both paper and Microsoft Excel electronic format.
    g. The report will be stamped, dated, and signed by the surveyor who will certify that the work was completed in compliance with the specifications and that the deliverables meet or exceed (are better than) the specified accuracy requirements.
    h. The surveyor's report will be delivered in hard copy, in pdf format, and in Microsoft Word format. It will be delivered in draft in Word format for review and comment by the Owner. A final version, addressing all comments, will also be delivered.
2. A record map containing all points surveyed. The map must include the minimum content requirements listed in the table in the Minimum Content of Map/Drawing Deliverables section of this document. This deliverable will be delivered in ESRI ArcMap GIS format, including an .mxd map document in ArcMap 10.2.1 or higher and associated shape files or a personal geodatabase. If the surveyor does not have ESRI GIS capabilities, then the CAD deliverables will be delivered in a manner that can be easily converted to GIS. The ease of conversion to GIS will be demonstrated as part of the delivery.

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. RA Contractor will participate in specified project meetings as required herein. The meetings include the following:

1. Pre-construction conference.
2. Scheduling and logistics meetings.
3. Pre-construction meetings.
4. 3 Phases of Control (POC) Preparatory and Initial phase meetings.
5. Post-construction meetings.
6. Daily tailgate meetings.
7. Weekly progress meetings.
8. Final post-construction meeting.
9. Other meetings that may be determined necessary during the construction period.

B. RA Contractor will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 2 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. RA Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Temporary controls (e.g., noise control, dust suppression, sanitation, stormwater controls).
5. Coordination with EGLE, the City of St. Louis, and other stakeholders.
6. Progress payment procedures.
7. Project changes and clarification procedures.
8. Use of Site, access, office and storage areas, security and temporary facilities.
9. Major product delivery and priorities.

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10. RA Contractor's HASP, Activity Hazard Analyses, and designated safety coordinator.
11. RA Contractor Key Personnel Information and Points of Contact.
12. Status of permits, license or required approvals.
13. Status of submittals.
14. Maintaining required records.
15. RA Contractor's Quality Control Plan.
16. Work Plan, including all supplemental plans outlined in Section 01 11 00, Summary of Work.
17. Soil Erosion and Sedimentation Control Plan.
18. Other Contract requirements as determined by Owner.

B. Attendees will include:

1. Owner's Representative.
2. EGLE representative(s), as necessary.
3. RA Contractor's project manager.
4. RA Contractor's resident superintendent.
5. RA Contractor's quality control representative.
6. RA Contractor's designated safety coordinator.
7. Subcontractors' representatives whom RA Contractor may desire or Owner may request to attend.
8. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation. A preliminary schedule review meeting will be conducted at the time of the Preconstruction Conference.

1.04 DAILY TAILGATE MEETINGS

A. Daily tailgate meetings will be conducted every workday morning prior to starting Work for the day. The time of the meeting will be determined during the Preconstruction Conference. Generally, attendees for this meeting will include all RA Contractor, Subcontractor and lower-tier Subcontractor personnel who will be working that day. Documentation of the meeting will be provided to Owner by 10 a.m. that same day.

B. Daily tailgate meetings will discuss the following subjects, as a minimum:

1. The work planned for the day.
2. Changes in work assignment.
3. Health and safety issues.
4. Quality issues.

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5. Review problems encountered the previous day.
6. Review and sign the AHA prior to beginning any Work onsite.

1.05 WEEKLY PROGRESS MEETINGS

A. RA Contractor will schedule regular progress meetings at Site, conducted weekly to review the Work progress, Schedule of Submittals, Schedule of Values, contract modifications, safety performance since the previous meetings, progress schedule, sample collection and submissions schedule, Quality Control meetings and other matters that require discussion and resolution. Attendees will include:

1. Owner
2. Owner's Representative.
3. RA Contractor's representative(s).
4. Subcontractors, lower-tier Subcontractors, and Suppliers, as appropriate.
5. Others as appropriate.

1.06 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control.

1.07 POST-CONSTRUCTION MEETINGS

A. Preliminary Post-Construction meetings will be conducted following completion of restoration to review acceptability of completed Work and to develop punch list items as required. During the meeting a copy of the edited survey notes and construction drawings will be reviewed. The RA Contractor will coordinate and lead the meeting with the Owner or Owner's Representative in attendance at the site.

B. A final Post-Construction meeting will be conducted one week after the preliminary post-construction meeting. The RA Contractor will attend a mandatory final post-construction meeting for the project, which will be scheduled after completion of all field activities but prior to RA Contractor demobilization. The purpose of this final inspection/meeting is to close out any punch list items, discuss schedule for demobilization, and discuss delivery of all required deliverables.

1.08 PUBLIC MEETINGS

A. The RA Contractor may attend, when specifically directed by Owner or Owner's Representative, public meetings between RA Contract award and final demobilization. During the meetings, the RA Contractor will provide technical support to the Owner and/or Owner's Representative. The meetings

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are typically held at a venue near the site, such as at a local public library or school. The meetings may occur in the evenings or on Saturdays to accommodate attendance by the public.

B. The RA Contractor may be required to answer questions related to construction and project schedule during the meetings. The RA Contractor will also support the Owner and/or Owner's Representative in preparation of educational materials related to the construction portion of the project. Materials may include fliers, figures, poster boards, and frequently-asked question (FAQ) sheets. The RA Contractor will also provide information to the Owner and/or Owner's Representative that can be used in updates provided to the public and the press.

C. All communications with the public and press will be coordinated by the Owner. The RA Contractor will not engage in unauthorized communications with the public or press related to the project.

1.09 OTHER MEETINGS

A. In accordance with RA Contract Documents and as may be required by Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.
2. Overall Progress Schedule: Submit adjusted schedule with each Monthly Application for Payment in accordance with the General Term and Conditions, and at such other times as necessary to reflect:
   a. Progress of Work in each area of the project to within 2 working days prior to submission;
   b. Include rolling 2-week look-ahead;
   c. Changes in Work scope and activities modified since submission;
   d. Delays in Submittals or resubmittals, deliveries, or Work;
   e. Adjusted or modified sequences of Work;
   f. Other identifiable changes; and
   g. Revised projections of progress and completion.
3. Time Impact Analysis (TIA): Submitted with each cost and time proposal for a proposed change.

4. For each progress schedule submission,
   a. RA Contractor's certification that Progress Schedule submission is actual schedule being utilized for execution of the Work.
   b. One electronic copy will be provided in specified application format.
   c. Electronic file compatible with Microsoft Office Project 365 unless otherwise approved by Owner.
   d. Narrative Progress Report.

5. Prior to final payment, submit a final updated progress schedule.

1.02 SCHEDULE COORDINATION

A. The construction schedule will be reviewed during the weekly progress meetings.

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1.03 PRELIMINARY PROGRESS SCHEDULE

A. The schedule will show major Work activities, beginning with Notice to Proceed. The major Work activities will include project coordination, mobilization, and all major activities outlined in the Summary of Work through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Preconstruction Conference.
4. Project Mobilization Activities.
5. Submittals, with review time.
6. Early procurement activities for long lead equipment and materials.
7. Initial Site work.
8. Site preparation activities.
9. Specified Work sequences and construction constraints.
10. Contract Milestone and Completion Dates.
11. Post-construction Meetings.
12. Project close-out summary.
13. Demobilization summary.

C. The Preliminary Progress Schedule will show Work approach, sequences, and constraints. This schedule data will be used by the RA Contractor in preparation of the Detailed Progress Schedule.

D. Format: In accordance with Article Progress Schedule—Gantt Chart.

1.04 OVERALL PROGRESS SCHEDULE

A. Notice to Proceed will be issued only after the Overall Progress Schedule has been reviewed as acceptable by Owner in accordance with Section 01 33 00, Submittal Procedures. Owner will review the initial submittal and subsequent resubmittals of the Overall Progress Schedule within 7 calendar days of receipt.

B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by RA Contractor.

C. When accepted by Owner, Overall Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.

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D. Format: In accordance with Article Progress Schedule—Gantt Chart.

E. Update weekly to reflect actual progress and occurrences to date, including weather delays.

F. Schedule(s) will reflect Work logic sequences, restraints, delivery windows, review times, Subcontract Times, and Milestones set forth in the Agreement and will begin with the date of Notice to Proceed and conclude with the date of Final Completion.

G. The schedule requirement herein is the minimum required.

H. RA Contractor may prepare a more sophisticated schedule if such will aid RA Contractor in execution and timely completion of Work.

I. Float time is a Project resource available to both parties to meet RA contract Milestones and Subcontract Times.

J. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques will be shared to proportionate benefit of the Owner and RA Contractor.

K. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, (iii) extends Work beyond contract completion date and is approved by Owner.

L. If RA Contractor provides an accepted schedule with an early completion date, Owner reserves the right to reduce RA Contract Times to match the early completion date by issuing a deductive Change Order at no change in cost.

1.05 PROGRESS SCHEDULES – GANTT CHART

A. General: Comprehensive Gantt chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this Specification, this Specification will govern.

B. Format:

1. Prepared in approved version of Microsoft Project 365, or similar program.
2. Electronic color Adobe Acrobat file sized to 11-inch by 17-inch sheets.

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3. Title Block: Show name of project, Owner, date submitted, revision or update number, and name of scheduler. Updated schedules will indicate data date.
4. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
5. Identify each activity with a unique number and a brief description of the Work associated with that activity.
6. Indicate the critical path.
7. Show, at a minimum, the controlling relationships between activities.
8. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
9. Plot activities on an early start basis unless otherwise requested by RA Contractor.
10. Provide a legend to describe standard and special symbols used.
11. Schedule will show accepted baseline start and finish dates, and actual start and finish dates.
12. Submitted electronically in Microsoft Project 365, or similar, and Adobe Acrobat file formats.

C. Contents:

1. Schedule will begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. Identify Work calendar basis using days as a unit of measure.
3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.
4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
5. Reflect sequences of the Work, restraints, delivery windows, review times, Subcontract Times and Project Milestones set forth in the Agreement and this section.
6. Include as applicable at minimum:
   a. Obtaining permits, submittals for early product procurement, and long lead time items.
   b. Mobilization and other preliminary activities.
   c. Pre-construction and Post-construction meetings.
   d. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s).
   e. Subcontract Work.
   f. Major equipment design, fabrication, and delivery dates.
   g. Site preparation activities.
   h. DGVBW construction activities.
   i. Dewatering activities.
   j. Transportation and disposal.

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k. Excavation and Backfilling.
l. Site restoration activities.
m. Project closeout and cleanup.
n. Demobilization.
o. Other important Work for each major DFOW.

1.06 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 2 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.
7. Report of changed logic.

B. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), RA Contractor shall submit, within 7 days of such failure, a written statement as to how RA Contractor intends to correct nonperformance to return Project to acceptable current Progress Schedule. Actions by RA Contractor to complete the Work within RA Contract Times (or Milestones) will not be justification for adjustment to RA Contract Price or RA Contract Times.

C. Owner may order RA Contractor to increase equipment, labor force, or working hours if RA Contractor fails to:

1. Complete a Milestone activity by its completion date.
2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.07 NARRATIVE PROGRESS REPORT

A. Format:

1. Organize same as Progress Schedule.
2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

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B. Contents:

1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
3. RA Contractor's plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential RA Contract changes.
4. Identification of new activities and sequences as a result of executed RA Contract changes.
5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from RA Contractor-caused delays.

1.08 CHANGES TO WORK SCHEDULE

A. Time Impact Analysis (TIA) submitted with each cost and time proposal for a proposed change to illustrate the influence of each change or delay on the Final Completion or milestones.

B. Each TIA must be in both narrative and schedule form. The narrative must define the scope and conditions of the change; provide start and finish dates of impact, successor and predecessor activity to impact period, responsible party, describe how it originated, and how it impacts the schedule.

C. All TIAs must include any mitigation, and must determine the apportionment of the overall delay assignable to each individual delay. The associated narrative must clearly describe the findings in a chronological listing beginning with the earliest delay event.

1. Identify types of delays as follows:
   a. Excusable Delay: Force-Majeure (e.g. weather) – RA Contractor may receive time extension, but the delay will not be compensable.

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b. Inexcusable Delay: RA Contractor Responsibility – RA Contractor will not receive time extension or compensation for the delay.
c. Compensable Delay: Government Responsibility – RA Contractor may receive compensable time extension.

2. If a combination of any of the delay types outlined above occurs, it is considered a Concurrent Delay, which will require an analysis of the facts to determine compensability and entitlement to any time extension under the applicable contract clauses.

1.09 SCHEDULE ACCEPTANCE

A. Owner's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. RA Contract Times, including Final Completion and all intermediate Milestones, are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected.
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
2. In all other respects, Owner acceptance of RA Contractor's schedule indicates that, in Owner's judgment, schedule represents reasonable plan for constructing Project in accordance with the RA Contract Documents. Owner review will not make any change in RA Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the RA Contract Documents will not thereby indicate acceptance of that change, unless RA Contractor has explicitly called the nonconformance to Owner's attention in submittal. Schedule remains RA Contractor's responsibility and RA Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the RA Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 2 days.
2. Until acceptable to Owner as Baseline Progress Schedule, continue review and revision process, during which time RA Contractor will update schedule on a weekly basis to reflect actual progress and occurrences to date.

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C. Unacceptable Detailed Progress Schedule:

1. Make requested corrections; resubmit within 2 days.
2. Until acceptable to Owner as Baseline Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Owner's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.10 CLAIMS FOR ADJUSTMENT OF RA CONTRACT TIMES:

1. Where Owner has not yet rendered formal decision on RA Contractor's Claim for adjustment of RA Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Owner.
2. It is understood and agreed that such interim acceptance will not be binding on either RA Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the RA Contract Times.
3. Revise Progress Schedule prepared thereafter in accordance with Owner's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 GENERAL

A. This section may be revised prior to or during the remedial action to comply with the Owner's submittal procedures.

1.02 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by RA Contractor that requires Owner's approval.

B. Informational Submittal: Information submitted by RA Contractor that requires Owner's review and determination that submitted information is in accordance with the Conditions of the RA Contract.

1.03 PROCEDURES

A. Direct sample submittals to Owner, at an address to be determined.

B. Electronic Submittals: Submittals will, unless otherwise specified, be made in electronic format.

1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
3. PDF files shall be set to open "Bookmarks and Page" view.
4. Add general information to each PDF file, including title, subject, author, and keywords.
5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch or, 11-inch by 17-inch. No other paper sizes will be accepted.
6. Submit new electronic files for each resubmittal.
7. Include a copy of the Transmittal form, located at end of section, with each electronic file.
8. Owner will reject submittal that is not electronically submitted, unless specifically accepted.
9. Provide Owner with authorization to reproduce and distribute each file as many times as necessary for Project documentation.

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10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. RA Contractor shall:
   a. Review each submittal and check for compliance with RA Contract Documents.
   b. Complete, sign, and transmit with each submittal package, one Transmittal of RA Contractor's Submittal form attached at end of this section or in alternative format approved by Owner.
   c. Identify each submittal with the following before submitting to Owner:
      1) Project name, submittal number, Specification number, RA Contractor reviewer name, date of RA Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with RA Contract Documents.
      2) Owner will not review submittals that do not bear RA Contractor's signature certifying the submittal has been checked and approved for compliance with RA Contract documents and will return them without action.
   d. Numbering and Tracking System:
         a) Sequentially number each submittal.
         b) Resubmission of submittal shall have original number with sequential alphabetic suffix.
   e. Specification section and paragraph to which submittal applies.
   f. Project title and Owner's project number.
   g. Date of transmittal.
   h. Names of RA Contractor, Subcontractor, Lower-tier Subcontractor or Supplier, and manufacturer as appropriate.
2. Identify and describe each deviation or variation from RA Contract Documents.
3. RA Contractor is responsible for thorough review of Subcontractor submittals, prior to submittal to Owner for final review and approval.
4. All action and information submittals will be submitted electronically by method determined by Owner (e.g., secure website, email).

D. Format:

1. Do not base Shop Drawings on reproductions of RA Contract Documents.

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2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with RA Contract Documents.
4. Index with labeled tab dividers in orderly manner.

E. Timeliness: Schedule and submit in accordance with approved project schedule.

F. Processing Time:

1. Time for review shall commence on Owner's receipt of submittal.
2. Owner will act upon RA Contractor's submittal and transmit response to RA Contractor not later than 10 work days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of RA Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

G. Resubmittals: Clearly identify each correction or change made.

H. Incomplete Submittals:

Owner will return entire submittal for RA Contractor's revision if preliminary review deems it incomplete.

I. Submittals not required by RA Contract Documents:

1. Will not be reviewed and will be returned stamped "Not Subject to Review."
2. Owner will keep one copy and return submittal to RA Contractor.

1.04 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. Copies: One reproduceable electronic copy, except copyrighted documents, unless requested otherwise by the Owner.

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2. Identify and Indicate:
   a. Applicable RA Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
   b. Equipment and Component Title: Identical to title shown on Drawings.
   c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
   d. Project-specific information drawn accurately to scale.
3. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
4. Product Data: Provide as specified in individual specifications.
5. Foreign Manufacturers:
   a. When proposed, include the following information:
      1) Names and addresses of at least two companies that maintain technical service representatives close to Project.
      2) Complete list of spare parts and accessories for each piece of equipment.

C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.
3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

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D. Action Submittal Dispositions: Owner will review submittals and respond as noted:

1. Approved:
   a. RA Contractor may incorporate product(s) or implement Work covered by submittal.
   b. Distribution:
      1) Electronic copy provided to Owner.
      2) Electronic copy retained in Owner's file.
      3) Electronic copy returned to RA Contractor appropriately annotated.
2. Approved as Noted:
   a. RA Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Owner's notations.
   b. Distribution:
      1) Electronic copy provided to Owner's.
      2) Electronic copy retained in Owner's file.
      3) Electronic copy returned to RA Contractor appropriately annotated.
3. Partial Approval, Resubmit as Noted:
   a. Make corrections or obtain missing portions, and resubmit.
   b. Except for portions indicated, RA Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Owner's notations.
   c. Distribution:
      1) Electronic copy provided to Owner's.
      2) Electronic copy retained in Owner's file.
      3) Electronic copy returned to RA Contractor appropriately annotated.
4. Revise and Resubmit:
   a. RA Contractor may not incorporate product(s) or implement Work covered by submittal.
   b. Distribution:
      1) Electronic copy provided to Owner's .
      2) Electronic copy retained in Owner's file.
      3) Electronic copy returned to RA Contractor appropriately annotated.

1.05 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: One electronic, except copyrighted documents, unless requested otherwise by the Owner.

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2. Refer to individual specification sections for specific submittal requirements.
3. Owner will review each submittal. If submittal meets conditions of the RA Contract, Owner will forward copy to appropriate parties. If Owner determines submittal does not meet conditions of the RA Contract and is therefore considered unacceptable, Owner will retain one copy and return remaining copy with review comments to RA Contractor, and require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.

C. Construction Photographs and Video: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in RA Contract Documents.

D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

E. RA Contractor-design Data (related to temporary construction):

1. Written and graphic information.
2. List of assumptions.
3. List of performance and design criteria.
4. Summary of loads or load diagram, if applicable.
5. Calculations.
6. List of applicable codes and regulations.
7. Name and version of software.
8. Information requested in individual specification section.

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F. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.

G. Payment:

1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.

H. Quality Control Documentation: As required in Section 01 45 16.13, RA Contractor Quality Control.

I. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
   a. Show for each, at a minimum, the following:
      1) Specification section number.
      2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
      3) Estimated date of submission to Owner, including reviewing and processing time.
      4) Provide updates weekly, or at timeframe otherwise requested, to the Owner. Show submittal status, anticipated submittal dates, dates submitted for each version, and date approved.
   b. On a monthly basis, submit updated Schedule of Submittals to Owner if changes have occurred or resubmittals are required.
2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

J. Special Guarantee: Supplier's written guarantee as required in individual specification sections.

K. Statement of Qualification: Evidence of qualification, certification, or registration as required in RA Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

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L. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to Owner one copy of correspondence and transmittals (to include enclosures and attachments) between RA Contractor and governing agency.

M. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
   a. Identification of product and specification section, type of inspection or test with referenced standard or code.
   b. Testing laboratory name, address, and telephone number, date of test, Project title and number, and name and signature of authorized person.
   c. Test results.
   d. If test or inspection deems material or equipment not in compliance with RA Contract Documents, identify corrective action necessary to bring into compliance.
   e. Provide interpretation of test results, when requested by Owner.
   f. Other items as identified in individual specification sections.
3. Field:
   a. As a minimum, include the following:
      1) Project title and number.
      2) Date and time.
      3) Record of temperature and weather conditions.
      4) Identification of product and specification section.
      5) Type and location of test, Sample, or inspection, including referenced standard or code.
      6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
      7) If test or inspection deems material or equipment not in compliance with RA Contract Documents, identify corrective action necessary to bring into compliance.
      8) Provide interpretation of test results, when requested by Owner.
      9) Other items as identified in individual specification sections.

N. Training Data: In accordance with Section 01 11 00, Summary of Work.

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1.06 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this specification.

1. Forms: Transmittal of RA Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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TRANSMITTAL OF RA CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO:_____	Submittal No.:_____
_____	☐ New Submittal ☐ Resubmittal
_____	Project:_____
_____	Project No.:_____
_____	Specification Section No.:_____ **(Cover only one section with each transmittal)**
FROM:_____ RA Contractor	Schedule Date of Submittal:
_____	_____
_____	
_____	

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to RA Contract	
				No	Yes

RA Contractor hereby certifies that (i) RA Contractor has complied with the requirements of RA Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the RA Contract Documents and requirements of laws and regulations and governing agencies.

By:_____
RA Contractor (Authorized Signature)

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within RA Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in RA Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these RA Contract Documents.
2. Where copies of standards are needed by RA Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to RA Contractor's personnel, Subcontractors, and Owner.

1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the RA Contract Documents, with abbreviations used.

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1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association
34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America

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40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EGLE	Michigan Department of Environment, Great Lakes, and Energy
47.	EIA	Electronic Industries Alliance
48.	EJCDC	Engineers Joint Contract Documents' Committee
49.	ETL	Electrical Test Laboratories
50.	FAA	Federal Aviation Administration
51.	FCC	Federal Communications Commission
52.	FDA	Food and Drug Administration
53.	FEMA	Federal Emergency Management Agency
54.	FIPS	Federal Information Processing Standards
55.	FM	FM Global
56.	Fed. Spec.	Federal Specifications (FAA Specifications)
57.	FS	Federal Specifications and Standards (Technical Specifications)
58.	GA	Gypsum Association
59.	GANA	Glass Association of North America
60.	HI	Hydraulic Institute
61.	HMI	Hoist Manufacturers' Institute
62.	IBC	International Building Code
63.	ICBO	International Conference of Building Officials
64.	ICC	International Code Council
65.	ICEA	Insulated Cable Engineers' Association
66.	IFC	International Fire Code
67.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
68.	IESNA	Illuminating Engineering Society of North America
69.	IFI	Industrial Fasteners Institute
70.	IGMA	Insulating Glass Manufacturer's Alliance
71.	IMC	International Mechanical Code
72.	INDA	Association of the Nonwoven Fabrics Industry
73.	IPC	International Plumbing Code
74.	ISA	International Society of Automation
75.	ISO	International Organization for Standardization
76.	ITL	Independent Testing Laboratory
77.	JIC	Joint Industry Conferences of Hydraulic Manufacturers

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78.	MIA	Marble Institute of America
79.	MIL	Military Specifications
80.	MMA	Monorail Manufacturers' Association
81.	MSS	Manufacturer's Standardization Society
82.	NAAMM	National Association of Architectural Metal Manufacturers
83.	NACE	NACE International
84.	NBGQA	National Building Granite Quarries Association
85.	NEBB	National Environmental Balancing Bureau
86.	NEC	National Electrical Code
87.	NECA	National Electrical Contractor's Association
88.	NEMA	National Electrical Manufacturers' Association
89.	NESC	National Electrical Safety Code
90.	NETA	InterNational Electrical Testing Association
91.	NFPA	National Fire Protection Association
92.	NHLA	National Hardwood Lumber Association
93.	NICET	National Institute for Certification in Engineering Technologies
94.	NIST	National Institute of Standards and Technology
95.	NRCA	National Roofing Contractors Association
96.	NRTL	Nationally Recognized Testing Laboratories
97.	NSF	NSF International
98.	NSPE	National Society of Professional Engineers
99.	NTMA	National Terrazzo and Mosaic Association
100.	NWWDA	National Wood Window and Door Association
101.	OSHA	Occupational Safety and Health Act (both Federal and State)
102.	PCI	Precast/Prestressed Concrete Institute
103.	PEI	Porcelain Enamel Institute
104.	PPI	Plastic Pipe Institute
105.	PS	Product Standards Section-U.S. Department of Commerce
106.	RMA	Rubber Manufacturers' Association
107.	RUS	Rural Utilities Service
108.	SAE	SAE International
109.	SDI	Steel Deck Institute
110.	SDI	Steel Door Institute
111.	SJI	Steel Joist Institute
112.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
113.	SPI	Society of the Plastics Industry
114.	SSPC	The Society for Protective Coatings
115.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association

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116.	SWI	Steel Window Institute
117.	TEMA	Tubular Exchanger Manufacturers' Association
118.	TCA	Tile Council of North America
119.	TIA	Telecommunications Industry Association
120.	UBC	Uniform Building Code
121.	UFC	Uniform Fire Code
122.	UL	formerly Underwriters Laboratories Inc.
123.	UMC	Uniform Mechanical Code
124.	USBR	U.S. Bureau of Reclamation
125.	WCLIB	West Coast Lumber Inspection Bureau
126.	WI	Wood Institute
127.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 45 16.13
RA CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. RA Contractor Quality Control (CQC): The means by which RA Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the RA Contract.

B. Preliminary Work: The work carried out on the job site before the start of the main construction, to include that performed by RA Contractor, Subcontractors, Lower-tier Subcontractors and suppliers, shall comply with the requirement of the RA Contract.

C. Definable Feature of Work (DFOW): A task that is separate and distinct form other tasks and has separate control requirements.

1.03 SUBMITTALS

A. Action Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.

B. Action Submittals:

1. CQC Report: Submit daily in electronic format. May be incorporated into the Construction Daily Report.

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1.04 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the RA Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:

1. Relieve RA Contractor of responsibility for providing adequate quality control measures;
2. Relieve RA Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of RA Contractor after acceptance of the completed Work.

C. The presence or absence of a quality assurance inspector does not relieve RA Contractor from any RA Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Owner.

E. Owner may charge RA Contractor for any additional cost of inspection or test when Work is not ready at the time specified by RA Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the RA Contract Documents.

B. Maintain complete inspection records and make them available at all times to Owner.

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C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the RA Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Owner to discuss the quality control system.

B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of RA Contractor's management and control with the Owner's Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by RA Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within RA Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the RA Contractor.
2. CQC System Manager may not perform other duties on the Project.
3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
4. CQC System Manager shall report to the RA Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

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B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Owner.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

C. Organizational Changes: Obtain Owner's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all DFOWs, as follows:

1. Preparatory Phase:
   a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet RA Contract requirements.
   c. The preparatory phase meeting shall be conducted within 2 weeks prior to the start of the associated DFOW. Several DFOWs may be discussed during a preparatory phase meeting.
   d. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and a distributed within 2 working days.

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e. Perform prior to beginning Work on each definable feature of Work:
   1) Review applicable RA Contract Specifications.
   2) Review applicable RA Contract Drawings.
   3) Verify that all materials and/or equipment have been tested, submitted, and approved.
   4) Verify that provisions have been made to provide required control inspection and testing.
   5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the RA Contract.
   6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
   7) Review the appropriate activity hazard analysis to verify safety requirements are met.
   8) Review procedures for constructing the Work, including repetitive deficiencies.
   9) Document construction tolerances and workmanship standards for that phase of the Work.
   10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Owner.

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.
      2) Perform prior to beginning Work on each definable feature of Work:
         a) Review minutes of the preparatory meeting.
         b) Check preliminary Work to verify compliance with RA Contract requirements.
         c) Verify required control inspection and testing.
         d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
         e) Resolve all differences.
         f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

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3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with RA Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 RA CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

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B. Content:

1. Plan shall cover the intended CQC organization for the entire RA Contract and shall include the following, as a minimum:
   a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
   b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
   c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the RA Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
   d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
   e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
   f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
   g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
   h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the RA Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require RA Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

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D. Notification of Changes: After acceptance of the CQC plan, RA Contractor shall notify Owner, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Owner.

3.06 RA CONTRACTOR QUALITY CONTROL REPORT

A. Prepare a CQC report for each day onsite. These reports can be incorporated into the Construction Daily Report. Account for all days throughout the life of the RA Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:

1. RA Contractor/subcontractor and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with RA Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and/or Specifications.
10. RA Contractor’s verification statement.
11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the RA Contract.

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3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the RA Contract requirements.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to RA Contract requirements. Perform the following activities and record the following data:
   a. Verify testing procedures comply with RA Contract requirements.
   b. Verify facilities and testing equipment are available and comply with testing standards.
   c. Check test instrument calibration data against certified standards.
   d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
   e. Documentation:
      1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
      2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
      3) Actual test reports may be submitted later, if approved by Owner, with a reference to the test number and date taken.
      4) Provide directly to Owner an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
      5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for the RA Contract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

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3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the RA Contract.

B. Completion inspections need to be performed before equipment, RA Contractor, Subcontractors, and Lower-tiered Subcontractors required for any element of the Work are demobilized.

C. Punchlist:

1. CQC System Manager shall develop a punchlist of items which do not conform to the RA Contract requirements.
2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen (AAN): American Standards for Nursery Stock.
2. Federal Emergency Management Agency (FEMA).
3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.
7. OSHA 29 CFR 1910 and 1926.
8. U.S. Environmental Protection Agency:
   a. Resource Conservation and Recovery Act (RCRA).
      1) Title 40 of the Code of Federal Regulations, Part 261 (40 CFR 261), Subpart C Characteristics of Hazardous Waste.
      2) 40 CFR 263, Standards Applicable to Transporters of Hazardous Waste.
      3) 40 CFR 268, Land Disposal Restrictions.
   b. Toxic Substances Control Act (TSCA), 40 CFR 761.
   c. Oil Pollution Prevention, 40 CFR, Part 112.
9. U.S. Department of Transportation:
   a. 49 CFR 171, General Information, Regulations, and Definitions.
   b. 49 CFR 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
   c. 49 CFR 173, Shippers - General Requirements for Shipments and Packaging.
   d. 49 CFR 178, Specifications for Packaging.

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10. State of Michigan:
    a. Part 91 (Soil Erosion and Sedimentation Control) of National Resources and Environmental Protection Act (NREPA) 1994 P.A. 451, as amended Mich. Admin Code, Water Resources Protection, Part 17 Soil Erosion and Sediment Control R 323.1709.
    b. Part 115 (Solid Waste Management) of NREPA 1994 P.A. 451, as amended (MCL 324.11501-11550) and Mich. Admin. Code R 299.41 01-4122
    c. Control of Fugitive Dust Mich. Admin. Code R 336.1372(8)(b).
    d. Part 121 (Liquid Industrial Waste) of NREPA 1994 P.A. 451, as amended (MCL 324.11501-11550).
    e. Part 365 (Endangered Species Protection) of the NREPA, and MCL 324.36501-36507), and Mich. Admin. Code R 299.1021-1028.
    f. Part 401 (Wildlife Conservation) of the NREPA, as amended. (MCL 324.40101-40120).
    g. Transportation Standards and Recordkeeping (Mich. Admin. Code R 299.9608-9609).
    h. Solid Waste Management (Mich. Admin. Code R 299.4101 - 299.4922).
    i. Part 121 of the Natural Resource and Environmental Protection Act (Liquid Industrial By-Products).
11. Michigan Department of Transportation (MDOT).
12. City of St. Louis Code of Ordinances.

1.02 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Utility Submittals: Electrical connections and water supply source.
3. Temporary Construction Submittals:
    a. RA Contractor's field office.
    b. Storage and staging area plans.
    c. Fencing and protective barrier locations and details.
    d. Plan for maintenance of access roads and intended haul routes.

1.03 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner's safety rules while on Owner's property.

B. Keep Owner informed of serious onsite accidents and related claims.

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C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

D. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.

E. In areas where RA Contractor's operations are adjacent to or near a utility, such as gas, telephone, cable, electric, water, or sewer, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by RA Contractor.

1.04 VEHICULAR TRAFFIC

A. Traffic Control: RA Contractor personnel must adhere to traffic control in approved Work Plan. Changes to this plan will be made only by written approval of appropriate public authority and Owner. Secure approvals for necessary changes so as not to delay progress of the Work.

B. Provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.

1.05 PERMITS

A. Permits, Licenses, or Approvals: Obtain in accordance with the General Terms and Conditions and as otherwise may be provided in the Supplementary Conditions and retain onsite.

B. During the performance of the Work, RA Contractor is responsible for adapting its means, methods, techniques, sequences, and procedures of construction consistent with applicable permit requirements, and Laws and Regulations.

1.06 TEMPORARY CONTROLS

A. RA Contractor will provide safety and environmental controls during construction activities to protect the public, workers, and environment and ensure that all work is performed in a manner that meets the intent of federal, state, and local environmental regulations.

B. Soil erosion and sedimentation controls as indicated in Section 01 57 13, Temporary Erosion and Sediment Control and the approved Soil Erosion and Sedimentation Control Plan.

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PART 2 PRODUCTS

2.01 FIELD OFFICES

A. Furnish field office and equipment for exclusive use of U.S. Army Corps of Engineer.

B. If needed, furnish field office and equipment for exclusive use of RA Contractor and its representatives.

C. Potable water is not available for use for field offices.

D. The RA Contractor will provide portable toilets and hand wash units for use.

2.02 TEMPORARY STOCKPILE COVERING

A. Placement and maintenance of reinforced plastic covering over stockpiles during non-working hours or inclement weather to reduce fugitive dust emissions from staging piles and protect from precipitation and erosion.

B. Material will be 6-mil minimum reinforced black plastic with an ultra-violet ray inhibitor or 10-mil minimum polyvinyl chloride (PVC). When freezing conditions are expected, use PVC material.

C. Anchor with sandbags or approved equivalent spaced along the perimeter to prevent the liner from becoming displaced.

D. When freezing conditions are expected, use PVC material.

2.03 BARRICADES AND LIGHTS

A. As required to perform Work.

2.04 SPILL RESPONSE AND CONTROL EQUIPMENT

A. Supply spill response equipment in areas where fuel and chemicals are stored or used, and where liquid wastes are stored.

B. Provide secondary containment structure around fuels, chemical, and liquid wastes or their storage areas such that a release of these materials do not reach waters of the state, drainage way(s), streams, storm sewers, or sanitary sewers.

PART 3 EXECUTION

3.01 MOBILIZATION

A. This task will consist of mobilizing RA Contractor personnel, equipment, any Subcontractors, and materials to the project site. The RA Contractor will be responsible for coordinating and making arrangements for storage and laydown areas for construction equipment.

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B. The RA Contractor will install, inspect, maintain and remove erosion control measures according to best management practices and the approved Soil Erosion and Sedimentation Control Plan, and also prepare a vehicle decontamination area, a soil storage area, and a waste management area that are designed to contain runoff from these activities.

C. Coordination and scheduling of mobilization activities will be discussed with Owner in detail during the pre-construction conference.

D. Mobilization includes, but is not limited to, these principal items:

1. Obtaining required permits.
2. Mobilizing RA Contractor's field office, if desired, and equipment required for operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite Internet service.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Preparing RA Contractor staging area(s) and parking areas.
7. Setting up stockpile area(s), if used.
8. Posting OSHA required notices and establishing safety programs and procedures.
9. Having RA Contractor's superintendent at Site full time.

3.02 TEMPORARY UTILITIES

A. Temporary utilities shall also be made available for use by U.S. Army Corps of Engineer personnel.

B. Power:

1. Electric power will not be available at Site. RA Contractor will arrange for electrical hook-ups at the field offices and staging areas, if desired.
2. Cost of electric power will be borne by RA Contractor.

C. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

D. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage because of temperature or humidity.

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2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Costs of installation, maintenance, operation, removal, and fuel consumed will be borne by the RA Contractor.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

E. Water:

1. Potable water is not available at Site. The RA Contractor is responsible for making arrangements for and will bear costs of providing water required for construction purposes.
2. Hydrant Water:
   a. Is available from hydrants. Secure written permission for connection and use from City of St. Louis water department and meet requirements for use. Notify fire department before obtaining water from fire hydrants.
   b. Use only special hydrant-operating wrenches to open hydrants. Make certain hydrant valve is open full, since cracking valve causes damage to hydrant. Repair damaged hydrants and notify appropriate agency as quickly as possible. Hydrants must be completely accessible to fire department at all times.
   c. Include costs to connect and transport water to construction areas in RA Contract Price.
   d. Cost of water obtained from hydrant(s) to be borne by RA Contractor.

F. Sanitary and Personnel Facilities will be provided and maintained by RA Contractor. Sanitary facilities will be anchored according to manufacturer instructions and located such that in the event of a release or spill, they will not drain to surface waters (e.g., storm drain inlets, ditches, streams, wetlands, floodplains, etc.).

G. Telephone Service: RA Contractor will arrange and provide onsite telephone service for use during construction, and pay costs of installation, and monthly bills during construction.

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H. Internet Service: RA Contractor will arrange and provide onsite internet service for use during construction, and pay costs of installation, and monthly bills during construction.

I. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.03 PROTECTION OF WORK AND PROPERTY

A. General:

1. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
2. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.
3. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
4. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
5. In areas where RA Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by RA Contractor.
6. Notify property owners and utility offices that may be affected by construction operation at least 4 days in advance by calling the Michigan utility one-call number (MISS DIG) or utility owner directly as appropriate and provide private utility locate to identify any utilities that may be present in the work area. Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to RA Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
7. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
8. Maintain original Site drainage wherever possible.

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B. Site Security:

1. Erect a temporary security fence, as necessary, to maintain site security during construction for protection of property, RA Contractor equipment and materials, and existing facilities and to keep unauthorized personnel from entering the site. Maintain security fence throughout construction period. Obtain Owner's written permission before removal of temporary security fencing.
2. Provide and maintain additional temporary security fences as necessary to protect the Work and RA Contractor-furnished products not yet installed.
3. The Owner is not responsible for theft, damages or losses incurred during the performance of this Work.

C. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

D. Barricades and Lights: Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of RA Contractor's employees, other employer's employees, and others who may be affected by the Work.

E. Archaeological Finds: Should finds of an archaeological or paleontological nature be made within Site limits, immediately notify Owner. Continue the Work in other areas without interruption.

F. Protected Species and Their Habitat:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna, fauna habitat, and migratory birds (including active nests).
2. Notify Owner of construction activities that might threaten endangered and threatened species, migratory birds, or their habitats.
3. Comply with requirements in Section 31 10 00, Site Clearing to avoid or minimize adverse effects on protected species.

G. Wetlands:

1. Comply with requirements in Section 31 10 00, Site Clearing to avoid or minimize adverse effects on wetlands.
2. Comply with any requirements for restoration if provided by addendum.

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H. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

3.04 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.

B. Noise Control:

1. Provide controls if noise emanating from tools or equipment will exceed legal noise levels.
2. Follow procedures outline in approved Noise Control Plan.
3. Standard hours of construction are Monday through Friday from 7 a.m. to 6 p.m. Weekend hours can be added from 9 a.m. to 6 p.m. if necessary work permits and approval from the Owner have been obtained.

C. Water Pollution Control:

1. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
2. Do not dispose of wastewater, stormwater, decontamination fluids, or volatile wastes in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
3. Notify Owner immediately of any spill, sheen, or release onto the ground or water.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sedimentation Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

E. Dust Control:

1. Follow procedures outline in approved Dust Control Plan.

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2. The RA Contractor will be responsible for controlling the dust and airborne dirt generated by construction activities. Water or other approved suppression means will be used as needed to control dust.
3. All excavation and earthmoving activities will be performed in a manner that limits blowing dust and tracking of mud onto site access roads. Dust control measures may include vacuuming, water spraying, and sweeping or other methods allowed under local regulations. The RA Contractor will prepare a fugitive dust control plan that will address the management of stockpiles and transport of bulk materials.
4. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust.
5. Limit drop height during soil loading and unloading.
6. Strictly adhere to applicable environmental regulations for dust prevention.
7. Perform dust monitoring as outlined in the approved Dust Control Plan.

3.01 ACCESS ROADS AND LAYDOWN AREAS

A. Construct access roads within Project limits as shown on Drawings. Utilize existing roads where shown.

B. Site access shall be from the existing access gate off of M-46/Washington Avenue. Use of the access gate off of North Street should be avoided to the extent possible.

C. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

D. Access roads and laydown areas will be constructed as specified on Drawings.

E. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

F. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

G. Provide good housekeeping practices at equipment laydown yards. Protect equipment and cover receptacles as necessary to prevent blowing trash.

H. Coordinate with Owner detours and other operations affecting traffic and access. Provide at least 72 hours' notice to Owner of operations that will alter access to Site.

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3.02 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.

B. Parking lot for personnel working on Project provided by RA Contractor.

3.03 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be allowed. Closures of up to 10 hours may be allowed if a week's written notice is given and undue hardship does not result.

E. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.

F. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices. Flaggers must have appropriate training as required by the Michigan Department of Transportation (MDOT).

G. Provide snow removal to facilitate normal vehicular traffic on private roads affected by construction. Perform snow removal promptly and efficiently by means of suitable equipment whenever necessary for safety, and as may be directed by proper authority.

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H. Notify fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish RA Contractor's night emergency telephone numbers to police department.

3.04 SURFACE WATER CONTROL

A. Ponding surface water that may interfere with the work area will be pumped to another area onsite, approved by the Owner. Install highly efficient pumps as controls to quickly discharge water from the work area.

B. Remove surface runoff controls when no longer needed.

C. Provide supplemental ditches and sumps only as necessary to collect water from rain events. Do not use ditches and sumps as primary means of water control.

3.05 SPILL PREVENTION, RESPONSE, AND REPORTING

A. Areas used to store fuel, chemicals and waste will be properly protected from vehicle traffic. If fuel is stored onsite, fuel tanks or containers (including fuel storage and waste storage) will be equipped with secondary containment. These tanks or containers will be inspected routinely for signs of leaks. Accumulated water must be inspected for signs of contamination (e.g., product sheen, discoloration and odor) before being discarded. Applicable fire protection codes and guidance will be adhered to.

B. The RA Contractor will prepare a Spill Prevention Control and Countermeasures Plan, as summarized in Section 01 11 00, Summary of Work.

C. Onsite vehicles and equipment will be refueled onsite at designated fueling areas, located on level ground and away from any surface water features including storm water inlets or ditches. Spill kits, drip pans, and absorbent spill cleanup materials will be available in the fueling area. These materials will be properly disposed of after use. Vehicle and equipment maintenance may be performed on the construction site with Owner's approval, in a designated area approved by the Owner.

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D. Chemical products will be properly stored, transferred, and used. Original labels on chemical containers with the identity of the chemical and any hazard warnings, will be maintained.

E. Spill response equipment will be adequately stocked and maintained throughout the project. Spills and leaks will be cleaned up immediately and disposed of properly.

F. The RA Contractor is responsible for the disposal of waste and contaminated environmental media from a spill or release of RA Contractor-owned hazardous substances and petroleum products (diesel, hydraulic oil, etc.). RA Contractor must immediately report all spills to Owner. Unless otherwise directed by Owner, RA Contractor will make notification to external agencies for reportable spills of RA Contractor-owned materials.

G. Good housekeeping procedures will be followed to reduce risks associated with construction materials and hazardous materials. These procedures include but are not limited to keeping materials in their original containers whenever possible, maintaining original labels and Safety Data Sheets, and using proper disposal methods for surplus materials.

3.06 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

B. Provide rumble strips for truck use prior to exiting site to minimize soil and debris tracked offsite. The rumble strip area shall be cleaned throughout the day when visible dirt is present.

C. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris.

D. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite or as necessary to prevent waste receptacles from overflowing.

E. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

3.07 DECONTAMINATION OF EQUIPMENT AND PERSONNEL

A. A decontamination pad will be constructed by the RA Contractor.

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B. All decontamination will be performed by RA Contractor personnel with current 40-hour HAZWOPER training, medical monitoring, and other required training.

C. Any dirt or mud that is tracked or spilled onto sidewalks, driveways, and/or roadways must be cleaned at the end of the work day, or more frequently as needed.

D. Store equipment and/or materials within the appropriate storage area. Stored materials will be neatly stacked or otherwise stored in an orderly fashion.

E. Wet decontamination will be performed on the decontamination pad at the staging area.

F. Decontamination water will be contained and characterized for offsite disposal at an approved facility. Decontamination water will be contained in 55-gallon United Nations (UN)-approved drums, portable tank(s), or approved equivalent.

G. Field equipment that has come into contact with any potentially contaminated material will be decontaminated. The equipment will be visually inspected for signs of contamination, and the cleaning procedure will be repeated until the equipment is visually clean. The RA Contractor will fully decontaminate all equipment on the decontamination pad at the staging area using a wet method before leaving the site. All contaminated equipment will be cleaned by the RA Contractor and inspected/accepted by the Owner before leaving the site. All equipment decontamination will be documented in field log books.

3.08 DEMOBILIZATION

A. Upon substantial completion of Work, RA Contractor will demobilize from the Site. Demobilization includes:

1. Final street sweeping to clean site entrances.
2. Removal of all field equipment, temporary facilities, and other miscellaneous items (for example, barricades, caution tapes, and signs) resulting from or used during field operations, unless otherwise directed by Owner.
3. Proper offsite disposal of all wastes and general construction debris generated by construction activities.

B. RA Contractor will complete closeout punch list described in Section 01 77 00, Closeout Procedures.

END OF SECTION

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SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This section covers Work to implement structural and nonstructural Best Management Practices (BMP) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this specification and shown on the Drawings are part of the project's temporary Soil Erosion and Sediment Control Plan (SESC Plan) and are the minimum for all project construction sites and conditions. This specification covers all project activities, including material sources, disposal sites, and offsite mitigation areas unless specific project activities are excluded elsewhere in this specification or in other RA Contract Documents controlling the Work.

B. Other Regulations: A local government erosion and sediment control permit may apply and some local agency requirements may be more stringent than this specification. Adequate erosion and sediment control is essential for complying with the federal Endangered Species Act where construction runoff enters waters inhabited by protected species.

C. This section covers Work necessary for stabilization of soil to prevent erosion during construction and land disturbing activities. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. Owner reserves right to modify use, location, and quantities of soil erosion and sediment control measures based on activities of RA Contractor.

D. The work will include the furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified. This includes the installation, maintenance, and final removal of all temporary soil erosion and sediment control measures.

E. See additional information noted on Drawings.

1.02 REFERENCES

A. Activities shall conform to applicable federal, state, and local substantial requirements, including the City of St. Louis and Gratiot County Soil Erosion and Sedimentation Control permits, EGLE Stormwater Notice of Coverage, and Drawings. In the event of a conflict, the more stringent requirement shall apply.

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B. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.
2. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   c. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   d. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   f. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   g. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   h. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   i. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
   j. D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
   k. D6459, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
   l. D6460, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion.
   m. D6475, Standard Test Method for Measuring Mass Per Unit Area of Erosion Control Blankets.
   n. D7322, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions.
   o. D7367, Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting.
3. National Weather Service:
   a. Precipitation-Frequency of the United States by State/Territory, 2012.
   b. Precipitation Frequency Data Server, 2012.

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4. North American Weed Management Association (NAWMA).
5. U.S. Department of Agriculture, Natural Resources Conservation Service: *Urban Hydrology for Small Watersheds*; 1986. Technical Release 55.
6. U.S. Environmental Protection Agency:
   a. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites, 2007. EPA-833-R-06-004.
   b. National Menu of BMPs, 2012.
7. Michigan Department of Environment, Great Lakes, and Energy (EGLE): Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act (NREPA).
8. *Michigan Nonpoint Source Best Management Practices Manual*, EGLE.
9. *Soil Erosion and Sedimentation Control Guidebook,* Michigan Department of Technology, Management, and Budget (DTMB).

1.03 GENERAL

A. The RA Contractor will revise the draft Soil Erosion and Sedimentation Control Plan developed by an Engineer from the RA Contractor. The draft Soil Erosion and Sedimentation Control Plan for the FPS is included in Exhibit 1. The Soil Erosion and Sedimentation Control Plan will be updated specific to the Work and submitted to the Owner for approval. Development of the SESC Plan will be coordinated with the City of St. Louis. The revised Soil Erosion and Sedimentation Control Plan must be consistent with substantive requirements of Part 21 R 323.2190 (National Permit for Stormwater Discharge During Construction) of NREPA 1994 P.A. 451, as amended; Gratiot County requirements; *Michigan Nonpoint Source Best Management Practices Manual*; and the *Soil Erosion and Sedimentation Control Guidebook*. The revised plan will at a minimum:

   1. Describe the structural best management practices (BMPs) to prevent the offsite discharge of pollutants and control soil erosion, sediment transport, and potential spills for each phase of the scheduled work. Include all temporary slopes, constructed for staging or other reasons, which may not have been identified in the original RA Contract plans. Erosion and sediment control BMPs will be installed, at a minimum, at the site perimeter, stockpiles of backfill and excavated soils, staging and storage areas, inlets and drains, and construction site entrance and exit. BMPs, including by not limited to sediment retention measures (e.g., silt fence), vegetated buffer zones, stormwater diversions, will be designed, installed, and maintained in accordance with the *Michigan Nonpoint Source Best Management Practices Manual* and the *Soil Erosion and Sedimentation Control Guidebook* – see References.

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2. Describe erosion and sediment control at staging, stockpiling, and storage areas, including silt fence or other appropriate measures and inlet protection.
3. Describe how water entering the work area will be discharged as clean stormwater and other stormwater management activities.
4. Address protection against stockpile runoff at the staging/stockpiling area.
5. Describe inspection and maintenance procedures.
6. Provide proof of a Michigan-qualified Certified Stormwater Operator who possesses the skills to assess conditions at construction sites that could impact stormwater quality and assess the effectiveness of any sediment and erosion control measures implement. The certification will be in accordance with the requirements of Michigan's Permit By-Rule for Construction Stormwater Activities, R 323.2190.
7. Describe non-structural BMPs, including but not limited to housekeeping practices, dust control, spill prevention and response measures, fuel storage and use, and equipment and vehicle maintenance practices.
8. Describe stabilization BMPs.
9. Describe inspection and maintenance procedures.
10. SESC Plan requirements:
    a. Narrative Site Description:
        1) Nature of construction activity planned for the Site.
        2) Estimates of total site area and the areas of the Site expected to be disturbed.
        3) Soil types found onsite and their erosion potential.
        4) The types of backfill to be used.
        5) Timetable for sequence of major construction events.
    b. Site Map:
        1) All areas of development.
        2) Drainage patterns.
        3) Areas of soil disturbance, including pre-development and post-development elevation contours.
        4) Areas used for storage of soils or wastes.
        5) Areas where vegetative practices are to be implemented.
        6) Location of structural erosion and sediment control BMPs.
        7) Location of stabilization measures.
        8) Location of all impervious structures and surfaces after project is completed.
        9) Springs, wetlands, and other surface waters located onsite and location of nearest receiving water(s).
        10) Boundaries of 100-year floodplain, if determined.
        11) Ordinary High Water line, if determined.
        12) Location of detention ponds, storm drain inlets and ditches.

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c. Required BMPs and Procedures for Erosion Prevention, Runoff Control, and Sediment Control:
   1) Construction entrances and parking areas.
   2) Unpaved site roads, such as haul roads.
   3) Hauling saturated soils from the site.
   4) Water washed from concrete trucks.
   5) Erosion and sediment control BMPs, including detail on design, installation, and maintenance.
   6) Clearing and grading practices to minimize area of exposed soil throughout life of the Project.
   7) Schedule of phased clearing operations to limit soils to what can be stabilized.
   8) Stabilization and vegetative buffers, including preservation of existing vegetation, seeding, mulching, and buffer strips.
   9) Perimeter controls.
   10) Additional controls for wet season work and temporary work suspensions.
   11) Sensitive areas, such as wetlands.
   12) Equipment waste storage areas.
   13) Dust control.
   14) Emergency materials stockpiled onsite.
   15) Soil stockpile management.

11. SESC Plan update/revision and implementation schedules must be prepared by a competent individual. Furnish a signed copy of the SESC Plan with individual's name, title, state certifications, and employing firm.
12. Do not begin any Site activities that have potential to cause erosion or sediment movement until the SESC Plan and implementation schedules are approved by Owner.
13. Keep a copy of the approved SESC Plan with updated changes onsite during all construction activities. During inactive periods longer than 7 calendar days, keep the SESC Plan onsite or provide a copy to Owner to retain.
14. Continually update the SESC Plan and schedules as needed for unexpected storm or other events to ensure that sediment-laden water does not leave the construction site. Add approved changes to the SESC Plan no later than 24 hours after implementation.

B. All activities must conform to the requirements of the City of St. Louis, Gratiot County, and the State of Michigan. In the event of a conflict, the more stringent requirement will apply.

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C. RA Contractor will install, inspect, and maintain and provide recordkeeping for temporary soil erosion and sediment control measures under the authorization of a Michigan-certified stormwater operator supplied by the RA Contractor.

D. Preventing erosion, and controlling runoff, sedimentation, and non-stormwater pollution, requires RA Contractor to perform temporary Work items including, but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water.
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows.
3. Controlling underground water found during construction.
4. Covering or otherwise protecting slopes until permanent erosion control measures are working.

E. To the degree possible, coordinate this temporary Work with permanent drainage and erosion control work the RA Contract requires.

F. Owner may require additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the Work.

G. When natural elements rut or erode the slope, restore and repair damage with eroded material where possible, and remove and dispose of any remaining material found in ditches and culverts. When RA Contractor orders replacement with additional or other materials, unit RA Contract prices will cover quantities needed.

H. Install all sediment control devices including, but not limited to, sediment ponds, perimeter silt fencing, or other sediment trapping BMPs prior to any ground disturbing activity. Do not expose more erodible earth than necessary during clearing, grubbing, excavation, borrow, or fill activities without written approval by Owner. Owner may increase or decrease the limits based on project conditions. Erodible earth is defined as any surface where soils, grindings, or other materials may be capable of being displaced and transported by rain, wind, or surface water runoff. Cover inactive areas of erodible earth, whether at final grade or not, within specified time period, using an approved soil covering practice. Phase clearing and grading to maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.

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I. Water Management:

1. Manage site water in accordance with the conditions of the waste discharge permit equivalent from a local permitting authority. If site water management is not subject to permit, manage as follows:
   a. Excavation water. When groundwater is encountered in an excavation, treat and discharge as follows:
      1) When excavation water conforms to Michigan Department of Environment, Great Lakes, and Energy (EGLE) Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion. The RA Contractor will be responsible for analytical testing to confirm excavation water meets the EGLE Water Quality Standards. All costs to perform analytical testing will be borne by the RA Contractor.
      2) When turbidity of excavation water is similar to turbidity of site runoff, water may be treated using same BMP being used to treat the site runoff and then discharged at a rate that will not cause erosion.
      3) When excavation water turbidity is greater than turbidity of site runoff, treat water separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.
      4) In no case, can the discharge of excavation water cause an exceedance of EGLE water quality standards in the receiving water.

J. Dispersion/Infiltration: Convey water only to dispersion or infiltration areas designated in the SESC Plan or to sites approved by Owner. Water will be conveyed to designated dispersion areas at a rate such that, when runoff leaves the area and enters waters of the State or Gratiot County, turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.

K. Detention/Retention Pond Construction: Whether permanent or temporary, construct before beginning other grading and excavation Work in the area that drains into that pond. Install temporary conveyances concurrently with grading in accordance with the SESC Plan so that newly graded areas drain to the pond as they are exposed.

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L. Pollution Control: Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:

1. Written spill prevention and response procedures.
2. Employee training on spill prevention and proper disposal procedures.
3. Spill kits in all vehicles.
4. Regular maintenance schedule for vehicles and machinery.
5. Material delivery and storage controls.
6. Training and signage.
7. Covered storage areas for waste and supplies.

M. If Owner orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.

N. Nothing in this section will relieve RA Contractor from complying with other RA Contract requirements.

1.04 SYSTEM DESCRIPTION

A. Erosion and Sediment Control:

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.
2. Design erosion and sediment controls to handle peak runoff resulting from 25-year, 24-hour storm event based on *Michigan Nonpoint Source Best Management Practices Manual* (EGLE) and the *Soil Erosion and Sedimentation Control Guidebook* (DTMB).
3. Size temporary stormwater conveyances based on procedures presented in *Michigan Nonpoint Source Best Management Practices Manual* (EGLE) and the *Soil Erosion and Sedimentation Control Guidebook* (DTMB).

B. Soil erosion stabilization and sedimentation control consists of the following elements:

1. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
2. Construction and maintenance of permanent and temporary storm drainage piping and channel systems, as necessary.

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3. Construction of temporary erosion and sediment controls, such as silt fences and check dams.
4. Placement and maintenance of stabilization measures such as temporary seeding on areas disturbed by construction.

1.05 SUBMITTALS

A. Action Submittals:

1. Soil Erosion and Sedimentation Control Plan and Procedures.
   a. The RA Contractor will update or modify the Draft SESC Plan. Provide a schedule for SESC Plan implementation and incorporate it into progress schedule. Obtain Owner's approval of the SESC Plan and schedule before any Work begins.
   b. Modified SESC Plans will meet all requirements of the applicable jurisdictions.
   c. The SESC Plan will cover all areas that may be affected inside and outside the limits of the Project (including all Owner-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water).
2. Initial Schedule for installation of drainage, erosion, and sedimentation control measures.
3. Method for placement of soil stabilization seed and additives.

PART 2 PRODUCTS

2.01 EROSION CONTROL BLANKET (MATTING), BIODEGRADABLE

A. Temporary erosion control blanket shall be made of natural plant fibers. Supply independent test results meeting the following:

Properties	ASTM Test Method	Requirements
Protecting Slopes from Rainfall-Induced Erosion	D6459: Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.	Maximum C factor of 0.15 using Revised Universal Soil Loss Equation (RUSLE)
Dry Weight per Unit Area	D6475	0.36 lb/sq. yd. minimum
Performance in Protecting Earthen Channels from Stormwater-Induced Erosion	D6460: Test in one soil type. Soil tested shall be loam as defined by the NRCS Soil Texture Triangle.	1.0 lb/sq. ft. minimum

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Properties	ASTM Test Method	Requirements
Seed Germination Enhancement	D7322	200 percent minimum
Netting, if present, shall be biodegradable with a life span not to exceed 1 year.		

B. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

2.02 GEOTEXTILE

A. Geotextiles shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. Geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. Geotextile properties shall be as described in Table 1 through Table 3.

Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
AOS	D4751	See Table 2		See Table 2		U.S. No. 30 max.	
Water Permittivity	D4491	See Table 2		See Table 2		0.02 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	250 lb min.	160 1b min.	315 lb min.	200 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	15% -50%	≥50%	15% -50%	≥50%	<50%	≥50%
Seam Breaking Strength	D4632/ D4632M	220 lb min.	140 lb min.	270 lb min.	180 lb min.	220 lb min.	140 lb min.
Puncture Resistance	D6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.	495 lb min.	310 lb min.

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Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
Tear Strength, in machine and x-machine direction	D4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device					

Table 2
Filtration Properties for Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements		
		Class A	Class B	Class C
AOS	D4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D4491	0.7 sec^{-1} min.	0.4 sec^{-1} min.	0.2 sec^{-1} min.

Table 3
Geotextile for Temporary Silt Fence

Geotextile Property	ASTM Test Method	Geotextile Property Requirements	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D4751	U.S. No. 30 max. for silt wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.	
Water Permittivity	D4491	0.2 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	180 lb min. in machine direction, 100 lb min. in x-machine direction	100 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	30% max. at 180 lb or more	
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device	

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2.03 HIGH VISIBILITY FENCING

A. High Visibility Fence: UV stabilized, orange, high-density polyethylene or polypropylene mesh.

B. Height: 4 feet minimum.

C. Support Posts: Wood or steel with sufficient strength and durability to support the fence through the life of the Project.

2.04 INLET PROTECTION

A. As specified under Article Geotextile.

2.05 STRAW MULCH

A. Clean salt hay or threshed straw of oats, wheat, barley, or rye; free from seed of noxious weeds.

2.06 OUTLET PROTECTION

A. Size riprap or quarry spall to resist movement under design flows. Install at least 8 inches deep. Provide riprap or quarry spall material free of extraneous material.

2.07 PLASTIC COVERING

A. Clear plastic meeting requirements of ASTM D4397 for polyethylene sheeting having a minimum thickness of 6 mils.

2.08 POLYACRYLAMIDE (PAM)

A. Meet ANSI/NSF Standard 60 for drinking water treatment with an AMD content not to exceed 0.05 percent.

B. Anionic, linear, and not cross-linked.

C. Minimum average molecular weight greater than 5 mg/mole and minimum 30 percent charge density.

D. 80 percent active ingredients minimum with moisture content not exceeding 10 percent by weight.

E. Delivered in a dry granular or powder form.

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2.09 SEDIMENT CONTROL BARRIERS

A. Specified by the RA Contractor with approval of Owner. May include Compost Filter Sock or Compost Filter Berm.

2.10 SEEDING

A. See Section 32 92 00, Turf and Grasses.

2.11 SILT (SEDIMENT) FENCE

A. Geotextile: As specified in Article Geotextile.

B. Support Posts: As recommended by manufacturer of geotextile.

C. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

2.12 STRAW

A. Straw:

1. Air dried condition free of noxious weeds, seeds, and other materials detrimental to plant life. Hay is not acceptable. Provide weed-free documentation:
   a. Certified Weed Free Straw using North American Weed Management Association (NAWMA) standards.
   b. Provide documentation that material is steam or heat treated to kill seeds.
   c. Provide U.S. or state's Department of Agriculture laboratory test reports, dated within 90 days prior to date of application, showing there are no viable seeds in the straw.

B. Straw Mulch: Suitable for spreading with mulch blower equipment.

C. Posts for Straw Bales: 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

2.13 STREET CLEANING

A. Use self-propelled pickup street sweeper(s). Mechanical broom sweepers are not allowed where environmental concerns exist about storm water pollution or air quality.

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2.14 TACKIFIERS

A. Biodegradable Hydraulically Applied Erosion Control Products (HECPs) in a dry condition, free of noxious weeds, seeds, chemical printing ink, germination inhibitors, herbicide residue, chlorine bleach, rock, metal, plastic, and other materials detrimental to plant life. Up to 5 percent by weight may be photodegradable material.

B. Suitable for spreading with a hydroseeder.

C. Furnish HECPs premixed by the manufacturer. Under no circumstances will field mixing of additives or components be acceptable.

D. Provide test results, dated within 3 years prior to the date of application, from an independent, accredited laboratory, as approved by Owner, showing that the product meets the HECP requirements in Table 7.

Table 7
HECP Requirements

Properties	Test Method	Requirements
Acute Toxicity	EPA-821-R-02-012 Methods for Measuring Acute Toxicity of Effluents. Test leachate from recommended application rate receiving 2 inches of rainfall per hour using static test for No-Observed-Adverse-Effect-Concentration (NOEC).	Four replicates are required with no statistically significant reduction in survival in 100 percent leachate for a Daphnid at 48 hours and Oncorhynchus mykiss (rainbow trout) at 96 hours.
Solvents	EPA 8260B	Benzene: < 0.03 mg/kg Methylene chloride: < 0.02 mg/kg Naphthalene: < 5 mg/kg Tetrachloreoethylene: < 0.05 mg/kg Toluene: < 7 mg/kg Trichloroethylene: < 0.03 mg/kg Xylenes: < 9 mg/kg

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Table 7
HECP Requirements

Properties	Test Method	Requirements
Heavy Metals	EPA 6020A Total Metals	Antimony: < 4 mg/kg Arsenic: < 6 mg/kg Barium: < 80 mg/kg Boron: < 100 mg/kg Cadmium: < 2 mg/kg Chromium: < 2 mg/kg Copper: < 5 mg/kg Lead: < 5 mg/kg Mercury: < 2 mg/kg Nickel: < 2 mg/kg Selenium: < 10 mg/kg Strontium: < 30 mg/kg Zinc: < 5 mg/kg
Water Holding Capacity	ASTM D7367	900 percent minimum
Organic Matter Content	ASTM D2974	90 percent minimum
Moisture Content	ASTM D2974	15 percent
Seed Germination Enhancement	ASTM D7322	Long-Term: 420 percent minimum Moderate-Term: 400 percent minimum Short-Term: 200 percent minimum

2.15 TEMPORARY CURB

A. Temporary curbs may consist of sand bags, compost socks, wattles, or geotextile/plastic encased berms of sand or gravel, or as approved by Owner.

2.16 WATTLES

A. Cylinders of biodegradable plant material such as weed-free straw, coir, compost, wood chips, excelsior, or wood fiber or shavings encased within biodegradable netting.

B. Diameter: 5 inches minimum.

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C. Netting Material: Clean, evenly woven, and free of encrusted concrete or other contaminating materials such as preservatives. Also free from cuts, tears, or weak places with a minimum lifespan of 6 months.

D. Compost Filler: Coarse compost, wood chips, or wood shavings.

E. Wood Stakes: Untreated softwood species, 2-inch by 2-inch nominal dimension and 36 inches in length.

PART 3 EXECUTION

3.01 PREPARATION

A. Owner's acceptance of the SESC Plan is required prior to starting earth disturbing activities.

B. RA Contractor is responsible for phasing Work in areas allocated for their exclusive use during Project, including proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities.

C. Areas designated for RA Contractor's use during Project may be temporarily developed as specified to provide working, staging, and administrative areas. Include control of sediment from these areas in the SESC Plan.

D. Provide stabilization, as needed, to enhance establishment of vegetation.

E. Erosion Control Blanket (Matting), Biodegradable: Temporary Erosion Control Blankets are used as an erosion prevention device and to enhance establishment of vegetation. Install erosion control blankets according to manufacturer's recommendations.

1. Erosion control blankets with an open area of 60 percent or greater may be installed prior to seeding and fertilizing. Install blankets with less than 60 percent open space immediately following seeding and fertilizing operation.
2. Select erosion control blanket material for an area based on the intended function; slope or ditch stabilization and Site-specific factors including soil, slope gradient, rainfall, and flow exposure. Do not use erosion Control Blankets on slopes or in ditches that exceed manufacturer's recommendations.
3. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

F. High Visibility Fencing: Install high visibility fencing in accordance with the Drawings.

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G. Inlet Protection: Install inlet protection below or above, or as a prefabricated cover at each inlet grate, as shown on the Drawings. Install inlet protection devices prior to beginning clearing, grubbing or earthwork activities. Geotextile fabric used in prefabricated inlet protection devices must meet or exceed the requirements for Moderate Survivability and minimum filtration properties. When depth of accumulated sediment and debris reaches approximately one-half the height of an internal device or one-third the height of external device (or less when so specified by the manufacturers) or as designated by Owner, remove deposits and stabilize onsite.

1. Below Inlet Grate:
   a. Prefabricated units specifically designed for inlet protection.
   b. Must remain securely attached to drainage structure when fully loaded with sediment and debris or at the maximum level of sediment and debris specified by manufacturer.
2. Above Inlet Grate:
   a. Devices may be silt fence, sandbags, or prefabricated units specifically designed for inlet protection.
   b. Must remain securely in place around drainage structure under all conditions.
3. Inlet Grate Cover:
   a. Prefabricated units specifically designed for inlet protection and:
      1) Be a sewn geotextile fabric unit fitted to individual grate and completely enclosing grate.
      2) Have built-in lifting devices to allow manual access of stormwater system.
      3) Use an orange monofilament geotextile fabric.
   b. Check dams or functionally equivalent devices may be used as inlet protection devices with approval of Owner.

H. Outlet Protection: Provide outlet protection to prevent scour at outlets of ponds, pipes, ditches, or other conveyances.

I. Plastic Covering: Use clear plastic covering to promote seed germination when seeding is performed outside of specified dates. Use black plastic covering for stockpiles or other areas where vegetative growth is unwanted. Place plastic with at least a 12-inch overlap of all seams. Install and maintain plastic cover tolon prevent water from cutting under the plastic and to prevent cover from blowing open in the wind.

J. Polyacrylamide (PAM): See Tackifiers.

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K. Sediment Control Barriers: Install sediment control barriers in accordance with TESC Plan or manufacturer's recommendations in the areas of clearing, grubbing, earthwork, or drainage prior to starting those activities. Maintain sediment control barriers until soils are stabilized.

L. Seeding: See Section 32 92 00, Turf and Grasses.

M. Silt (Sediment) Fence:

1. Silt fence shall be installed in accordance with the Drawings. When backup support is used, use steel wire with a maximum mesh spacing of 2 inches by 4 inches, or plastic mesh as resistant to ultraviolet radiation as the geotextile it supports. Provide wire or plastic mesh with strength equivalent to or greater than as required for unsupported geotextile (for example, 180 pounds grab tensile strength in the machine direction).
2. Attach geotextile to posts and support system using staples, wire, or in accordance with manufacturer's recommendations. Geotextile shall be sewn together at the point of manufacture, or at a location approved by Owner, to form geotextile lengths as required.
3. Provide wood or steel support posts at sewn seams and overlaps and as shown on the Drawings and necessary to support fence.
4. Wood Posts: Minimum dimensions of 1-1/4-inch by 1-1/4-inch by the minimum length shown on Drawings.
5. Steel Posts: Minimum weight of 0.90 lb/ft.
6. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.

N. Street Cleaning: Use self-propelled pickup street sweepers whenever required by Owner to prevent transport of sediment and other debris off Project Site. Provide street sweepers designed and operated to meet air quality standards. Street washing with water will require approval by Owner. Intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

O. Tackifiers:

1. Mix and apply tackifier in accordance with manufacturer's recommendations. If applied with a hydroseeder, add Short-Term Mulch as a tracer at a rate of 125 pounds to 250 pounds per acre to visibly aid uniform application.

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2. Soil Binding Using Polyacrylamide (PAM): Apply PAM on bare soil completely dissolved and mixed in water or applied as a dry powder. Apply dissolved PAM at a rate of not more than 2/3 pound per 1,000 gallons of water per acre. Apply a minimum of 200 pounds per acre of Short-Term Mulch with the dissolved PAM. Dry powder applications may be at a rate of 5 pounds per acre using a hand-held fertilizer spreader or a tractor-mounted spreader.
   a. Apply PAM only to areas that drain to completed sedimentation control BMPs in accordance with the TESC Plan. PAM may be reapplied on actively worked areas after a 48-hour period.
   b. PAM shall not be applied during rainfall or to saturated soils.

P. Temporary Curb: Provide temporary curbs to divert or redirect water around erodible soils. Temporary curbs shall be installed along pavement edges to prevent runoff from flowing onto erodible slopes. Water shall be directed to areas where erosion can be controlled. Temporary curbs shall be a minimum of 4 inches in height. Ponding shall not be in roadways.

Q. Wattles: Install wattles as soon as construction will allow or when designated by Owner. Begin trench construction and wattle installation at base of slope and work uphill. Spread excavated material evenly along the uphill slope and compact using hand tamping or other method approved by Owner. On gradually sloped or clay-type soils, provide trenches 2 inches to 3 inches deep. On loose soils, in high rainfall areas, or on steep slopes, provide trenches 3 inches to 5 inches deep, or half the thickness of the wattle. Exercise care when installing wattles to minimize disturbance of waterways and prevent sediment or pollutant discharge into waterbodies.

3.02 ADDITIONAL REQUIREMENTS

A. Installation and maintenance will be in accordance with the *Michigan Nonpoint Source Best Management Practices Manual* and the *Soil Erosion and Sedimentation Control Guidebook* – see References and in accordance with manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

A. Conduct inspections jointly with Owner every week to evaluation conformance to requirements of Specifications, SESC Plan, and local and state authorities.

B. Replace or repair failed or overloaded silt fences, or other temporary erosion control devices, within 2 days after Site inspections.

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C. Complete an inspection report within 24 hours of an inspection. Each inspection report shall be signed and identify corrective actions. Document that corrective actions are performed within 7 days of identification. Keep a copy of all inspection reports at the Site or at an easily accessible location.

3.04 MAINTENANCE

A. Promptly repair or replace silt fence that becomes damaged.

B. The SESC measures described in this specification are minimum requirements for anticipated Site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.

C. Maintain erosion and sediment control BMPs so they properly perform their function until Owner determines they are no longer needed.

D. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather.

E. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

F. Regrade unpaved earth drainage ditches as needed to maintain original grade and remove sediment buildup. If ditch becomes difficult to maintain, install additional erosion control devices as directed by Owner.

G. Unless otherwise specified, remove deposits before the depth of accumulated sediment and debris reaches approximately height of BMP. Dispose of debris or contaminated sediment at approved locations. Clean sediments may be stabilized onsite using BMPs as approved by Owner.

H. Sediment Fence: Remove trapped sediment before it reaches one-third of the above ground fence height and before fence removal.

I. Other Sediment Barriers (such as biobags): Remove sediment before it reaches 2 inches depth above ground height and before BMP removal.

J. Catch Basins: Clean before retention capacity has been reduced by 50 percent.

K. Sediment Basins and Sediment Traps: Remove trapped sediments before design capacity has been reduced by 50 percent and at completion of Project.

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L. Initiate repair or replacement of damaged erosion and sediment control BMPs immediately, and work completed by end of next work day. Significant replacement or repair must be completed within 7 days, unless infeasible.

M. Within 24 hours, remediate any significant sediment that has left construction site. Investigate cause of the sediment release and implement steps to prevent a recurrence of discharge within same 24 hours. Perform in-stream cleanup of sediment according to applicable regulations.

N. At end of each work day, stabilize or cover soil stockpiles or implement other BMPs to prevent discharges to surface waters or conveyance systems leading to surface waters.

O. Temporarily stabilize soils at end of shift before holidays and weekends, if needed. Ensure soils are stable during rain events at all times of year.

P. Initiate stabilization by no later than end of next work day after construction work in an area has stopped permanently or temporarily.

Q. Within 14 days of initiating stabilization or as specified in permit, either seed or plant stabilized area (see Section 32 92 00, Turf and Grasses); or apply non-vegetative measures and cover all areas of exposed soil. Seed dry areas as soon as Site conditions allow. Ensure that vegetation covers at least 70 percent of stabilized area. In areas where RA Contractor's activities have compromised erosion control functions of existing grasses, overseed existing grass. Non-vegetative measures may include blown straw and a tackifier, loose straw, or an adequate covering of compost mulch. Complete initial stabilization within 7 days if storm water discharges to surface waters impaired for sediment or nutrients, or high quality waters.

R. Provide permanent erosion control measures on all exposed areas. Do not remove temporary sediment control practices until permanent vegetation or other cover of exposed areas is established. However, do remove all temporary erosion control measures as exposed areas become stabilized, unless doing so conflicts with local requirements. Properly dispose of construction materials and waste, including sediment retained by temporary BMPs.

3.05 REMOVAL

A. When Owner determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits. When materials are biodegradable, Owner may approve leaving temporary BMP in place.

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B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and seed graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

3.06 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this specification.

1. Exhibit 1 – Draft Soil Erosion and Sedimentation Control Plan.

END OF SECTION

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SOIL EROSION AND SEDIMENTATION CONTROL PLAN

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall Operable Unit 1 St. Louis, Michigan

Remedial Action

Prepared for

June 2023

Draft

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Acronyms and Abbreviations

ARAR	Applicable or relevant and appropriate requirement
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	U.S. Environmental Protection Agency
FPS	Former plant site
NPL	National Priorities List
NREPA	Natural Resources and Environmental Protection Act
OU1	Operable Unit 1
ROD	Record of Decision
SESC	Soil Erosion and Sedimentation Control
SM	Site manager

Draft

1. Introduction

This Soil Erosion and Sedimentation Control (SESC) Plan was developed for the downgradient vertical barrier wall (DGVBW) installation in Operable Unit 1 (OU1) at the Velsicol Chemical Corporation Superfund Site, EPA ID# MID000722439. The site is located in Gratiot County, St. Louis, Michigan. The remedial actions will take place at the former plant site (FPS) and will be conducted in accordance with the Record of Decision (ROD) for this site as required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The U.S. Environmental Protection Agency (EPA) will contract a remedial action (RA) contractor ("RA Contractor") to conduct the remedial activities.

This SESC Plan applies to DGVBW construction remedial activities performed at the FPS and within the Pine River. This plan provides an overview of construction activities and includes procedures that will be implemented to mitigate soil erosion and sedimentation from the work areas.

Under CERCLA 121(e), onsite remediation activities (that is, activities within OU1) are exempt from permitting and other administrative requirements; however, the remedial action must comply with applicable, relevant, and appropriate requirements (ARARs). The ROD for this site includes the following ARAR:

> *Part 91 (Soil Erosion and Sedimentation Control) of the* Natural Resources and Environmental Protection Act *[NREPA]. 1994 P.A. 451 as amended (MCL 324.9101 – 324.9123a [Michigan Administrative Rules 323.1701 - 1714]). Prevents uncontrolled erosion and sedimentation in lakes, streams and rivers from earth-changing activities. Requires a soil erosion control and sedimentation plan for any earth change. Substantive requirements are applicable for excavation and earth changing activities.*

In accordance with the substantive requirements of Rule 323.1704, an SESC plan is required if an earth change:

- Disturbs more than 1 acre of land or
- Is within 500 feet of a lake or stream, as defined under Administrative Rule R323.1701 to 1714, Part 17, Soil Erosion and Sedimentation Control

DGVBW construction will occur within 500 feet of the Pine River. This SESC Plan was therefore developed following the substantive requirements of Administrative Rules 323.1703 and 323.1706.

A copy of the SESC permit application is provided in Appendix A for informational purposes. To address the Gratiot County SESC Permit Application and Plan Requirements, the following items are provided in this SESC Plan.

- Scaled maps
- Site location sketch
- Proximity to lakes, streams or drains
- Limits of earth change
- Predominant land features
- Slope information
- Soils information
- Drainage facilities
- Timing and sequence
- Temporary SESC measures and timing sequence for installation and removal
- Permanent SESC measures
- Maintenance program for SESC measures

Draft

This plan provides an overall approach to be implemented for soil erosion and sedimentation control. This plan will be updated by the RA Contractor prior to starting RA activities and will be modified by the RA Contractor when there is a change in design, operation, or maintenance in construction activities. The plan will also be revised by the RA Contractor if procedures or controls prove to be ineffective in eliminating or significantly minimizing soil erosion or sedimentation from the work area.

Draft

2. Site Description

2.1 Site Background

The following sections give a general overview of the location, setting, and history of the site, as well as surface soil types that can be found in the vicinity.

2.1.1 Site Location

The Velsicol Chemical corporation/Pine River Superfund Site is located in Gratiot County, St. Louis, Michigan, and encompasses a 52-acre land parcel commonly referred to as the FPS. The staging area for use during DGVBW construction activities will be located at the FPS. Proposed staging areas are shown on the drawings included in the *Basis of Design Report, Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan* (BODR; CH2M 2023); however, the location of the staging area will be determined by the RA Contractor.

2.1.2 Site History

The FPS was used for industrial operations beginning in the mid-1930's until the plant was closed in 1977. Historical operations at the site included a lumber mill, oil refinery, salt processing plant, and chemical manufacturing plant. After the plant closed in 1977, demolition and decommissioning activities began in 1978. The site buildings were razed, and some structures were buried onsite, including storage tanks and process piping. Building and tank foundations were not removed and a significant amount of debris remains buried at the site beneath a clean soil cover.

2.1.3 Surface Soil Types

Surface soil types that are found within the vicinity of the site include the Marlette Sandy Loam and the Spinks Loamy Sand.

2.1.3.1 Marlette Sandy Loam

The Marlette sandy loam is a gentle to moderate sloping, well-drained soil found on foot slopes, knolls, and ridges. The surface layer is typically described as a dark grayish brown or brown sandy loam underlain by a pale brown sandy loam. The subsoil is friable and described as a mixed yellowish brown loam and pale brown loam or sandy loam underlain by a brown clay loam to a depth of about 60 inches. The hydrologic properties of these soils are extremely variable. Typically, the permeability is moderate or moderately slow, and the available water capacity is high with medium to rapid runoff.

2.1.3.2 Spinks Loamy Sand

The Spinks loamy sand is a level and gently sloping, well-drained soil on foot slopes, knolls, and ridges. Typically, the surface layer is described as grayish brown loamy sand. The subsoil is loose, yellowish brown sand underlain by pale brown sand to a depth of about 60 inches.

Permeability is moderately rapid or rapid, and available water capacity is low with slow runoff.

2.1.3.3 Topography

Topography in this area is generally flat with some areas of gentle relief, see attached erosion control plans. There is no anticipated significant change in topography as a result of the remedial activities.

The Pine River flows along the western and northern boundary of the FPS into Mill Pond, where a hydroelectric dam is located (about 0.25 miles east of the FPS). The DGVBW will be installed within the Pine River.

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There are no surface water bodies within the FPS, including wetlands, rivers, streams, or lakes. However, construction of the DGVBW will occur within the Pine River.

The project area is located within the limits of the 100-year floodplain, as documented within the Floodplain Delineation Report approved and published by EGLE in accordance with Mich. Admin. Code R. 560.303.

2.2 Description of Construction Activities

The site preparation subcontract is intended to facilitate future activities that will be performed to achieve remedial action objectives (RAOs) for contaminants of concern (COCs) on the FPS in accordance with the 2012 ROD.RAOs are goals that are specific to media or OUs for protecting human health and the environment and were established in the 2012 ROD. DGVBW construction activities are proposed to begin in Spring 2024 and be completed in 2025.

2.2.1 Downgradient Vertical Barrier Wall Construction Activities

The following definable features of work (DFOWs) are the major components of the DGVBW construction activities:

1. Preconstruction
2. Mobilization
3. Site Preparation
4. Sheet Pile Wall Construction Activities
5. Sampling, Testing, and Monitoring
6. Site Restoration
7. Demobilization

2.2.2 Staging Area

The DGVBW staging area will include parking, field offices, tool trailers, storage trailers, water supply and portable sanitary facilities.

2.2.3 Potential Sources of Pollutants in Stormwater Discharges from Construction Activities

The potential sources of pollutants during construction activities include:

- Sediment from DGVBW installation
- Sediment from vehicle and equipment decontamination areas
- Sediment from vehicle tracking
- Sediment from soil stockpile areas
- Sediment from loading and unloading areas
- Sediment and waste (including wastes from portable sanitary facilities and material storage areas)
- Petroleum products (gasoline, diesel, oil, hydraulic fluid, lubricants, etc.) from vehicle and equipment maintenance and fueling

2.3 Site Drawing

The drawings attached to the BODR show existing conditions at the FPS and Pine River, including general drainage patterns within this area. The drawings also provide the limits of the work, including its proximity to and within the Pine River.

2.4 Schedule

The DGVBW construction schedule summary will be presented in Appendix B as part of the SESC Plan updates during the RA.

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3. Best Management Practices

Best Management Practices (BMPs) will be implemented as described below to control soil erosion and sedimentation, and otherwise prevent the discharge of pollutants during construction activities. The BMPs will be selected, installed, and maintained in an appropriate and functional manner that is in accordance with the relevant manufacturer specifications and accepted engineering practices. The description of controls includes:

- Control measures during construction
- Erosion and sediment controls, including structural and stabilization controls
- Spill prevention and control
- Employee training

Appendix C contains the Michigan Department of Environment, Great Lakes, and Energy (EGLE) BMP specifications.

3.1 Control Measures during DGVBW Construction Activities

The potential sources of pollutants were described previously in Section 2.2.3. BMPs will be implemented prior to DGVBW construction activities and will be maintained until DGVBW activities are completed where the control measures have been implemented. Specific measures to control pollutant discharges from these sources are discussed below.

3.1.1 DGVBW Installation Areas

To prevent erosion and sedimentation from stormwater runoff at the construction areas, the control measures discussed below and BMPs described in Section 3.2, Erosion and Sediment Controls, will be implemented as applicable.

- **Inlet Protection:** Generally, there are no stormwater drains (for example, curb, and gutter, drop inlet) present in the FPS where construction activities will occur. Stormwater drains are present in the grassed right-of-way at select corner intersections. If present within 500 feet (roughly 1 block) of the work area, sild fence, fiber logs, inlet traps, or other appropriate BMP will be installed around the nearest downgradient storm sewer inlet. The inlet protection BMP will be placed prior to start of construction activities and removed after disturbed areas have been vegetated. If needed, the disturbed area may be stabilized with erosion control blanket and staples (Appendix C).
- **Silt Fence:** Silt fence (Appendix C) will be installed as a perimeter control along the down slope of potential disturbed areas during construction activities.
- **Seeding:** Seeding and mulching of disturbed areas within the work area and along the newly constructed temporary access roads, laydown areas, and staging areas will be completed as part of the site restoration. The final graded areas will be seeded using a mix native to the local area in accordance with Michigan Department of Transportation Standard Specifications for Construction.
- **Erosion Control Blanket:** If necessary, erosion control blankets will be secured over soil in disturbed areas for the winter months. The erosion control blanket will be Type 1D, double-netted blanket secured in place with staples. If necessary, erosion control blankets will be removed during site restoration activities.

3.1.2 Dewatering Areas

Due to the existing clay cap on the FPS a minimal amount of excavation is planned. Dewatering will be performed as needed between the FPS shoreline and DGVBW installation. It is anticipated that accumulated water will be contained and transported offsite for disposal.

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3.1.3 Loading and Unloading Areas

Loading and unloading will be performed at the FPS. Temporary ground coverings, such as tarps or plastic sheeting, will be placed beneath the trucks during loading activities (as needed). Soils or other materials spilled during loading or unloading will be cleaned up immediately. This includes soils on the outside of trucks (side rails), ground and road surface.

3.1.4 Vehicle and Heavy Equipment Decontamination Areas

Decontamination will be performed to remove contaminated soil and debris from vehicles and equipment prior to leaving the project site. During the progress and upon completion of the work, all tools, heavy equipment, vehicles, exteriors of trucks, and other items used at the FPS to perform intrusive activities involving contaminated soil or debris will be decontaminated. If haul trucks that are used to transport impacted soils are later used for uncontaminated backfill materials, the bed of the haul trucks will be decontaminated between hauling impacted and uncontaminated soils. Construction tools and equipment that contact impacted soils will be decontaminated prior to use for uncontaminated soils. Liquids, rinse water, solids, and sludge generated during decontamination operations will be collected and contained for offsite disposal.

3.1.5 Offsite Vehicle Tracking

Offsite tracking of soil and the generation of dust will be minimized. Vehicles will be inspected prior to leaving the FPS. The object is to reduce fugitive dust emissions within the FPS and neighboring areas.

3.1.6 Soil Stockpile Areas

In general, stockpiles may be located at the FPS for management of imported clean borrow soils (general backfill, aggregate and topsoil) and uncontaminated soils excavated for road construction and stockpiled for reuse. It is anticipated that stockpiles will be managed in the following manner:

- Stockpiles of imported borrow soils and uncontaminated soils for reuse at the FPS staging area will be protected by constructing a material storage bin with sidewalls on three sides (back and sides) to facilitate handling of the material and to provide a level of confinement. The bin will be lined with geotextile or fiber logs to minimize sediment movement. Silt fence, hay bales, fiber logs, or other sediment control means will be used along the open side of the bin overnight or when construction activities have ceased due to adverse weather to prevent movement of the soil into surface waters. The RA Contractor will determine means and methods to be implemented for erosion control; at the FPS and the specific BMP will vary depending on the materials stockpiled.
- During road construction activities stockpiles may accumulate within the proposed road boundaries. Stockpile quantities will be limited in size to prevent erosion from occurring and covered with polyethylene covers and anchored with sandbags or approved equivalent as needed.
- Signs will be posted in each direction of approach to the stockpile clearly identifying what material is in the stockpile.

3.1.7 Waste and Material Storage Areas

3.1.7.1 Material Storage

- Petroleum products will be stored with appropriate secondary containment in containers compatible with the material stored.
- Other vehicle maintenance liquids (antifreeze, motor oil, hydraulic fluid, etc.) will be stored either indoors or in bermed areas in containers compatible with the material stored.
- Safety data sheets (SDS) will be made available for all materials. SDS will be stored in the RA Contractor field office trailer.

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- Sufficient separation will be allowed between storage containers to allow for cleanup and emergency response.
- Chemically incompatible materials will not be stored together or in the same storage facility.
- Original labels must not be removed. Materials must be relabeled properly to maintain current, legible labels with proper safety and disposal information.
- Equipment, trailers, and trucks will be staged in designated areas within the FPS.
- All equipment will be returned to the equipment staging area at the FPS each night for security purposes.
- The staging area and work area are to be locked at all times when onsite personnel are absent. At no time will unauthorized personnel be admitted onto the FPS site. Signs will be posted at the entrance and around the site fence indicating “UNAUTHORIZED PERSONNEL KEEP OUT”. All personnel will sign in and out each workday.

3.1.7.2 Waste Storage

These practices are to be used to minimize and prevent solid waste associated with construction activities from entering stormwater. This applies to facilities or designated construction work areas where solid waste is generated. Solid waste can be classified as non-hazardous solid material including: rock, debris, soil, wood, plastic, fabrics, mortar, metal scraps, Styrofoam, and general litter such as beverage containers and plastic wrappers.

- Waste materials will be contained and will not be discharged to waters of the state.
- Litter will be minimized in all construction areas and collected on a regular basis into covered containers. Trash receptacles will be provided in various locations within the site boundaries. Trash receptacles will be located away from streets, gutters, watercourses, and storm drains. A trash-hauling contractor will properly dispose of the collected waste in a timely manner. Dumpster washout at the site is not permissible.
- Waste storage areas will be located at least 50 feet from drainage ways and watercourses and will not be located in areas susceptible to frequent flooding.
- Solid waste will be segregated properly into various categories for recycling or disposal. Proper disposal is required for each waste category in accordance with federal, state, and local regulations.
- Useful vegetation, packaging material, and surplus construction materials will be recycled when practical.

3.1.7.3 Temporary Sanitary Facilities

These practices are to be used to minimize and prevent sanitary and septic waste associated with construction activities from entering stormwater. This BMP applies to facilities or designated work areas that use temporary or portable sanitary systems.

- Waste materials must not be discharged to waters of the State.
- Sanitary wastes will be stored in sanitary facilities (for example, individual portable toilets), which will be periodically hauled off by a licensed disposer.
- Temporary sanitary facilities will be located away from drainage ways, inlets, receiving waters, areas of high traffic, and areas susceptible to flooding or damage by construction equipment.
- In project areas susceptible to strong winds, temporary sanitary facilities will be secured to prevent overturning.

Sanitary wastes will be stored, managed, and disposed of in accordance with federal, state, and local regulations.

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3.1.8 Vehicle and Equipment Maintenance and Fueling

The following practices are to be used during vehicle and equipment staging, fueling, cleaning, and maintenance to prevent associated pollutants from entering stormwater. This BMP applies to facilities or designated work areas where vehicles and equipment are staged, fueled, cleaned, or maintained.

- Fueling will be performed offsite whenever possible.
- Perform cleaning, washing, and maintenance in a centralized station offsite where possible. Designated onsite stations should preferably be located on impervious surfaces.
- Use drip pans or absorbent materials under equipment and during fuel transfer and maintenance activities to catch/contain leaks.
- A spill kit will be maintained at refueling locations.
- Eliminate or reduce the amount of toxic or hazardous solvent used where possible.
- Use proper waste or recycling drums for used or spilled fluids; separate and recycle materials when possible.
- Do not pour liquid waste into storm drains or watercourses.
- Avoid hosing down work stations.
- Properly maintain vehicles and equipment and routinely check for leaking oil or fluids.
- Proper spill and illicit discharge reporting and cleanup procedures shall be followed for both hazardous and non-hazardous materials.
- Implement storm drains inlet protection near maintenance, fueling, and servicing activities.

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3.2 Erosion and Sediment Controls

In accordance with Rule 1709 promulgated under the authority of Part 91, Soil Erosion and Sedimentation Control of the NREPA, remedial activities will be implemented to meet the following provisions:

- Perform ground disturbance in the shortest period of time.
- Capture sediment in stormwater before it leaves the FPS.
- Use erosion control measures to prevent erosive stormwater flow through disturbed areas.
- Install erosion control measures prior to performing ground-disturbing activities and maintain them until the area is stabilized. Stabilized means the establishment of vegetation or proper placement, grading, or covering soil to ensure its resistance to soil erosion, sliding, or other earth movement.
- Complete permanent soil erosion control measures within 5 calendar days after final grading. If it is not possible to permanently stabilize the area, maintain temporary measures until permanent measures can be in place and the area stabilized.

Table 3-1 lists erosion and sediment control BMPs that may be implemented to meet these goals.

TABLE 3-1
Structural and Stabilization Measures at the Velsicol FPS
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan

Control Measure	Location	Description of Control Measure[1]
Vegetative Buffers	Wherever practical.	Wherever possible, existing vegetation will be retained between drilling areas and the Pine River. It minimizes erosion potential and protects water quality. The preservation of natural vegetation will provide additional water quality improvement prior to the stormwater entering State or U.S. waters.
Erosion Control Blanket	On appropriate disturbed areas after construction is complete.	Erosion control blanket is a mat made of netting layered with straw, wood, coconut, or man-made fibers that prevents erosion by sheltering the soil from rainfall and runoff while holding moisture for establishing plants.
Inlet Protection	At the first down gradient storm sewer inlet which receives runoff within 500 feet from the disturbed areas.	The inlet protection will consist of inlet traps, silt fence or fiber logs. Inlet protection will be installed prior to the start of construction activities and will be removed after the placement of erosion control blanket over the disturbed area. The inlet protection materials will be cleaned after storm events are as needed.
Seed	Seed is to be implemented in disturbed areas.	Growing of a vegetative cover on disturbed areas.
Fiber Logs	Around areas requiring protection, such as to form a temporary containment.	Fiber logs include straw, wood, or coconut fiber logs that slow water and filter sediment. Fiber logs may be used for perimeter control where inlet traps or silt fence are infeasible or for temporary containment.
Silt Fence	Downslope at excavation areas with positive slope greater than 1V:5H.	Silt fence reduces stormwater-flow velocity and filters sediment from runoff by allowing water to pass through a geotextile fabric or by creating a pool to allow sediment to drop out of the water column. It is primarily installed at downslope boundaries of disturbed soil. Silt fence consists of posts with filter fabric stretched across the posts. The lower end of the fence fabric is vertically trenched and covered with backfill.
Sediment Trap	In upland area immediately adjacent to drainage inlet points and waterways.	Sediment traps provide a catchment for shifting sediment to accumulate in before it can enter a drainage inlet point and/or the Pine River and be periodically removed as necessary.

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TABLE 3-1
Structural and Stabilization Measures at the Velsicol FPS
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan

Control Measure	Location	Description of Control Measure[1]
Sediment Pond or Basin	In upland areas between the Pine River DGVBW installation and FPS shoreline. Can also be placed as a component of and/or temporary application of stormwater basins.	Construction activities to install the DGVBW will result in sediment release within the Pine River. Sediment ponds and basins can be used to provide an accessible location for sediment deposition, basin maintenance, and sediment removal.
Interceptor Dike	Adjacent to in-river construction areas	Interceptor dikes will be used to temporarily divert stormwater runoff around construction activities to stabilize existing flow corridors and prevent riverbank blowouts, gullying, subsurface seepage failures, and reduce the volume of dewatering needed to install the DGVBW.
Interceptor Swale	Adjacent to in-river construction areas	Interceptor swales will be used to temporarily divert stormwater runoff around construction activities to stabilize existing flow corridors and prevent riverbank blowouts, gullying, subsurface seepage failures, and reduce the volume of dewatering needed to install the DGVBW.
Turbidity Curtain	Parallel to Pine River flow.	Turbidity curtains provide isolation of a work area from a waterbody and contain fine grained or suspended sediments (clays and silts).
Hay Bales	Placed at the entry and exit of drainage culvert to collect sediment.	A straw (or hay) bale sediment trap is a row of bales entrenched and secured to detain and filter sediment-laden runoff. Hay bales may potentially be aligned and staked to create a perimeter around storm drain inlets.

3.3 Employee Training

The RA Contractor will have an employee onsite during construction activities who is a certified Construction Stormwater Operator/Soil Erosion Inspector in the state of Michigan. The Construction Stormwater Operator/Soil Erosion Inspector will be responsible for the following:

- Inspection of sites to determine compliance with the SESC Plan
- Documentation of inspection observations
- Identification of SESC measures that are failing or require maintenance
- Identification of areas where additional SESC measures may be necessary
- Reporting of findings of the inspection, including any corrective or additional action recommended

Certified Construction Stormwater Operators/Soil Erosion Inspectors may be the same person responsible for installing and maintaining the SESC measures, although this is not a required duty under the certification.

3.4 Spill Prevention and Control

These practices are implemented to prevent and control spills to ensure that spills and leaks do not result in water quality impacts. This BMP applies to all construction activities. Spill prevention and control measures will be implemented any time chemicals or hazardous substances are used, stored, or handled.

- Project areas and activities potentially susceptible to spills will be identified. Areas and activities most vulnerable to spills include loading and unloading areas, fuel and chemical storage areas, process activities, dust- or particulate-generating processes and waste disposal activities.
- Spills will be contained and cleaned up as soon as possible.

- If complete cleanup is not immediately possible, spills will be fully covered and not exposed to precipitation.
- Spills will not be washed down or buried.
- Residuals left over from the cleanup activity, such as absorbent pads or containers of spill material, will be disposed of properly.
- Proper spill and illicit discharge reporting procedures will be followed.
- An area where a spill has occurred must be inspected to verify that spill residuals are not present after the initial cleaning and that the area does not need to be re-cleaned.
- Emergency phone numbers will be posted at the construction area.
- Personnel will be trained in emergency response procedures.
- Proper notification of regulatory agencies will occur in the event of a reportable spill.

3.4.1 Cleanup Response Procedures

The following response guidelines have been identified below for responding to spills that may potentially result in an illicit discharge.

- Immediately warn any nearby workers and notify supervisor.
- Assess the spill area to ensure that it is safe to respond.
- Evacuate area if spill presents an emergency.
- Ensure any nearby ignition sources are immediately eliminated.
- Stop source of spill.
- Establish site control for spill area.
- Contain and control spilled material through use of sorbent booms, pads, or other material.
- Use proper personal protective equipment in responding to spills.
- Properly barricade material staging areas for containment and to control runoff as needed.
- If rainfall is present at the time of the spill, cover the spill with a tarp to prevent contaminating runoff.
- Use absorbent materials to contain spills and clean the area of residuals.
- As necessary, a licensed contractor or HAZMAT team shall be used to properly clean up spills.
- Dispose of the absorbent material properly.
- Do not hose down spill area with water.

3.4.2 Spill Reporting

The RA Contractor will follow the emergency response and reporting procedures in their approved health and safety plan and Spill Prevention Control and Countermeasures Plan (if required).

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4. Maintenance

All erosion and sediment control measures and other protection measures will be maintained in effective operating condition. All non-functional BMPs will be repaired, replaced, or supplemented with functional BMPs within 24 hours after discovery, or as soon as field conditions allow access.

Maintenance will be performed as needed, as determined by the inspections. Specific maintenance requirements may include the following:

- Removal of sediment and other debris that has collected within sediment traps or behind silt fences, fiber logs, geotextile, or hay bales
- Re-staking of silt fences or hay bales; securing of fiber logs
- Securing loose edges or damage to erosion control blankets

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5. Inspections

Inspections will be performed to review the areas for evidence of, or the potential for, pollutants leaving the work area. The controls identified in Section 3 will be inspected to verify they are being implemented properly. Maintenance and/or repairs will be made to erosion and sediment control measures as identified by the inspections. As necessary, this SESC Plan will be revised to incorporate any changes that come about as a result of the inspection. A record of the inspections will be maintained at the FPS as part of the SESC Plan. Appendix D includes an SESC inspection form.

5.1 Requirements during Construction

The following areas will be inspected at a minimum every 7 days and within 24 hours of the end of a storm event of 0.5 inch or greater in a 24-hour period, as determined using an onsite rain gauge:

- Disturbed areas where stabilization measures have not been completed and any nearby stormwater inlets
- Storage areas that are exposed to precipitation
- Structural control and stabilization measures
- Construction entrances/exits
- Construction perimeter controls

Following an inspection that occurs within 24 hours after a rainfall event, the next inspection will be conducted within 7 days after that. Documentation of inspections will include at least the following:

- Date and time of inspections
- Initials of person conducting inspection
- Type of inspections
- Findings of inspections, including recommendations for corrective actions
- Corrective actions taken (including dates, times, and party completing maintenance activities)
- Date and amount of rainfall events greater than 0.5 inch in 24 hours
- Documentation of changes made to the SESC Plan
- Inspection of discharge points and downstream, offsite areas for signs of impact
- Inspection of perimeter controls
- Comparison of BMPs in the SESC Plan with construction site conditions
- Inspection of disturbed areas not currently being worked
- Inspection of areas with final stabilization
- Areas used for storage of materials, soil, or waste

A copy of the detailed area drawing will be used during inspections and will be manually updated, as necessary, to reflect any changes. Table 5-1 provides stormwater BMP inspection/maintenance guidelines.

5.2 Requirements Prior to Final Stabilization

Permanent or interim stabilization measures of disturbed land area will be implemented within 5 calendar days after final grading or the final earth change has been completed. Grass seed will be placed in the disturbed land area for final stabilization. A final inspection will be performed after completion of site restoration activities and removal of control measures.

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TABLE 5-1
Stormwater Inspection/Maintenance Guidelines
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan

EROSION CONTROL BLANKET

- Is fabric damaged, loose, or in need of repairs?
- Are sections overlapping 4 to 6 inches? Are staples 12 inches apart on overlapping sections and 24 inches apart along the sides and in the middle?

SILT FENCE

- Is the fence damaged, collapsed, or ineffective?
- Has sediment been removed from behind fence? (Sediment should be 1/3 height of fence or less.)
- Is the silt fence properly installed and positioned? Is the silt fence trenched at least 6 inches deep and 6 inches wide with stakes on downhill side?

HAY BALES

- Are the hay bales damaged, deteriorated, or ineffective?
- Are the hay bales positioned and installed correctly?
- Has sediment been removed from behind the hay bales?

SEDIMENT TRAP

- Is there accumulated sediment that needs to be removed?
- Is the trap intact and in good condition?
- Is the trap impeding the flow of stormwater?

FIBER LOGS

- Are the fiber logs damaged or deteriorated, or ineffective?
- Has sediment been removed from behind the logs?
- Are the logs installed and positioned correctly?

INLET PROTECTION

- Is inlet clear and free of debris?
- Is there accumulated sediment that needs to be removed?
- Is the inlet protection intact and in good working condition?
- Is the inlet protection impeding stormwater flow?

SEDIMENT POND OR BASIN

- Are inlets and outlets free of debris?
- Are any repairs needed?
- Is there accumulated sediment that needs to be removed?

INTERCEPTOR DIKE

- Is the interceptor dike free of debris?
- Is water flowing as intended by the interceptor dike?
- Are any repairs needed?

INTERCEPTOR SWALE

- Is the interceptor swale free of debris?
- Is water flowing as intended throughout the interceptor swale?
- Are any repairs needed?

TURBIDITY CURTAIN

- Are anchors, tie-downs, or other mechanisms sufficiently isolating construction activities from the waterbody?
- Is the turbidity curtain installed and positioned correctly?

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TABLE 5-1
Stormwater Inspection/Maintenance Guidelines
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan

- Is the turbidity curtain impeding the flow of the waterbody?

VEHICLE TRACKING

- Is the site graded away from the construction exit to prevent runoff from leaving the site?
- Is there evidence of sediment tracking from the site?
- Is there evidence that vehicles are leaving the site from other locations, and not using the designated construction exits?

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Appendix A
SESC Permit Application

PERMIT APPLICATION
For Part 91
SOIL EROISION AND SEDIMENTATION CONTROL

1. APPLICANT

Name (Land owner Only			Date of Birth
Address			Drivers License #
City	State	Zip Code	Phone Number

1. LOCATION

Section	Town	Range	Township	City / Village	County
Subdivision	Lot No.	Tax ID Number	Street Address		

2. PROPSED EARTH CHANGE

Project type: ☐ Residential ☐ Multi-family ☐ Commercial ☐ Industrial ☐ Land Balancing / Mining		
Describe Project		Size of Earth Change (acres or square feet)
Name and distance to Nearest Lake, Stream or Drain	Date project to start	Date project to be completed

3. SOIL EROSION AND SEDIMENTATION CONTROL PLAN (Refer to Rule 323.1703)

Note: 2 Completed sets of plans must be attached	Estimated cost for Soil Erosion and Sedimentation Control
	Plan Prepares Name and Telephone Number Area Code ( ) -

4. PARTIES RESPONSIBLE FOR EARTH CHANGE

Name of Land Owner (if not provided in Box No 1)		Address		
City	State	Zip Code	Area code/Telephone Number	
Name of Individual "On Site" Responsible for Earth Change		Company Name		
Address	City	State	Zip Code	Area code/Telephone Number

5. PROFORMANCE DEPOSIT (If required by the permitting agency)

Amount Required $_____ ☐ Cash ☐ Certified Check ☐ Irrevocable Letter of Credit ☐ Surety Bond				
Name of Surety Company				
Address	**City**	State	Zip Code	Are Code/Telephone Number

I (we) affirm that the above information is accurate and that I (we) will conduct the above described earth change in accordance with Part 91, Soil Erosion and Sedimentation Control , of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, applicable local ordinances, and the documents accompanying this application.		
Landowner's Signature	Print Name	Date
Designated Agent's Signature*	Print Name	Date

*Designated agent must have a written statement from the landowner authorizing him/her to secure a permit in the landowner's name.

PLEASE INCLUDE THIS PAGE WITH SESC PLANS.

Have	Need	N/A	☑ SITE PLAN CHCKLIST FOR SOIL EROSION PERMITS
			Drawing must be to scale (map scale:1”=200’ or less)
			Site location map showing nearest road intersection
			Legal description of property (i.e. T12N R4W Section 17 NW ¼, NE ¼.)
			Location and size of each proposed earth change (clearly defined ON DRAWING)
			Location and size of all temporary soil stockpiles
			Major geographic and vegetation features
			Location and size of all tree lines and forested areas
			Location and size of all existing buildings and structures
			Soil information (on drawing or in written form)
			Distance to nearest water body (lake, stream, river, county drain, wetland, etc.) for each proposed earth change.
			Location of all existing and proposed drainage and dewatering facilities
			Slope information or topography
			Location and detailed description of all TEMPORAY erosion and sedimentation control measures (shown on drawing)
			Location and detailed description of all PERMANENT erosion and sedimentation control measures (shown on drawing)
			Maintenance program for erosion and sedimentation control measures (including person responsible)
			Timing and sequence of construction (construction schedule)

TYPE OF EARTH CHANGE

- ☐ single family residence (new construction)
- ☐ single family residence (addition/alteration)
- ☐ garage (addition or detached)
- ☐ pole barn
- ☐ pool (in ground)
- ☐ pond
- ☐ commercial/industrial (new)
- ☐ commercial/industrial (add./alt.)
- ☐ residential development (subdivision, multi-family)
- ☐ recreation development
- ☐ golf course
- ☐ road
- ☐ pipeline
- ☐ utility
- ☐ school/church
- ☐ hospital
- ☐ other_____

ADDITIONAL EARTH CHANGE INFORMATION

Has earth-moving activity started?	Yes ☐	No☐	
Is the earth-moving activity over 1 acre?	Yes ☐	No☐	
Will the work be occurring in a wetland?	Yes ☐	No☐	if yes, contact MDEQ
Will de-watering occur?	Yes ☐	No☐	
Will work be occurring in a waterway/floodplain?	Yes ☐	No☐	if yes, contact MDEQ
Will a designated county drain be affected?	Yes ☐	No☐	if yes, contact Gratiot County Drain Office
Will fill be brought on site?	Yes ☐	No☐	Amount in cubic yards_____
Will material be removed from site?	Yes ☐	No☐	Amount in cubic yards_____

APPROXIMATE PROJECT TIMING (Month/Year)

MINOR PROJECTS

___/___ Temporary Erosion Control Measures installed

___/___ Gravel Drive/Entrance Installed

___/___ Land Cleared or Excavation Started

___/___ Final Grade / Seeding

___/___ Permanent Erosion Measures in Place

___/___ Temporary Erosion Measures Removed

MAJOR PROJECTS

___/___ Temporary Erosion Control Measures installed

___/___ Gravel Drive/Entrance Installed

___/___ Land Cleared or Excavation Started

___/___ Detention/Retention /Sediment Ponds Installed

___/___ Road Construction

___/___ Utilities Installed

___/___ Final Grade / Seeding

___/___ Catch Basins/Ponds Cleaned

___/___ Permanent Erosion Measures in Place

___/___ Temporary Erosion Measures Removed

Larry Wymer Building Official
Terri Ball Deputy Permits Officer

214 E Center St.
Court House
Ithaca, MI. 48847

Phone: (989)875-5201
Fax: (989)875-5206
E-mail address
permits@gratiotmi.com

Gratiot County Permits Office

PERMIT REQUIRMENTS:

A land owner who contracts for, allows or engages in an earth change in the County shall obtain a soil erosion permit from the Gratiot County Permits Office prior to commencement of an earth change which disturbs one or more acres of land or if the earth change is within 500 feet of a lake, river or water course of this County.

If construction or earth change is started without a permit Or continues without a permit, the total fee will be doubled.

PLAN REVIEW FEE

At the time of application for a permit a non-refundable fee shall be charged for plan review

Less than 1 acre	$25.00
1 to 5 acres	$50.00
6 acres or more /Commercial	$75.00

Additionally fees for inspection and permit will be charged according to the following schedule

PERMITS:

1. Residential – Single or Duplex
   a. New Home $80.00
   b. Building addition, improvement, pole building, garage, sanitary waste system or Driveway $40.00

2. Site Development: Up to 1 acre $100.00
   Each additional acre or fraction thereof $25.00

   Plat developments, mobile home parks, multiple housing units/ apartments commercial / industrial, cut & fill operations, contiguous family homes erected at the same time, by the same owner, developer and contractor.

3. Utilities: Up to 1 mile $100.00
   Each additional mile $35.00
   Including, but not limited to, underground cables, conduit or pipelines.

4. Gravel/Sand Mining: (Annual permit) $250.00 (1-2 acres)
   $500.00 (3-5 acres)
   $750.00 (6+ acres)

DRAFT

INSPECTION FEE:

1. Number of inspections determined at one inspection per month
   Until permanent ground cover is established.

Residential	$30.00
Non-Residential	$75.00

   Additional inspections may be required by the Soil Erosion Officer because of conditions that might occur through non-compliance on the part of the permit holder or the permit holder my request additional inspections

2. Site Evaluation/Consultation
   a. A single family residential home or accessory structure $35.00
   b. All other projects (including 2+ homes) $75.00

NOTES TO APPLICANT:

The applicant (person signing the application) is legally responsible for the final ground cover. If the property is sold the legal responsibility remains with applicant unless the buyer signs a written agreement to take over all responsibility for installing the required final cover. A copy of that signed agreement must be submitted to the Soil Erosion Officer before the permit expires.

The fully completed application forms and schedule, plus a legal description of the property and two sets of site plans must be submitted at least 14 days before work is to begin. Submit completed applications to

Gratiot County Permits office
214 E Center St.
Ithaca, MI. 48847

Fax # (989)875-5260

All sites where over 5 acres of ground are disturbed must have a licensed Storm Water Operator. That person must be listed on the application as the on-site contact. Please include the licensed operator's Michigan Department of Environment Quality license number on the application.

If you have any questions, contact our office at (989)875-5201

Fee Schedule Effective October 1, 2011

DRAFT

Larry Wymer Building Official
Terri Ball Deputy Permits Officer

214 E Center St.
Court House
Ithaca, MI. 48847

Phone: (989)875-5201
Fax: (989)875-5206
E-mail address
permits@gratiotmi.com

Gratiot County Permits Office

Designated Agent Assignment Form

_____
Date

I authorize _____ to act as my representative in regard to

Soil Erosion and Sedimentation Controls at my property located

At_____. In doing so, I agree to the

Specified requirements on the Soil Erosion and Sedimentation Control permit.

_____ _____
Signature Phone number of Property Owner

DRAFT

Draft

Appendix B
Construction Schedule
(to be provided during the RA)

Draft

Appendix C
Michigan Department of Environment, Great Lakes, and Energy Best Management Practices Specifications

Seeding

Description

Seeding is the establishment of a temporary or permanent vegetative cover by planting seed. For the purposes of this BMP, "grass" and "turf" will be used interchangeably.

This BMP does not address planting individual sprigs of grasses or other vegetation. See the Trees, Shrubs, and Ground Covers BMP for information on planting sprigs.

Other Terms Used to Describe

Hydroseeding
Vegetative Cover

Pollutants Controlled and Impacts

Once established, turf helps keep soil on site, absorbs nutrients, and allows groundwater recharge.

Application

Land Use
This BMP is applicable to all land uses.

Soil/Topography/Climate
Vegetative establishment is important on all exposed areas, but particularly on sloping terrain and areas adjacent to waterbodies or wetlands. It is also important in areas which frequently flood or which are impacted by spring runoff or strong winds.

When to Apply
Seed should be applied immediately after grading and preparation of the seed bed is finished on each small segment of a construction project. Mulch and/or soil erosion control blankets should be used to keep seed in place until the vegetation is established.

Where to Apply
Apply on all construction or earth change sites which require temporary or permanent vegetative stabilization.

Relationship With Other BMPs

Seeding can be used in conjunction with almost all temporary and permanent soil erosion and sedimentation control measures. Any fertilizer or lime that is applied should be done based on the results of soil tests. See the Soil Management BMP. Mulching should be used in conjunction with seeding to ensure establishment of an effective vegetative cover.

Proper grading is needed to ensure the seed bed is adequate for seed application. See the "Site Preparation" section, below.

Specifications

Planning Considerations:

1. The proper **species** of seed should be selected following basic integrated pest management practices (see the Pesticide Management BMP). To reduce the amount of fertilizer, pesticides and other inputs needed, choose adapted varieties based on environmental conditions, management level desired, and the intended use. Consider mixes because they are more adaptable than single species.

2. The proper **time to seed** is dependent upon the climate of the area. In Michigan, there are three different climatic areas which determine when seeding should occur. These are included in Exhibits 1 and 2.

   Seeding dates for permanent cover and dormant seeding are given in Exhibit 1. Dormant seeding is done after the normal growing season, using seed which will lay dormant in the winter but start growing as soon as soil conditions are favorable. Note that perennial grasses should be used for all permanent cover.

   To determine seeding dates for temporary cover use Exhibit 2. Note that the seeds listed here are annual grasses. Be sure to use annual grasses for all temporary cover. Seed mixtures for temporary seeding usually consist of rye or wheat. These species grow better after over-wintering (via a process called vernalization).

3. **Seeding mixture** for permanent cover. For permanent cover, the appropriate seeding mixture is determined in a two-step process. First, consult Exhibit 3, which lists various land uses and site conditions. Determine conditions at your site and use the table to come up with an appropriate seeding mixture number. Exhibits 4 and 5 indicate the various species and seeding rates associated with the selected seeding mixture number on a pound per acre and 1,000 square foot basis, respectively.

   Seeding mixtures for dormant seedings. Use Exhibits 3, 4, and 5 to determine proper seeding mixtures. Dormant seedings are completed in the late fall after the soil temperature remains consistently below 50°F. Perennial grasses are to be used with all dormant seedings.

   Seeding mixtures for temporary cover. Temporary vegetative cover is provided to protect Spoil Piles and larger areas which are staged. Seeding mixtures for temporary vegetative cover are given in Exhibit 2.

4. Subsurface Drains may be needed where water movement may cause seeps or soil slippage. Wet waterways should be tiled to ensure the vegetation is established.

5. Note: Some wildflower seed packages contain seeds of plant species which will compete with native plants. For example, some packages contain purple loosestrife, which is detrimental to cattail populations. The Department therefore does not recommend wildflower plantings unless the seed can be certified as being native to Michigan and is appropriate to the soil and other site conditions.

Site Preparation:

1. Consider protecting seeded areas from pedestrian access using the Construction Barriers BMP.

2. Where possible, divert concentrated flows away from the seeded area at least until the vegetation is established. Follow specifications in the Diversions BMP.

3. Soil tests should be done to determine the nutrient and pH content of the soil. Depending on the results of soil tests, Soil Management may be necessary to adjust the pH to between 6.5 and 7.0 (for most conditions). All lime, fertilizer and other soil amendments should be addressed following the Soil Management specifications. Note that sandy loam, loam, and silt loam are the preferred soils for seeding. Consideration should be given to incorporating these soils into the seedbed.

4. Prepare a 3-5-inch deep seedbed, with the top 3-4 inches consisting of topsoil. Note that the earth bed upon which the topsoil is to be placed should be at the required grade.

5. The seedbed should be firm but not compact. The top three inches of soil should be loose, moist and free of large clods and stones. For most applications, all stones larger than 2 inches in diameter, roots, litter and any foreign matter should be raked and removed. The topsoil surface should be in reasonably close conformity to the lines, grades and cross sections shown on the grading plans.

6. Slopes steeper than 3:1 should be roughened.

Planting:

1. Seed should be applied as soon after seedbed preparation as possible, when the soil is loose and moist. If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed with a disk, a spring tooth drag, a spike tooth drag, or other equipment designed to condition the soil for seeding. Harrowing should be done horizontally across the face of the slope.

2. Always apply seed before mulch.

3. Apply seed at the rates specified in the attached Exhibits using calibrated spreaders, cyclone seeders, mechanical drills, or hydroseeders.

4. Ideally, broadcast seed should be incorporated into the soil by raking or chain dragging, or otherwise floated, then lightly compacted to provide good seed-soil contact.

5. For hydroseeding operations:

   - Seed should be applied at recommended rates. If no rates are given, use 150-200 lbs/acre.

   - Use 2 tons/acre straw mulch, unless otherwise recommended. Use 3 tons/acre when dormant.

- If recycled newsprint is used, follow specifications in the Mulching BMP.

6. All newly seeded areas should be protected from erosive forces by mulch. See the Mulching BMP.

7. Species of grasses which cannot be planted with seed should be planted by sprigging or sodding. See the Trees, Shrubs and Ground Covers BMP for information on sprigging, and the Sodding BMP for information on sodding.

8. Excess topsoil should be disposed of following specifications in the Spoil Piles BMP.

Maintenance

Newly seeded areas need to be inspected frequently for the first few months to ensure the grass is growing. If the seeded area is damaged due to runoff, additional stormwater measures may be needed. Spot Seeding can be done on small areas to fill in bare spots where grass didn't grow properly.

Once the vegetation is well established:

1. Construction Barriers may be removed.

2. Water the grass following specifications in the Lawn Maintenance BMP.

3. If the grass is to be mowed, keep it to a height appropriate for the species selected and the intended use. Follow mowing specifications in the Lawn Maintenance BMP.

4. Occasional soil tests should be collected and analyzed to determine if the soil is appropriately fertilized. Follow the procedures in the Soil Management BMP.

5. Control pests following specifications in the Pesticide Management BMP.

6. Refer to the Lawn Maintenance BMP for determining the steps which can be taken to improve unhealthy turf.

Exhibits

Exhibit 1: Seeding Dates for Permanent Cover. Modified from the Soil Conservation Service Technical Guide, #342.

Exhibit 2: Seeding Dates for Temporary Vegetation. USDA Soil Conservation Service Technical Guide, #342.

Exhibit 3: Determining the Appropriate Seed Mixture. Extracted from USDA Soil Conservation Service Technical Guide, #342.

Exhibit 4: Seeding Mixture (in pounds/acre). Extracted from USDA Soil Conservation Service Technical Guide, #342.

Exhibit 5: Seeding Mixture (in pounds/1,000 ft^2). Extracted from USDA Soil Conservation Service Technical Guide, #342.

Exhibit 1

Seeding Dates for Permanent Cover

Zones	Normal Seeding Dates	Dormant* Seeding Dates
Lower Peninsula, South of U.S. 10	May 1 to October 10	Nov. 1 to freeze up
Lower Peninsula, North of U.S. 10	May 1 to October 1	Oct. 25 to freeze up
Upper Peninsula, entire area	May 1 to Sept. 20	Oct. 20 to freeze up

* Dormant seeding may be done in the late fall after the soil temperature remains consistently below 50°F. This is appropriate if construction on a site is completed in the fall but seed was not planted prior to Normal Seeding Dates. Since the initial temperature for seed germination is approximately 50 degrees F (soil temperature), this practice intends germination will not occur until spring. Extra cereal rye, a cool season annual grass, may be added to attempt to get some fall growth.

- Mulching must be used on any dormant seed. This is particularly important on erosive sites.

- Do not seed when the ground is frozen or snow covered.

- Do not use a dormant seeding on Grassed Waterways.

Source: Modified from USDA Soil Conservation Service Technical Guide.

Exhibit 2

Seeding Dates for Temporary Vegetation Cover

Planting Zones:

1. Lower Peninsula, South of US 10.

2. Lower Peninsula, North of US 10.

3. Upper Peninsula.

Zone			Kind of Seed	Amount	
1	2	3		Per 1,000 Sq. Feet	Per Acre
Apr. 1 to Sept. 15	Apr. 15 to Aug. 1	May 1 to Aug. 1	Oats*, barley*	2 lbs.	3 bu.
June-July	June-July	Not. rec.	Sudangrass	1 lb.	30-40 lbs.
Aug. 1 to Oct. 15	Aug. 1 to Oct. 10	Aug. 1 to Oct. 1	Rye*	3 lbs.	2-3 bu.
Sept. 20 to Oct. 15	Sept. 10 to Oct. 10	Sept. 1 to Oct. 1	Wheat	3 lbs.	2-3 bu.

* Indicates species best suited for wildlife food.

Immediately after seeding, mulch:
-all slopes
-unstable soils, and
-heavy clay soils
with unweathered small grain straw or hay spread uniformly at a rate of 1.5 to 2 tons per acre, or 100 pounds (2-3 bales) per 1,000 square feet. Other suitable materials may be used, according to specifications in the Mulching BMP.

Source: USDA Soil Conservation Service Technical Guide #342

Exhibit 3

Determining Appropriate Seeding Mixture Numbers Based on Site Conditions.

Site	Rough Areas	Steep Areas Ditch Banks Cuts Fills	Utility Rights-of way	Pond Edges[b]	Grassed Waterways Diversions[b]
Well and moderately well drained sand and loamy sand (coarse textured soils)	sunny-1, shady-2 or 4	4 or 6	15	4	4
Well and moderately well drained, moderately coarse to moderately fine textured soils (sand loam, loam, silt loam, and clay loam)	sunny-1, shady-2 or 5	4, 7, 8, 9, or 19	15	11 or 14	11, 13 17, 20
Well and moderately well drained clay and or 5 silty clay (fine texture soils)	sunny-1 shady-2	7, 8, 9, 13 or 19	15	11, 12 or 14	11, 13, 17, 20
Somewhat poorly drained or poorly drained soils without artificial drainage[a]	3 or 5	8, 10, 13 or 16	15	12 or 13	17, 18
Organic soils[a]	3	10, 16 or 18	16	11 or 12	

[a] With artificial drainage, use the appropriate site condition in the well-drained groups above.

[b] Mixtures one and two can be used on grassed waterways that are to be given care and management as lawn.

Source: USDA Soil Conservation Service Technical Guide #342

Exhibit 4

Seeding Mixtures (in pounds per acre) Corresponding with Seeding Mixture Number

Under the seed mixture number selected in Exhibit 3, use all species shown in that column. For example: for Exhibit 3, seeding no. 6, the correct seeding mixture is 25 lbs. of creeping red fescue plus 5 lbs. of perennial ryegrass and 20 lbs. of tall fescue. These are minimum rates for ideal conditions. Use judgement to increase rates for less than ideal conditions.

Seeds Per Pound	Species	Seed Mixtures From Exhibit 3*																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
615000	Creeping red fescue**	20	30	10	40		25		20						20	20					
227000	Perennial ryegrass	(a)	(a)		(a)		5					5	5			5		5	5		
2177000	Kentucky bluegrass	20	10	25					5						15						
4990000	Redtop**								1							1	1	2	2		
533000	Reed canarygrass**										10						10				
8700000	Seaside bentgrass											1	1	1	1						
136000	Smooth bromegrass**											30		15		10		25			20
227000	Tall fescue					50	20		20	10			40	15		15			30	15	20
1230000	Timothy**							3	2								4				
375000	Birdsroot trefoil (b)**							10	10											10	
110000	Crownvetch (b)**									15											
TOTAL POUNDS		40	40	35	40	50	50	13	58	25	10	36	46	31	36	51	15	32	37	25	40

Seed per square foot at the recommended seeding rate

(a) Five pounds of ryegrass may be added to this mixture on erodible sites or other areas where quick cover is essential

(b) Inoculate all legume seeds with correct inoculant.

* Seeding rates have been rounded off.

** Indicates species best suited for wildlife cover.

Source: USDA Soil Conservation Service Technical Guide #342

Exhibit 5

Appropriate Seeding Mixtures (in pounds/sq. ft.) Corresponding with Seeding Mixture Number

Under the seed mixture number selected in Exhibit 3, use all species shown in that column. For example, for Exhibit 3, seeding no. 6, the correct seeding mixture is .6 lbs. of creeping red fescue plus .2 lbs. of perennial ryegrass and .5 lbs. of tall fescue. These are minimum rates for ideal conditions. Use judgement to increase rates for less than ideal conditions.

Seeds Per Pound	Species	Seed Mixture From Exhibit 3*																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
515000	Creeping red fescue**	.5	.7	.3	1.0		.6		.5						.75	.75					
227000	Perennial ryegrass	(a)			(a)		.2					.2	.2			.2		.2	.2		
2177000	Kentucky bluegrass	.5	.3	.6					.2						.4						
4990000	Redtop**								.03						.03	.03	.05	.05			
533000	Reed canarygrass**										.3						.3				
8700000	Seaside bentgrass											.03	.03	.03	.03						
136000	Smooth bromegrass**											.7		.4		.3		.6			.5
227000	Tall fescue					1.2	.5		.5	.3			1	.4		.4			.7	.4	.5
1230000	Timothy**							.1	.05								.1				
375000	Birdsroot trefoil[b] **							.3	.3											.3	
110000	Crownvetch[b] **									.4											

[a] 0.15 pounds of cereal ryegrass may be added to this mixture on erodible sites or other areas where quick cover is essential.

[b] Inoculate all legume seeds with correct inoculant.

*Seeding rates have been rounded off.

**Indicates species best suited for wildlife cover.

Source: USDA Soil Conservation Service Technical Guide #342

Hydroseeding

Definition

Hydroseeding is a mechanical method of applying seed, fertilizer, and mulch to land in one step.

Description and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, which temporarily protects exposed soils from erosion by water and wind.

The practice may also be called hydro mulching, hydraulic planting, hydraulic mulch seeding, hydraseeding

Pollutant(s) controlled:

- Suspended Sediments

Pollution Removal Efficiencies:

- Hydroseeding initially reduces sediment generation by 70 to 80% as compared to sediment production off bare slopes.

Companion and Alternative BMPs

- Mulching
- Seeding/Vegetation
- Rolled Erosion Control Products

Advantages and Disadvantages

Advantages:

- Tackifiers can be used with the application to help keep the seed in place
- Provides mulching medium around the seed to hold moisture

Disadvantages:

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and erosion control. Otherwise, hydroseeding must be used in conjunction with a soil binder or mulching
- Hydroseeding may be inappropriate in dry periods without supplemental irrigation
- Wood fiber hydraulic mulches are generally short-lived (only last a part of a growing season) and need 24 hours to dry before rainfall occurs to be effective.
- May not be able to access remote areas with hydroseeder

Location

Hydroseeding is applied on disturbed soil areas requiring temporary protection until permanent vegetation is established or disturbed soil areas that must be re-disturbed following an extended period of inactivity

General Characteristics

- Hydraulic planting mulch is the ingredient that makes the technique possible. Water-laden mulch shot from high-pressure hose or spray gun travels farther than seed and water alone. Once the mulch is on the soil surface, it creates a "mat" or blanket that holds the seed in place, retains soil moisture, resists wind and water erosion, and creates a favorable environment for seed germination.
- Mulch materials may be made from wood chips, newsprint, or corrugated cardboard. Some products may include synthetic poly-based fibers or natural agricultural fibers, paper mill sludge, sawdust, slick papers, or some combination of these.
- Each mulch product group has unique performance characteristics and associated costs. Some materials simply perform the mulch function better than others
- Mulch Fiber length is the key to holding power, while germination is most influenced by moisture holding ability and application rates.
- Virtually any fertilizer formulation can be incorporated into the hydroseeding slurry. It is important to use soil testing to determine the appropriate fertilizer for the site.
- A difficult to access site is best fertilized with a long acting or time-release product at the same time it is seeded. An easily accessible site can be fertilized (again) after germination.
- Tackifier is powdered or granular glue, which when added to the slurry, serves to glue the mulch blanket in place, helping it to withstand wind and rain erosion. Steep slopes are best protected with a tackifier, though any site susceptible to erosion (including that caused by the project's own irrigation) should be a candidate.
- A wide variety of special use products can be incorporated into the hydroseed slurry when conditions dictate. Soil amendments, such as lime and gypsum, or organics such as sludge and humus can be applied right along with the seed and other ingredients. Dyes, surfactants, growth stimulators, fungicides, inoculants, and a host of other liquid, powdered and granular products are also widely available.

Materials

- Cellulose Fiber Mulch
- Fertilizer
- Tackifier
- Hydro – seed mix.

Design Specifications

- To select appropriate hydroseeding mixtures, an evaluation of site conditions shall be performed with respect to:
  - soil conditions
  - site topography
  - season and climate
  - vegetation types
  - maintenance requirements
  - sensitive adjacent areas
  - water availability
  - plans for permanent vegetation.
- Paper Mulch is frequently applied at 1,200-1,500 pounds per acre (approximately 25lbs.-35 lbs. per 1,000 square feet). With a polyacrylamide additive, such rates can be effective. Many contractors avoid using more than 2,000-2,500 lbs per acre of paper mulch, because too much paper mulch tends to crust, and can inhibit germination.
- Wood Mulch is most effective at rates beginning at 2,000 lbs per acre (about 45 lbs. per 1,000 square feet). In very hot conditions, 3,000 lbs (about 70 lbs. per 1,000 square feet) per acre will provide more moisture retention, and will therefore improve the probability of success significantly. A guar based tackifier is also highly recommended to improve the probability of yielding an excellent grass stand.
- Bonded Fiber Matrix rates start at about 3,000 lbs per acre. At 4,000 lbs. per acre (about 90 lbs. per 1,000 square feet), most wood based Bonded Fiber Matrix products provide an excellent probability of achieving total coverage of grass, even when pounded with destructive rains or in very hot conditions.
- Regardless of the quality of the mulch protection, rainfall or irrigation is always necessary to produce a stand of grass.
- Guar tackifier can be used at 25-150 lbs per acre. The standard recommend application rate is 1½ lbs per 1,000 Sq. ft. or about 60 lbs per acre. This product has been the mainstay as a glue additive for hydro-mulching for many years.
- Seed and fertilizer recommendations are dependent upon the location of the area to be treated. See the Seeding/Vegetation BMP on Page # BMP Guidebook for specific seed recommendations
- Hydroseeding can be accomplished using a multiple-step or one-step process.
  - The multiple-step process ensures maximum direct contact of the seeds to soil.
  - When the one-step process is used to apply the mixture of seed, fiber, etc., the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.
- Follow-up applications shall be made as needed to cover weak spots.
- The time allowed between placement of seed in the hydraulic mulcher and the emptying of the hydraulic mulcher tank should not exceed 30 minutes.
- Application of the slurry should proceed until a uniform cover is achieved. The applicator should not be directed at one location for too long a period of time or the applied water will cause erosion.

Construction Guidelines

1. Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.
2. Hydraulic matrices require 24 hours to dry before rainfall occurs to be effective

Monitoring

- Hydromulched slopes should be inspected periodically for damage due to wind, water, or human disturbance.

Maintenance

- Repair all damaged areas immediately using hydromulching at the original specifications or straw mulch.
- Supplemental watering may be required

References

IDEQ Storm Water Best Management Practices Catalog, September 2005. Hydromulching.

Mellon, Michael. *Hydroseeding: Getting All You Paid For*.

Rolled Erosion Control Products

Definition

Rolled erosion control products (RECPs) consist of prefabricated blankets or netting which are formed from both natural and synthetic materials.

Description and Purpose

The predominantly used RECPs generally fall into the following two categories, each having unique characteristics:

- Erosion control blanket (ECB): A temporary degradable rolled erosion control product composed of processed natural or polymer fibers mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.
- Turf reinforcement mat (TRM): A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix. TRM's, which may be supplemented with degradable components, are designed to provide immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. TRM's are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

The practice may also be called Erosion Control Blanket, Mulch Blanket, or Erosion Control Matting

Pollutant controlled

- Suspended Sediment

Companion and Alternative BMPs

- Seeding/Vegetation
- Mulching

Advantages and Disadvantages

Advantages

- Can provide for some degree of immediate stabilization
- Numerous manufacturers, each with a number of different products, allow for the selection of a product which meets the individual characteristics of each site.

- Stabilizes disturbed slope and protects surface from erosive forces of raindrop impact.
- Promotes growth of vegetation.
- Most products degrade over time, eliminating potential maintenance issue.

Disadvantages

- Various products and manufacturers have different design and construction standards. Designer must rely on manufacturer's data.
- Permanent stabilization and protection is dependent on the establishment of vegetation unless TRMs are used.

Location

Rolled erosion control products should be used on bare ground that is highly susceptible to erosion, such as steep slopes and channels, and in locations where establishing vegetation may otherwise be difficult.

General Characteristics

- Several factors, such as soil conditions, steepness and length of slope, depth of flow, runoff velocities, and time required to establish desired vegetation, influence the choice of product.
- RECPs and TRMs are manufactured from a wide variety of different materials including coconut fiber (coir), jute, nylon, polypropylene, PVC, straw, hay, or wood fibers. These materials may be used individually, or in combination to form nets or blankets.
- The products function by protecting the ground surface from the impact of raindrops and stabilize the surface until vegetation can be established. RECPs and TRMs also promote the growth of vegetation by helping to keep seed in place, and by maintaining a consistent temperature and moisture content in the soil.
- Most RECPs are either biodegradable or photodegradable and will decompose over a period of time.
- RECPs should generally be installed parallel to the direction of water flow.

Materials

- Seed
- Fertilizer
- RECP
- Degradable Stakes/Pegs/Pins

Design Specifications

- RECPs are produced by a number of manufacturers, and are available in a wide variety of different configurations. Competing products from different manufacturers can have completely different material compositions and construction, but be intended to serve the same purpose. Given the wide variety of RECPs available, product selection and specification can be difficult.

- Table 1 is modified from the product selection guide produced by the ECTC and classifies products based upon longevity and product description.
- Factors such as the slope on which the RECP is to be placed and the sheer stress that the RECP will experience shall be used to determine which RECP product is adequate for the application it is intended for.
- Stake placement and installation should follow manufacturer recommendations

Construction Guidelines

1. Prior to placing a RECP, a topsoil seedbed should be prepared, smooth graded, and seeded and fertilized. It is imperative that seeding occur prior to placement of the RECP to ensure proper contact between seed and soil. Some manufacturers can embed the specified seed mixture into the product during the manufacturing process (if this process is used, follow the manufacturer's recommended installation specifications).
2. After seeding, the appropriate RECP may be placed and anchored with stakes or staples. The manufacturer will provide specifications for the pattern and spacing of anchor stakes or staples, overlap between rolls (typically 6 inches), and any additional product requirements.
3. It is important that the stakes or staples be properly installed to prevent "tenting" of the product as the vegetation begins to grow and push up on the matting. This can impact vegetative establishment and the product can become entangled in mowing equipment.
4. At the tops of slopes and at the entrance to a channel, the leading edge of the RECP should be trenched into the ground, approximately 6 inches, anchored in place with stakes or staples, and backfilled. This prevents runoff from lifting the leading edge, and flowing between the ground and the RECP.
5. Subsequent segments of RECPs should have their upstream edges trenched in, and the downstream edge should slightly overlap the next section to prevent water from flowing under the product.

Monitoring

Inspect weekly and after every storm event that results in a discharge from the site until adequate vegetation is established.

Maintenance

- Repair erosion and/or undermining at the top of the slope.
- Repair undermining beneath RECP(s), pull back the RECP(s), fill and compact eroded area, reseed and then secure RECP(s) firmly.
- Reposition or replace RECPs that have moved along the slope or channel and secure firmly.
- Replace damaged RECPs.

References

Erosion Control Technology Council, 2006. *Standard Specification for Rolled Erosion Control Products*.

Ontario. *Rolled Erosion Control Product (RECP) BMP 11*.

Statewide Urban Design and Specifications, 2008. *Design Manual 7E-7*.

Table 1. Rolled Erosion Control Product Comparison

Desired Time Scale		Type Code	Product Category	Material Composition	Max Slope Gradient (H:V)	Max Channel Shear Stress[1]	
Description	Length					(lb/sq ft)	(Pa)
Short-Term	3-12 months	1A	Single-Net Erosion Control Blanket	Processed degradable natural and/or polymer fibers mechanically bound together by a single rapidly-degrading synthetic or natural fiber netting	3:1	1.50	72
			Open-Weave Textile	Processed rapidly-degrading natural or polymer yarns or twines woven into a continuous matrix			
		1B	Double-Net Erosion Control Blanket	Processed degradable natural and/or polymer fibers mechanically bound together between two rapidly-degrading synthetic or natural fiber nettings	2:1	1.75	84
Extended-Term	24 months	2A	Erosion Control Blanket	Processed slow-degrading natural or polymer fibers mechanically bound together between two slow-degrading synthetic or natural fiber nettings to form a continuous matrix	3:2	2.00	96
			Open-Weave Textile	Processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix			

(continued)

[1] Shear stress unvegetated rolled erosion control product can sustain without physical damage or excessive erosion (>12.7 mm (0.5 in) soil loss) during a 30-minute flow event, based on historical experience and large-scale testing of products with Manning's roughness coeffecients of 0.01-0.05. Test methods include ASTM D6459, or others deemed acceptable by the engineer.

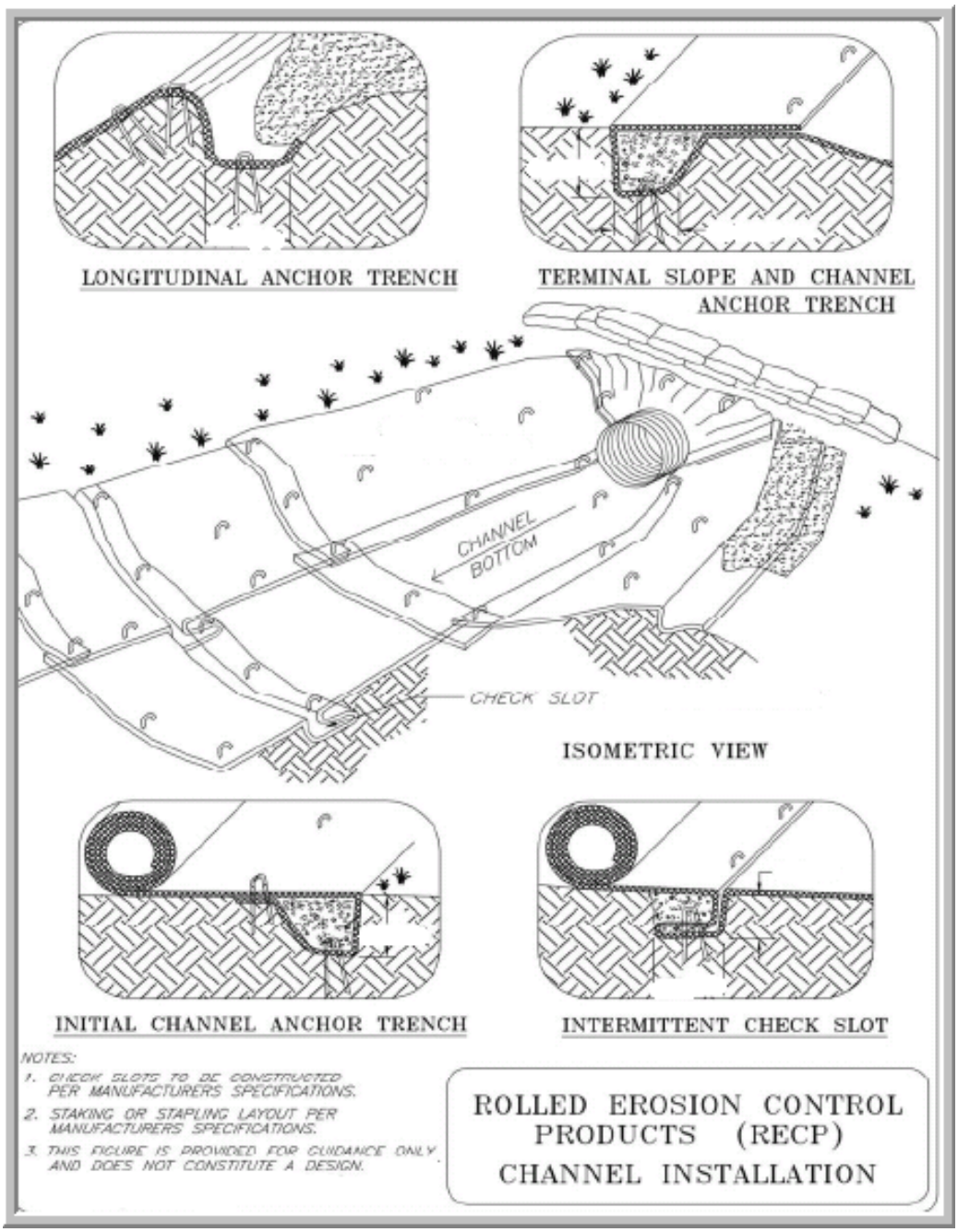
Table 1. Rolled Erosion Control Product Comparison (continued)

Desired Time Scale		Type Code	Product Category	Material Composition	Max Slope Gradient (H:V)	Max Channel Shear Stress[2]	
Description	Length					(lb/sq ft)	(Pa)
Long-Term	36 months	3A	Erosion Control Blanket	Processed slow-degrading natural or polymer fibers mechanically bound together between two slow-degrading synthetic or natural fiber nettings to form a continuous matrix	1:1	2.25	108
			Open-Weave Textile	Processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix			
Permanent	--	4A	Turf Reinforcement Mat	Non- or partially degradable synthetic fibers, filaments, nets, wire mesh, and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness	1:2	6.00	288
		4B				8.00	384
		4C				10.0	480

Source: Adapted from Erosion Control Technology Council, 2006. *Standard Specification for Rolled Erosion Control Products*.

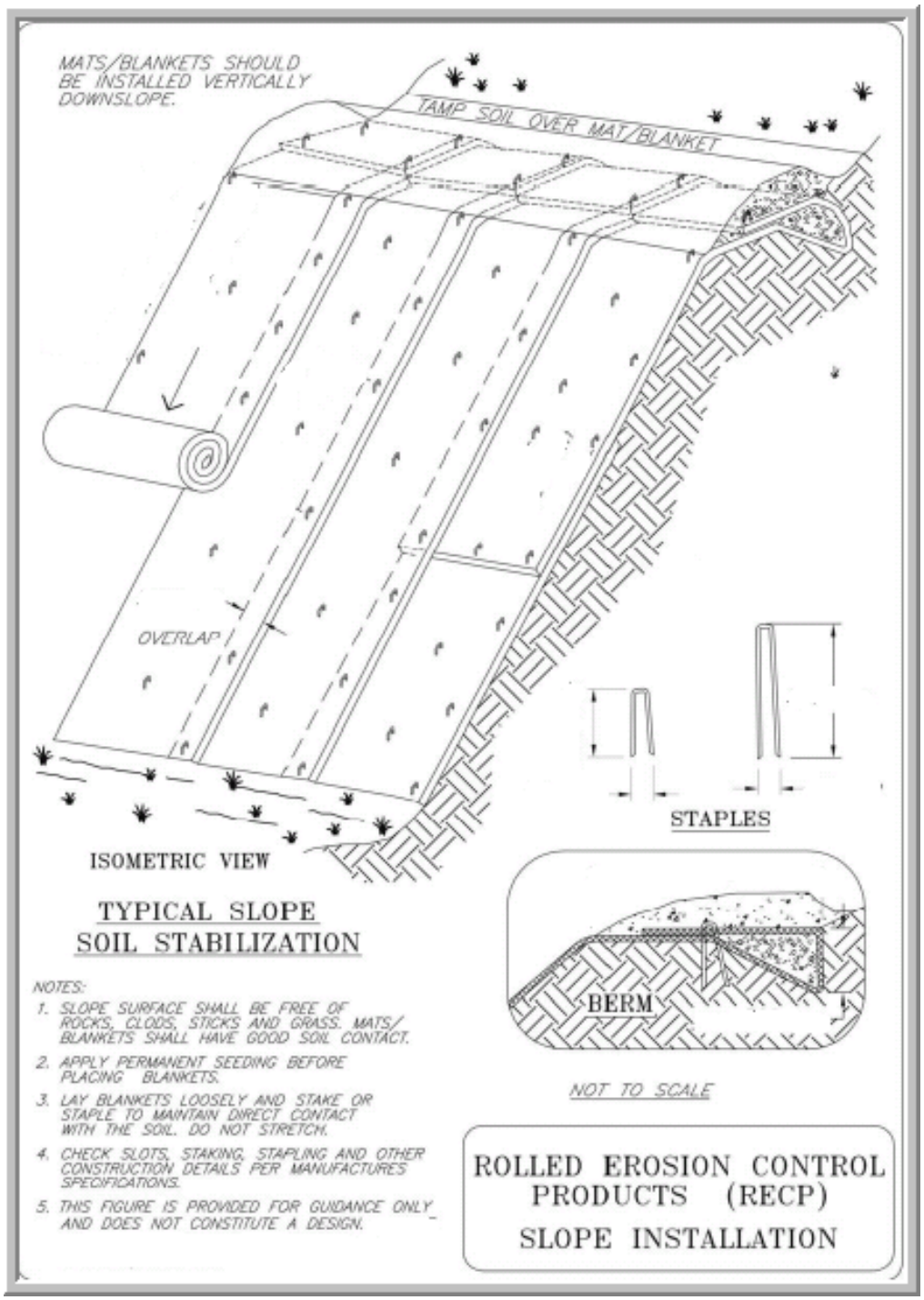
[2] Shear stress fully vegetated turf reinforcement mat can sustain without physical damage or excessive erosion (> 12.7 mm (0.5 in.) soil loss) during a 30-minute flow event, based on large-scale testing. Test methods include ASTM D6460, or others deemed acceptable by the engineer.

Exhibit 1. Rolled Erosion Control Product Channel Installation



Source: Ontario. *Rolled Erosion Control Product (RECP) BMP 11*.

Exhibit 2. Rolled Erosion Control Product Slope Installation



Source: Ontario. *Rolled Erosion Control Product (RECP) BMP 11.*

Silt Fence

Definition

Silt fence is a perimeter sediment control device. Generally, silt fence is constructed of porous woven geotextile fabric attached to wooden posts.

Description and Purpose

Silt fence is a linear fence installed at the edge of earth disturbances. The purpose of silt fence is to protect downslope surface waters and properties by removing suspended solids from runoff prior to leaving the site.

The practice may also be called filter fence.

Pollutant(s) controlled:

- Suspended solids

Treatment Mechanisms:

- Slowing and ponding of runoff water to promote settlement of suspended solids
- Fabric provides some filtration of larger soil particles

Pollution Removal Efficiencies:

- Moderate to good removal of silt and sand particles if properly placed, installed, and maintained
- Poor removal of clay particles

Companion and Alternative BMPs

- Perimeter Sedimentation Controls
- Storm Sewer Inlet Protection

Advantages and Disadvantages

Advantages:

- Relatively inexpensive
- Easy to install
- Readily available

Disadvantages:

- Poor effectiveness on fine sized soil particles such as clay
- May require frequent maintenance
- Effective only for sheet runoff flow, fails in concentrated flow areas due to low permeability
- Limited effectiveness at large, sloping sites

Location

Silt fence should be installed at the downslope edge of disturbed areas, along a line of equal elevation (parallel to contour lines). Place beyond the toe of steeper slopes if possible to increase the "ponding" or settling effect.

Materials

Table 1: Materials and properties for silt fence construction

Woven Geotextile Fabric Width (in)	Min. Hardwood Post Length (in)*	Min. Grab Tensile (lbs) (ASTM D 4632)	Min. Trapezoidal Tear Strength ((lbs) (ASTM D 4533)	Min. Permittivity (sec^{-1}) (ASTM D 4491)	Max. Apparent Opening Size (mm) (ASTM D 4751)
24	36	100	45	0.1	0.6
36	48	100	45	0.1	0.6

*Hardwood posts shall be a minimum of 1 1/8 inches x 1 1/8 inches thickness

Source: Adapted from Michigan Department of Transportation 2003 Standard Specifications for Construction

Additional materials:

- Metal Staples or nails for attaching lath and fabric to posts
- Hardwood Lath six to eight inches shorter than fabric width

Design Specifications

- Fabric attached to post by stapling or nailing through lath and into hardwood posts, at a minimum of four locations, evenly spaced along lath to prevent fabric tear out.
- six-inch loose bury flap unattached to post at bottom of lath
- Maximum post spacing: ten feet
- Whenever possible, place silt fence in flat areas at least ten feet from the toe of slopes (silt fence is not an appropriate measure for placement on steep slopes)
- Maximum contributing drainage area is ½ acre per 100 linear feet of fence

Performance Enhancers

- Wider Fabric and longer posts (i.e. 36-inch fabric and 48-inch posts)
- Heavier posts (i.e. two inches by two inches)
- More frequent post spacing (i.e. 6.5 feet)
- Reinforcing mesh on fabric
- Placing multiple parallel rows may provide a factor of safety

Construction Guidelines

Construction guidelines in consecutive order are:

1. Dig a six-inch trench at equal elevation (parallel to contour lines) at the downslope edge of earth disturbance (avoid placement on steep slopes);

2. Unroll and extend silt fence along trench line. Orient fence such that the posts are down slope of the fabric and lath (i.e. storm water will push the lath and fabric against the post);

3. Turn end post 360 degrees so that fabric surrounds the post;

4. Pound end post into the ground at the downslope edge of the trench until the top of the six-inch bury flap is at ground elevation;

5. Continue to pound in posts consecutively starting with post adjacent to the end already installed. Assure fabric is as taught as possible;

6. Join consecutive rolls by rolling end posts similar to item 3 above. Cross over the end posts or place them side by side and roll them (180 or 360 degrees). Drive the end posts together;

7. Backfill the trench and compact. If possible, leave a compacted ridge of soil along the upslope edge of the fabric.

Acceptable alternate construction methods include:

1. In situations where the bury flap cannot be trenched in, backfill and compact over the bury flap. Note that this method is less effective and more prone to failure;

2. In some cases, it may be advantageous to construct silt fence in the field; i.e. fabric, posts, and lath come separate and must be put together. The same construction guidelines apply;

3. Silt fence installation machines may make the process of installing silt fence easier. The machines “slice” the fabric into the ground, then posts and lath are manually installed.

Monitoring

Silt Fence should be inspected at least weekly, immediately before a forecasted runoff event, and after each runoff event from rain or snowmelt. Look for fabric tears, post failure, undermining, sediment build up, overtopping, side cutting around the silt fence, and areas damaged by construction activities.

Maintenance

- Fabric tears, post failures, vehicle damage, and/or undermining should be repaired immediately;

- Sediment build up should be removed when it reaches 1/3 to 1/2 the height of the silt fence above ground elevation;

- Overtopping and side cutting are signs that the silt fence is either not appropriately placed or that additional measures are necessary due to site runoff conditions;

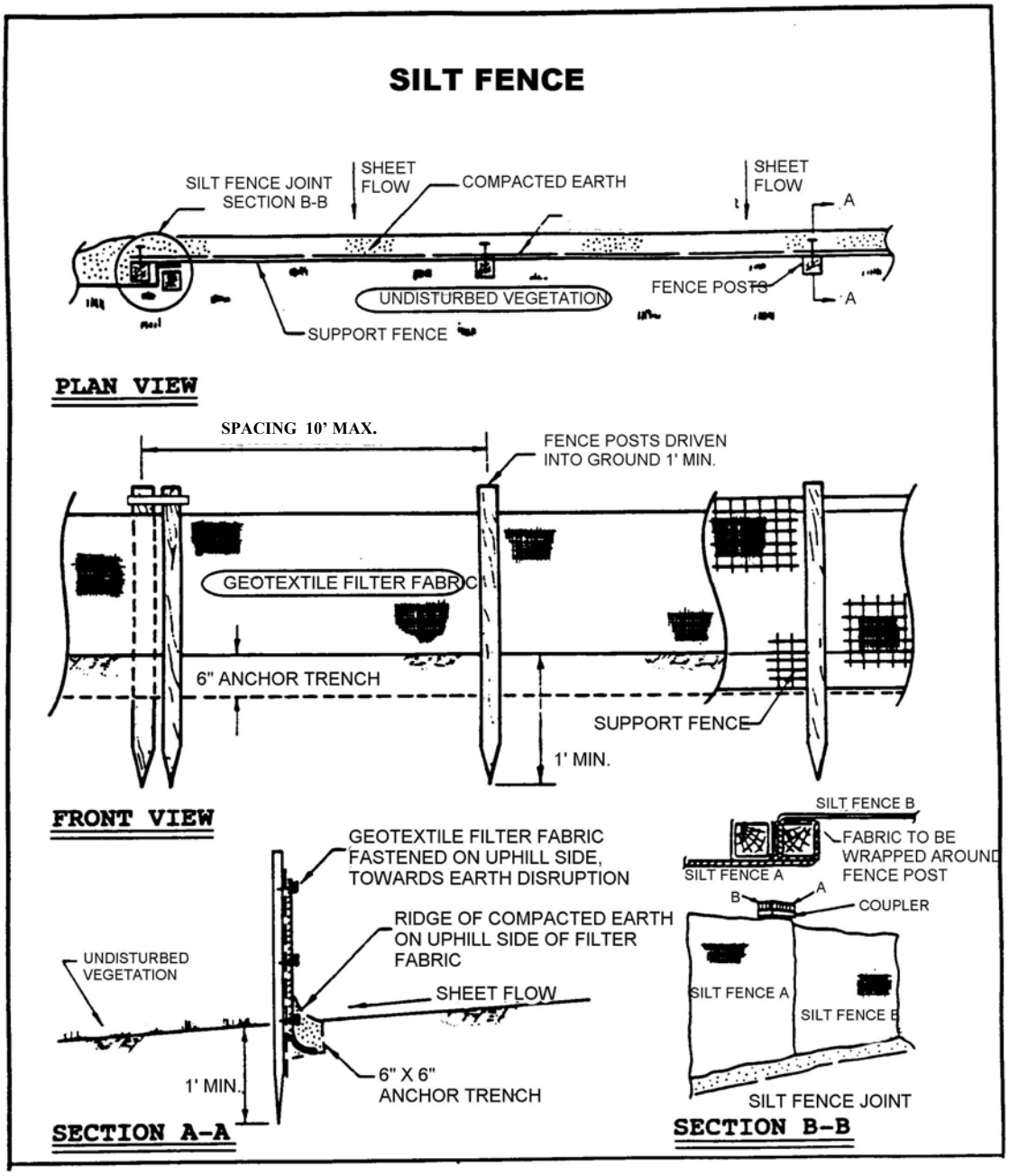
- Remove the silt fence after the site has been stabilized with permanent soil erosion/sedimentation control (SESC) measures.

References

Michigan Department of Transportation. 2003. Standard Specifications for Construction.

Oakland County, Michigan Water Resources Commissioner. Individual Soil Erosion and Sedimentation Details, SP-2-Silt Fence.

Exhibit 1: Silt fence construction and installation diagram



Source: Adapted from Oakland County (Michigan) Erosion Control Manual

Storm Sewer Inlet Protection

Definition

Storm sewer inlet protection consists of a sediment filter or an impounding area around or upstream of a storm sewer, drop inlet, or curb inlet.

Description and Purpose

Storm sewer inlet protection measures temporarily pond runoff before it enters the storm sewer, allowing sediment to settle, or remove sediment by filtering.

The practice may also be called Storm Sewer Inlet Protection or Inlet Protection

Pollutant(s) controlled:

- Suspended Solids

Treatment Mechanisms:

- Settling of sediment through detention
- Filtration of sediment

Pollution Removal Efficiencies:

- Varies with soil type on site and type of inlet protection selected

Companion and Alternative BMPs

- Silt fence
- Sediment basins

Advantages and Disadvantages

Advantages:

- Will reduce the amount of sediment entering the storm sewer system, potentially extending the time until maintenance is needed
- In many cases, provides a last chance to remove suspended particles from runoff
- Areas requiring protection are easy to indentify during both planning and construction

Disadvantages:

- Requires an adequate area for water to pond without encroaching into portions of the site where active construction is occurring or onto roadways subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm sewer system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden.

- Frequent maintenance is required.
- May be improperly used as the sole method of erosion and sedimentation control

Location

Every storm sewer inlet receiving sediment-laden runoff should be protected.

General Characteristics

- Three types of inlet protection are detailed in this specification:
  1. Silt Fence Barrier: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
  2. Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  3. Premanufactured devices: A variety of manufactured products are available including: storm inlet filter socks, synthetic filter tubes for open throat curb inlets, inlet inserts, pop-up filters for area inlets, and many others. These products should be used and installed according to the manufacturer's recommendations.

- DEQ does not recommend the use of filter fabric under the grate as an inlet protection measure. Fabric blinds off quickly when the pores space in the fabric close with sediment causing flooding to occur. When flooding occurs the fabric is often tampered with (slits cut in) rendering it ineffective at reducing or preventing sediment discharge into the stormwater system. In addition fabric is often unable to be effectively removed without causing the sediment on top of the fabric to drop into the catch basin.

Materials

1. Silt Fence Barrier:

Table 1: Materials and properties for silt fence construction

Woven Geotextile Fabric Width	Min. Hardwood Post Length*	Min. Grab Tensile (ASTM D 4632)	Min. Trapezoidal Tear Strength (ASTM D 4533)	Min. Permittivity (ASTM D 4491)	Max. Apparent Opening Size (ASTM D 4751)
24"	36"	100 lbs	45 lbs	0.1 sec^{-1}	0.6 mm
36"	42"	100 lbs	45 lbs	0.1 sec^{-1}	0.6 mm

*Hardwood posts shall be a minimum of 1 1/8" x 1 1/8" thickness

Source: Adapted from Michigan Department of Transportation 2003 Standard Specifications for Construction

Additional materials:
- Metal Staples or nails for attaching lath and fabric to posts
- Hardwood Lath 6 to 8 inches shorter than fabric width

2. Block and Gravel Filter:
    - Hardware cloth or comparable wire mesh with 0.5 in. openings
    - Concrete blocks
    - Washed stone 0.75 to 3 in.

Design Specifications

- If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Using any inlet protection device that restricts the flow into the inlet should be avoided for inlets that are on-grade. Because of the flow restriction, a majority of the flow to an on-grade inlet will be bypassed to the downstream inlet. This creates the potential for flooding problems downstream.
- To limit the potential for flooding, limit the upstream drainage area to 1 acre
- Runoff should be routed to a sediment-trapping device designed for larger flows (e.g. sediment basin) when the drainage area exceeds 1/2 acre.
- Silt Fence Barrier (see figure 1)
    1. Silt fence must be installed per Silt Fence Specification.
    2. Stakes must be a maximum of 3ft apart
    3. Fabric must be trenched in
    4. You may want to consider spill-over protection on the inlet side of the silt fence barrier such as mulch blanket, geotextile fabric, stone, etc. This prevents the dislodging of soil on the inside of the silt fence barrier by water passing through or over top of the silt fence.
- Block and Gravel Filter (see figure 2)
    1. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
    2. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
    3. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

Performance Enhancers

- An excavated drop inlet sediment trap can be used in conjunction with other inlet protection to enhance the settling of large sediment particles prior to it entering the storm sewer system.

Construction Guidelines

- Identify existing and planned storm sewer inlets that have the potential to receive sediment laden surface runoff. Determine if storm sewer inlet protection is needed and which method to use.
- Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm sewer inlet protection device.
- Select the appropriate type of inlet protection and design
- Inlet protection should be placed immediately after storm sewer inlets are installed.
- Inlet protection should be left in place and maintained until the drainage area is stabilized with established vegetation and pavement.
- Remove storm sewer inlet protection once the drainage area is stabilized.

Monitoring

Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

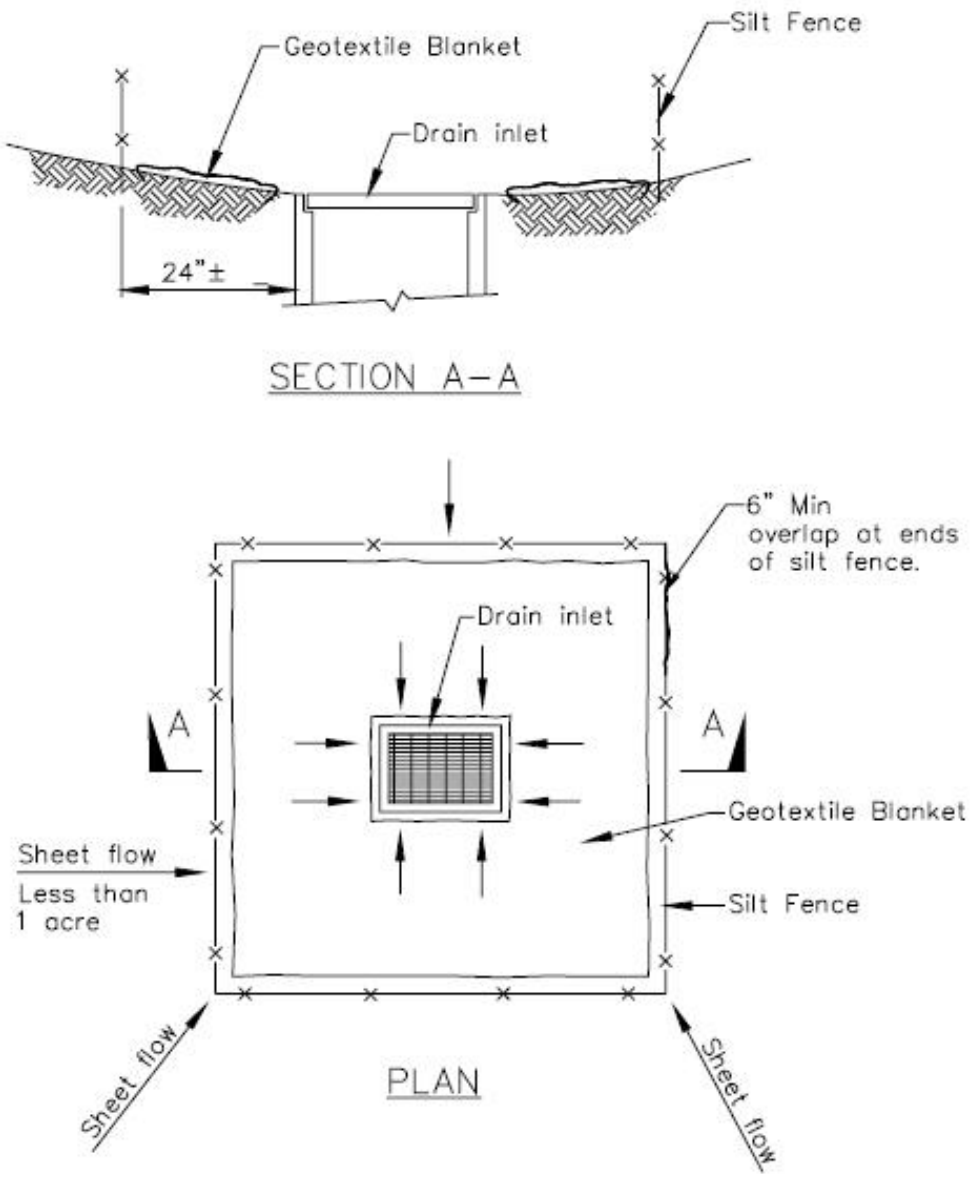
Maintenance

- Silt Fence Barriers. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.
- Block and Gravel Filters. If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches 1/3 – 1/2 of the silt fence height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

References

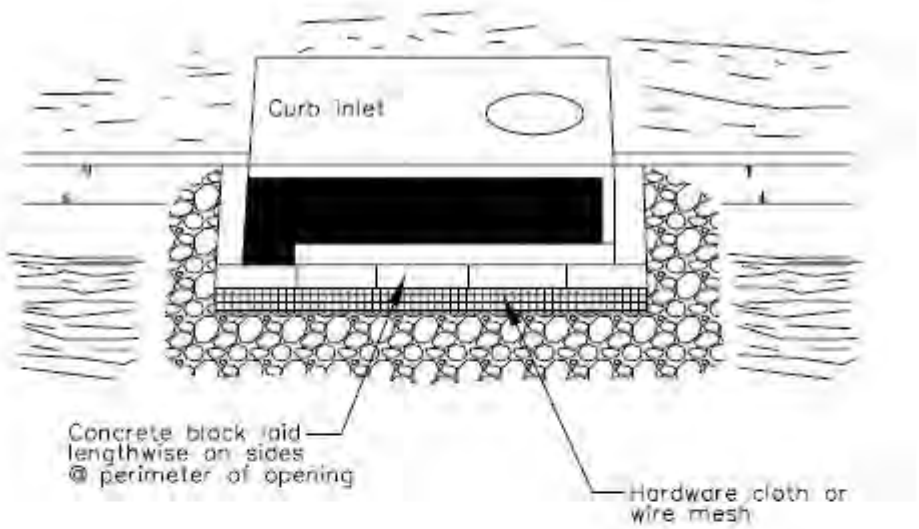
California Stormwater BMP Handbook, Construction, 2003

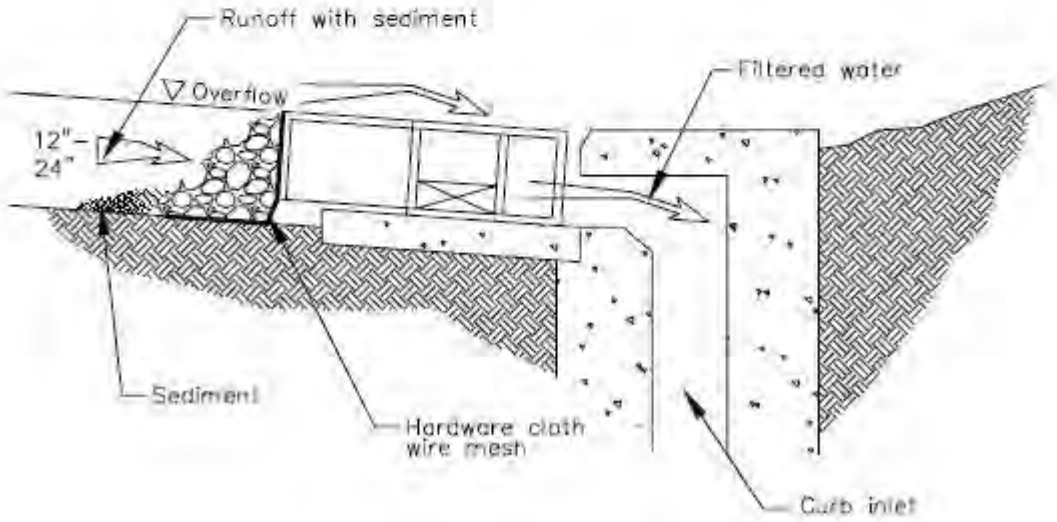
Figure 1. Silt Fence Barrier



Source: California Stormwater BMP Handbook, Construction, 2003

Figure 2. Block and Gravel Filter





Source: California Stormwater BMP Handbook, Construction, 2003

Turbidity Curtain

Definition

A turbidity curtain is a flexible, impermeable barrier used to trap sediment in water bodies. This curtain is generally weighted at the bottom to ensure that sediment does not travel under the curtain, which is supported at the top through a flotation system. Staked curtains are available for applications with very limited exposure to water flow or wave action.

Description and Purpose

Turbidity curtains prevent the migration of sediment from a work site in a water environment into the larger body of water.

The practice is also sometimes referred to as 'turbidity barrier' or 'silt curtain'.

Pollutant(s) controlled:

- Suspended Solids

Treatment Mechanisms:

- Settling

Advantages and Disadvantages

Advantages:

- Allows for containment of sediment-laden water within a work area;
- Protects contained water from turbulence, allowing particles to fall out of suspension.

Disadvantages:

- Can fail when subjected to significant water flows or wave action;
- Cannot be used as a filter across stream flow;
- Possible mobilization of fine sized settled particles after removal.

Location

A turbidity curtain is generally used when construction activity occurs within a waterbody or along its shoreline and is of short duration, generally less than one month. Curtains are used in calm water surfaces. Turbidity curtains are not to be used across flowing watercourses.

General Characteristics

- Turbidity curtains should be oriented parallel to the direction of flow;

- For sites not subject to heavy wave action the curtain height shall provide sufficient slack to allow the top of the curtain to rise to the maximum expected high-water level (including waves) while the bottom maintains continuous contact with the bottom of the water body. The bottom edge of the curtain shall have a weight system capable of holding the bottom of the curtain down and conforming to the bottom of the water body, so as to prohibit escape of turbid water under the curtain;

- For sites subject to heavy wave action, the curtain height shall provide sufficient slack to allow the top of the curtain to rise to the maximum expected high-water level (including waves) while the bottom remains one foot above the bottom. The weight system shall hold the lower edge of the curtain in place so as to allow one foot of clearance above the bottom at mean low water, so that the curtain does not stir up sediment by repeatedly striking the bottom;

- The curtain should be constructed of nonwoven material;

- Materials should be of bright colors, when applicable, to attract attention of boaters or swimmers using areas near the work site.

Materials

- Rope or cable with floats;
- Anchors;
- Pre-manufactured Turbidity Barrier (which generally consists of a woven geotextile with a polymer coat).

Design Specifications

- The turbidity curtain shall be located beyond the lateral limits of the construction site and firmly anchored in place;

- The alignment should be set as close to the work area as possible but not so close as to be disturbed by construction equipment;

- The height of the curtain should be designed to account for expected wave action and water level fluctuations as a result of storm events. At a minimum, the curtain height should be 20 percent greater than the depth of the water;

- The area that the turbidity curtain protects shall not contain large culverts or drainage outlets which may cause the curtain to fail during flow events;

- If water depth is less than two feet, and flow at the designed alignment is minimal, the toe can be anchored in place by staking. Refer to the 'shallow' installation in Figure 1;

- If water depth is greater than two feet, or if high flow exists, the 'deep' Turbidity Curtain design must be used. Refer to Figure 2;

- Hard armor (i.e., concrete barriers) may be necessary to protect the curtain on the upstream side in certain flowing water applications.

Construction Guidelines

1. Assure that all necessary permits for work within a water of the state are obtained from the DEQ Land and Water Management Division prior to starting work;

2. The area of proposed installation of the curtain shall be inspected for obstacles and impediments that could damage the curtain or impair its effectiveness to retain sediment;

3. All construction materials shall be removed so they cannot enter the water body;

4. Shallow installations can be made by securing the curtain by staking rather than using a flotation system;

5. Supplemental anchors of the turbidity curtain toe shall be used, as needed, depending on water surface disturbances such as boats and wave action by winds.

Monitoring

1. The turbidity curtain shall be inspected daily and repaired or replaced immediately.
2. If the curtain is oriented in a manner that faces the prevailing winds, frequent checks of the anchorage shall be made.
3. While inspecting, look for areas where turbid water is escaping into the larger water body.

Maintenance

- It is not normally necessary to remove sediment deposited behind the curtain; but, when necessary, removal is usually done by hand prior to removal of the barrier. All removed silt is stabilized away from the water body;

- The barrier shall be removed by carefully pulling it toward the construction site to minimize the release of attached sediment;

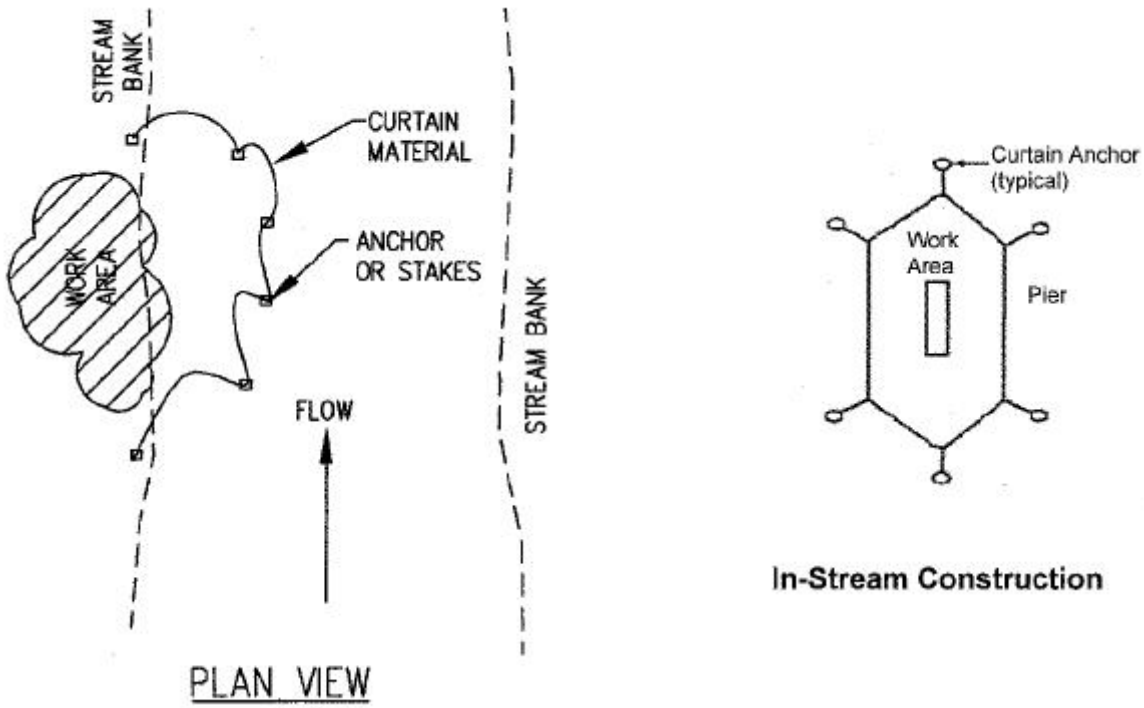
- Any floating construction or natural debris shall be immediately removed to prevent damage to the curtain.

References

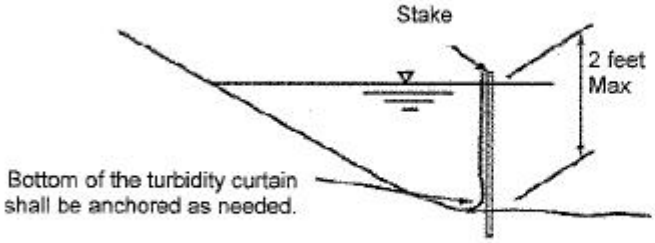
MDOT, 2006. *Soil Erosion & Sedimentation Control Manual*.
DMB, 2003. *Soil Erosion and Sedimentation Control Guidebook*.

Figure 1:

Shallow Turbidity Curtain



In-Stream Construction

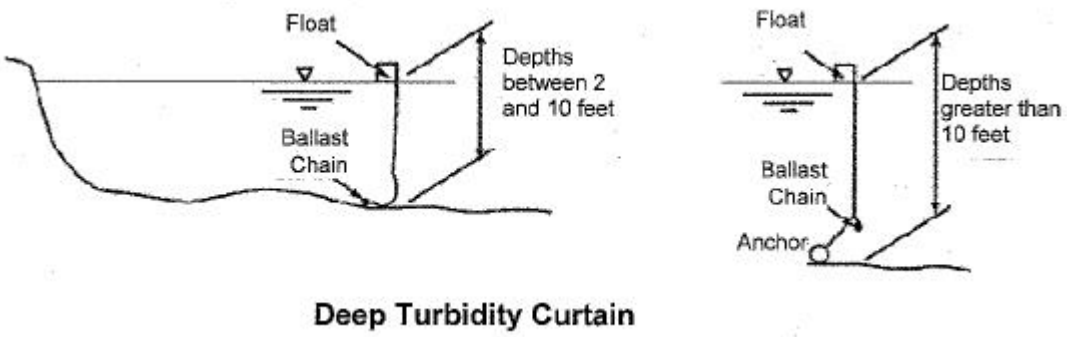


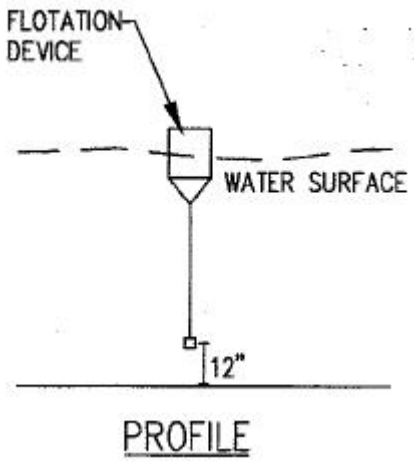
When water is less than 2 feet deep and has low flow, a shallow turbidity curtain may be used. Curtain shall be securely fastened to stakes.

Shallow Turbidity Curtain

Figure 2:

Deep Turbidity Curtain





Source: Adapted from Michigan Department of Transportation 2006 Soil Erosion & Sedimentation Control Manual and Michigan Department of Management and Budget 2003 Soil Erosion and Sedimentation Control Guidebook

Water Resources Division

Sediment Basin

Definition

Sediment basins are temporary ponds with appropriate control structures, used on construction sites to capture eroded or disturbed soil that are washed off during or after rainstorms or other runoff events. Sediment basins are designed to protect the water quality of nearby streams, rivers, lakes, and wetlands, and to protect neighboring properties from damage. Some sediment basins are converted to permanent storm water controls following the completion of construction activity.

Purpose and Description

The primary purpose of sediment basins is to prevent sediment from entering streams, rivers, lakes, or wetlands. They do this by collecting and detaining runoff, allowing suspended solids to settle out prior to the runoff leaving a site.

Sediment basins are also sometimes called settling basins, sumps, debris basins, or dewatering basins.

Pollutant Controlled: Suspended solids

Treatment Mechanism: Settling

Removal Efficiency

- Sediment basins remove only 70 to 80 percent of medium- and coarse-sized sediment particles, so use them in conjunction with other erosion control best management practices (BMPs).
- Sediment basins are not effective at controlling fine soil particles such as silt or clay.

Companion and Alternative BMPs

- Construction Barrier
- Mulching
- Polyacrylamide
- Riprap-Stabilized Outlet
- Seeding
- Sodding

Advantages and Disadvantages

Advantages

- Sediment basins are a cost-effective measure for treating sediment-laden runoff from drainage areas ranging from five (5) to 100 acres in size, with soil particle sizes of predominantly sand, or medium to large silt.
- Sediment basins are relatively easy to construct.

Disadvantages

- The construction and proper functioning of sediment basins require adequate space and topography. Basins require large surface areas to facilitate the settling of sediment. The available area can limit the potential maximum size of sediment basins.
- Install sediment basins only within the property or special easement limits, and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Sediment basins can attract children, and therefore can be very dangerous. Adhere to all local ordinances regarding health and safety. If fencing of basins is required, show the fence type and location on the soil erosion and sedimentation control plan, and in the construction specifications. Refer to the Construction Barrier BMP.
- Sediment basins effectively remove sediment down to only about medium-sized silt. Removing smaller particles—such as fine silt or clay—typically requires additional controls or practices, such as polyacrylamide.
- Standing water has the potential to cause the breeding of mosquitoes or other pests.

General Characteristics

- It is recommended that sediment basins be designed by licensed professional engineers.
- Utilize sediment basins until the contributory drainage area has been stabilized.
- Sediment basins are temporary and can serve drainage areas up to 100 acres in size. However, other conservation practices might be more economical for smaller drainage areas, typically less than five (5) acres in size.

Materials

- Earth
- Riprap
- Risers
- Collars
- Seed for stabilization of disturbed soil

Planning

- Utilize sediment basins during construction activities in areas of concentrated flow or at points of discharge.
- Conduct a site investigation to determine the size of the drainage area, and the best location for the basin or basins.
- Select the site for the sediment basin based on the natural drainage of the area and the soil type.
- Site conditions must allow for runoff to be directed into sediment basins.
- Do not locate sediment basins in perennial streams or wetlands. In-stream sediment basins are allowed only through a permit from the Michigan Department of Environmental Quality (MDEQ) Water Resources Division.
- Choose an area to which runoff can be easily diverted to the sediment basin. The most logical location is typically the lowest part of a site.
- Determine soil types. If the soils are predominantly clay, the basin size required might be larger than practical. However, if soils are sand or silts there will be little structural integrity of the basin if constructed with on-site soils. With clay soils it is particularly important to make the best use of soil erosion control measures, because sedimentation measures, including sediment basins, do not readily retain clays. Sediment basins by themselves are not effective at settling out fine silt or clay particles; additional treatment must be used, such as polyacrylamide.
- Determine the number of basins needed. In some cases, it is more effective to have multiple smaller basins versus one large basin. This is particularly important in areas with larger-grained sediments. In addition, potential damage from basin failure can be minimized by using multiple smaller basins, versus one large basin.
- There are three classes of sediment basins, based on drainage area, embankment height, and the use of mechanical controls:
    - Class 1 is a simple, temporary basin, frequently used on construction sites. This basin consists of an excavated area or an earth embankment less than three (3) feet high, constructed of the soil or stone which is available on the site. These basins can be quickly located and constructed with equipment available on most construction sites. Stabilization of the embankment with vegetation or paving is necessary. The recommended maximum drainage area to a Class 1 basin is 20 acres.
    - Class 2 is a carefully constructed temporary or permanent sediment basin. It consists of an embankment of selected soil materials constructed under controlled procedures, with provisions for an emergency discharge for storm water to prevent embankment failure. A Class 2 basin is most applicable in situations where significant damage can result to downstream and off-site areas if the basin fails. The recommended maximum drainage area to a Class 2 basin is 30 acres.
    - Class 3 is a carefully engineered basin, with sophisticated controls, and is usually permanent. Both outlets and embankments are intended to serve as grade stabilization structures, which will continue to function as storm water control measures after construction activities are completed. Always use a Class 3

basin if it is to be converted to a permanent storm water detention practice. Class 3 basins must be restored to original design specifications prior to conversion to a storm water control. The recommended maximum drainage area to a Class 3 basin is 100 acres.

- Select the appropriate basin type. If a basin is to be temporary, use either a Class 1 or a Class 2. If a basin is to be permanent, use either a Class 2 or Class 3, and note that the design criteria for both the temporary sediment basin and the permanent storm water basin must be met.
- Determine the ultimate fate of the basin. If the basin is to become part of a storm water runoff "treatment train" upon completion, then the design of the basin must be coordinated with the design of the future use of the basin. If the ultimate fate of the basin is an infiltration basin, avoid using heavy equipment in the area so as not to compact the soils. Soil compaction will decrease the ability of the soil to infiltrate water. If the basin is to be a temporary structure which will be filled and stabilized upon completion of the project, then proceed with the design criteria below.
- Locate sediment basins so that they can easily be cleaned out periodically.
- Construct sediment basins at locations that are accessible for cleanout.
- Incorporate into the overall site plan the locations for disposal of the material removed from sediment basins.

Design

- The effectiveness of reducing runoff velocity and allowing suspended solids to settle out depends on:
  - Surface area of the basin. In general, the greater the surface area, the greater the detention time, and the less the flow velocity.
  - Sizes of the sediment particles entering the basin.
  - Concentration of sediment particles entering the basin.
  - Rate of flow into the basin.
  - Volume: As sediment accumulates, the volume decreases, as does the effectiveness of the basin.
  - Travel distance.
- Temporary structures are expected to last no more than three years. Design sediment basins which will be in place longer than three years as permanent structures (i.e., with emergency spillways).
- Side Slopes: For safety, make the side slopes of sediment basins at least 2H:1V. Use even flatter slopes (i.e., larger ratios) in urban or urbanizing areas. To prevent access in the first place, consider construction barriers around both construction sites, and sediment basins.
- Shape: To maximize settling and improve sediment trapping efficiency, design sediment basins with at least a 4:1 length-to-width ratio. If construction sites cannot accommodate basins of this dimension, to increase the effective flow path length, use baffles perpendicular to the direction of flow.

- Make sediment basins at least four times longer than they are wide, unless baffles are used to increase the flow path length. Refer to Figure 1, which depicts (a) an example baffle, and (b) the use of such a baffle in three irregularly-shaped basins, to increase flow path length, and prevent short-circuiting. These flow paths are also depicted in the figure.
    - It is critically important to the proper operation of the sediment basin that the inlet and outlet are not placed too close together, or that baffles are used, if necessary. An adequately long flow path through the basin provides the pollutant removal capacity, by giving small, light sediment particles enough time to settle out of the water column.
- Basin Capacity: Refer to the "Hydrology" section of the *BMP Manual* "Introduction" for guidance on determining the appropriate design precipitation event, on which to base the basin capacity.
- Design sediment basins so that discharges from a site approximate the pre-development runoff.
- Depth: Make sediment basins at least two (2) feet deep, and no shallower than the average flow path distance from the inlet to the outlet (the 'flow length') divided by 200.
- Basin dimensions can be determined using the following equations:
    - [Volume] = [Length] x [Width] x [Depth]
    - Basins less than 80,000 ft^3 in volume:

$$[\text{Width}] = \sqrt{\frac{[Volume]}{8}}$$

$$[\text{Length}] = 4 \times [\text{Width}]$$

$$[\text{Depth}] = 2 \text{ feet (a constant)}$$

    - Basins greater than 80,000 ft^3 in volume:

$$[\text{Width}] = \sqrt[3]{12.5 \cdot [Volume]}$$

$$[\text{Length}] = 4 \cdot [\text{Width}]$$

$$[\text{Depth}] = \frac{[Flow\ Length]}{200}$$

- Principal Outlet: Class 2 and Class 3 basins include principal outlets to allow controlled discharges of water. The outlet structure is located at the deepest part of the basin, connected to a nearly-horizontal pipe, called the "barrel" (described below), which discharges through the embankment and out of the basin.
    - Preferred Outlet Type—Floating Skimmer: A type of outlet being used with increasing frequency is the floating skimmer, which is depicted in Figures 2 and 3. Some early tests indicate that the skimmer (which draws water only from the surface) might be more effective at retaining sediment in the basin than the

previous standard riser and barrel configuration. This is especially true if the perforated type of riser is used, which draws water from the entire water column.

- Alternate Outlet Type—Riser Pipe: An alternate outlet type is the riser pipe, which was traditionally used prior to the advent of the floating skimmer. The riser can be solid or perforated.
    - Solid Riser: A solid riser allows flow only through the top of the pipe. Thus, a sediment basin with a solid riser will have a permanent pool up to the invert elevation of the riser pipe.
    - Perforated Riser: An alternative to the solid riser pipe is the perforated riser, which can consist of any of various orifices along the length of the riser pipe. It is important that any outflow allowed to discharge through a perforated riser pipe be adequately filtered, such as with wire mesh and a mound of well-graded gravel. However, do not wrap geotextile fabric around the perforated riser, because it can clog quickly, effectively blocking the perforations, preventing discharge through the outlet.
    - Set the top of the riser at least three (3) feet below the top of the embankment or crest of the emergency spillway.
    - Place a trash rack over the top of the riser to prevent debris from entering and clogging the outlet.
    - To maximize the efficiency of this type of outlet, set the cross-sectional area of the riser pipe at least 1.5 times that of the barrel (described below).
    - Refer to Figure 4 for a depiction of a perforated riser pipe with adequate filtering provided, and to Figures 5 and 6 for examples of sediment basins with solid and perforated riser pipes, respectively.

- Barrel: The barrel is the nearly horizontal pipe which carries flow from the vertical outlet pipe of a floating skimmer or riser pipe, to the sediment basin point of discharge.
    - To facilitate installation and reduce blockage potential, use a minimum barrel pipe diameter of eight (8) inches for corrugated metal pipe, and six (6) inches for smooth pipe.
    - Provide the barrel with anti-seep collars to prevent piping along the outside of the pipe.
    - Following the specifications in the Riprap-Stabilized Outlet BMP, stabilize Class 2 and Class 3 basin principal outlet discharge point with riprap. The Class 1 basin does not have an outlet.

- Design Discharge: Design the outlet system to carry the peak runoff from design storm with a two-foot (2-foot) freeboard, and so that velocity of the discharge from the basin does not exceed that allowable for the receiving water body. Size the principal outlet to pass at least 80 percent of the calculated peak discharge from the drainage area. For Class 1 basins, base the peak discharge on the storm frequency equivalent to the lifetime of the project in years. Design the Class 2 and Class 3 basins on 10-year and 25-year storm frequencies, respectively. If a sediment basin will also be used as a storm water basin, design the outlet using the appropriate storm water basin procedure.

- Emergency Spillway: Class 2 and Class 3 basins require emergency spillways to protect embankments, by providing outlets from the basins for runoff volumes exceeding principal outlet capacity:
    - Size the emergency spillway to pass the difference in discharge between the design storm frequency and the capacity of the principal outlet.
    - If the practice will be used as a storm water basin, design the emergency spillway to pass the 100-year storm.
    - Emergency spillways can be as simple as a slope drain constructed of a half section of corrugated metal pipe, or a riprap channel constructed down the embankment slope.
    - Set the crest of the spillway at least three (3) feet above the crest of the primary outlet structure, and a minimum of two (2) feet above the expected water level following the design storm.
    - Make the spillway trapezoidal in cross-section, with side slopes 3H:1V or flatter.
    - Following the specifications in the Riprap-Stabilized Outlet BMP, stabilize the emergency spillways outlets of Class 2 and Class 3 basins. The emergency spillway for a Class 1 basin can consist of a simple berm alongside the outlet to channel water to a stabilized area.
- Embankments: Construct embankments with the most stable fill material available. For permanent embankments, appropriate material might have to be hauled in. Where possible, use soils other than sand, which tends to shift.
- Sediment basins with embankments over six (6) feet in height and with impoundment areas of five (5) or more acres are considered dams, and are therefore regulated under Part 315, Dam Safety of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended; information on which is available from the MDEQ Dam Safety Program. Other permits might also be needed.

Construction

- Construct sediment basins before any other land clearing or grading is done. Construct according to the design and by following the guidelines below.
- Stabilize the basin before the upstream area is cleared.
- Preserve as much existing natural vegetation as possible. Clear and strip any trees, other vegetation, and roots from the natural ground under any proposed embankment. Clear the remainder of the basin area of trees and larger vegetation to allow easy periodic removal of sediment. Retain natural grasses and groundcover to provide stabilization.
- To allow a good bond between any fill and existing soil, disc or scarify areas where embankment fill will be placed. Place and compact fill in controlled, uniform layers.
- Stabilize all exposed embankment areas by seeding and mulching or sodding. Embankment stabilization is particularly important with Class 1 basins, since the embankment functions as the spillway.
- Immediately after sediment basins are constructed, stabilize the top banks of the basins and all surrounding areas with vegetation.

Post-Construction

- Temporary Basins: After construction is completed at a site, dewater all sediment basins, removed all bulkheads or other structures, then fill and grade the basins to the contours of the surrounding land. Stabilize the areas by seeding and mulching or sodding.
- Permanent Basins: Using a sediment basin as a post-construction permanent storm water control (such as a detention basin) requires that the practice be properly converted from one control type to the other. Failure to properly convert a sediment basin can result in improper operation as a permanent storm water control, resulting in any number of undesirable outcomes, including (a) required maintenance well before the intended design life of the practice, and/or (b) undesirable and illegal sediment discharges to the receiving stream.
- Conversion of a sediment basin to a permanent storm water control can require any or all of the following steps, depending on the situation: 1. Dewatering; 2. De-mucking; 3. Removing sediment from the forebay and sediment pond area; 4. Removing dewatering structures; 5. Surveying and checking basin dimensions, dams, and spillways; 6. Re-engineering storage and outlet facilities; 7. Reshaping and re-excavating the pond area to meet storm water control requirements; 8. Installing peak flow controls; 9. Repairing any damaged areas; and 10. Stabilizing the entire facility (Tschantz, 2012).

Monitoring

- Check the basin depth to ensure the capacity of the basin is adequate for storm water and sediment deposition.
- Check the basin for piping, seepage, and other mechanical damage.
- Check for the presence of soil caking around the perforated riser pipe, which would prevent proper drainage from the basin.
- Check the outfall to ensure drainage is not causing erosive velocities, and to ensure the outlet is not clogged.

Maintenance

- Immediately address any problems discovered during the maintenance monitoring.
- Remove sediment when it has accumulated to no more than 50 percent of the design depth.
- Place sediment removed during cleaning in an upland area, and stabilize it so that it does not re-enter the drainage course.

This publication is intended for guidance only, and can be impacted by changes in legislation, rules, policies, and procedures adopted after the date of publication. Although this publication makes every effort to teach users how to meet applicable compliance obligations, use of this publication does not constitute the rendering of legal advice.

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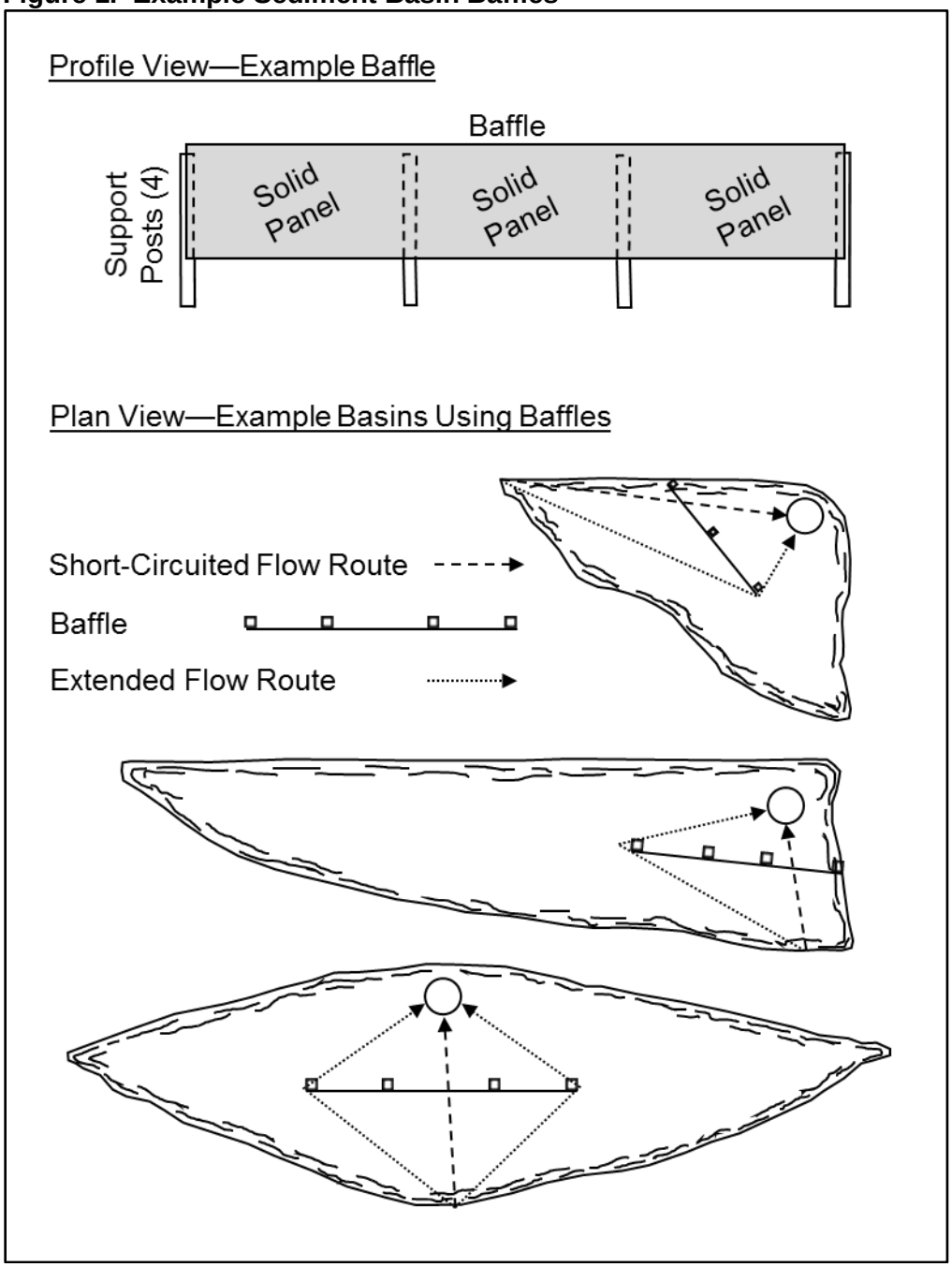
Delaware Department of Transportation (DelDOT). 2013. *Erosion & Sediment Control Field Guide*. Section 3.2.3.1: Skimmer Dewatering Device.

Tennessee Department of Environment and Conservation (TDEC). 2012. *Tennessee Erosion & Sediment Control Handbook*. Fourth edition.

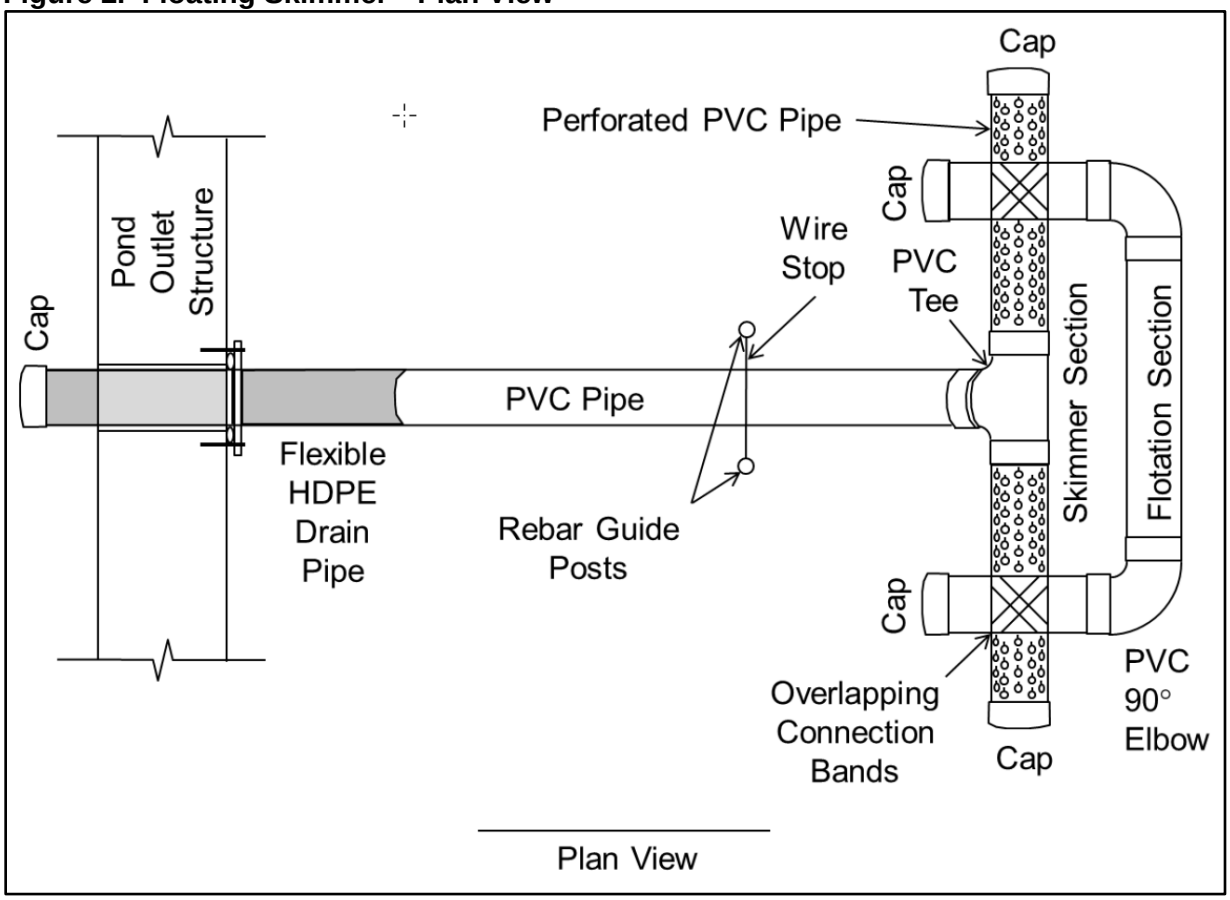
Tschantz, Dr. Bruce A. 2012. *Converting Temporary Sediment Basins to Permanent Stormwater Detention Ponds in Tennessee*. Prepared for ASCE-TSPE-ACEC Joint Annual Meeting presentation, Sept. 13-14, 2012, Murfreesboro, TN.

Figure 1. Example Sediment Basin Baffles



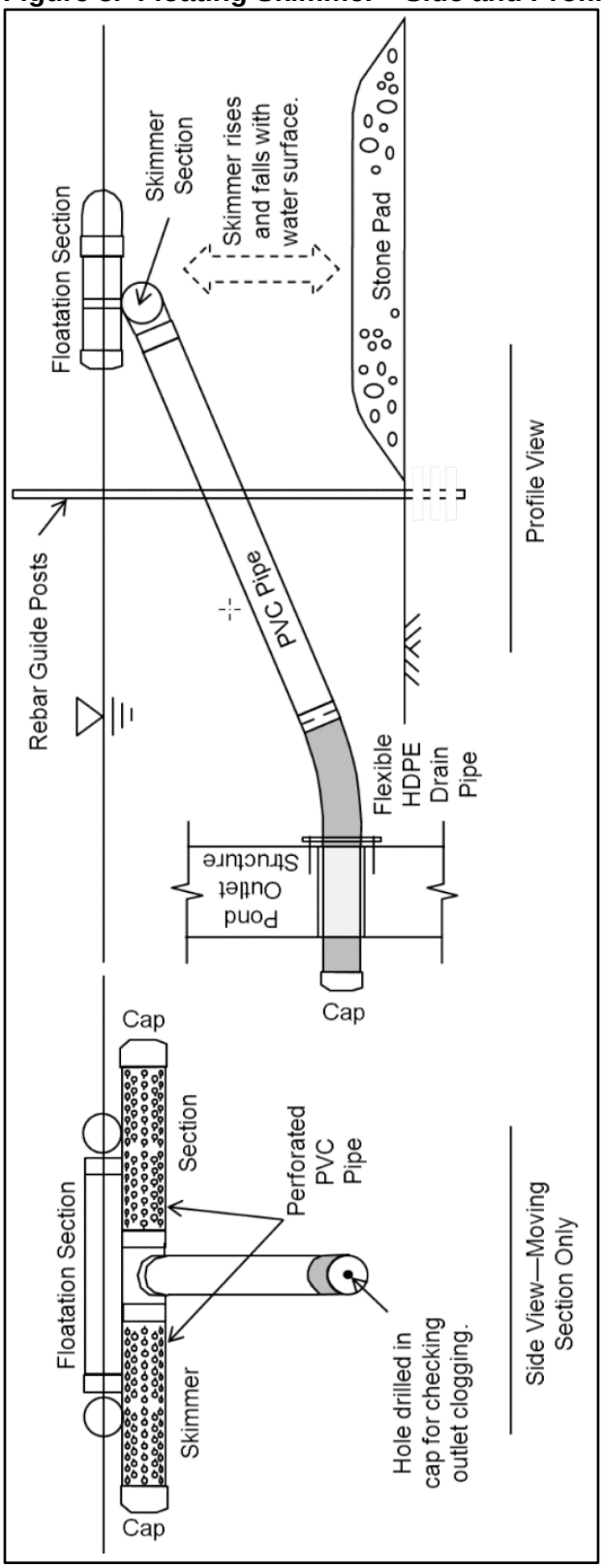
Source: TDEC, 2012.

Figure 2. Floating Skimmer—Plan View



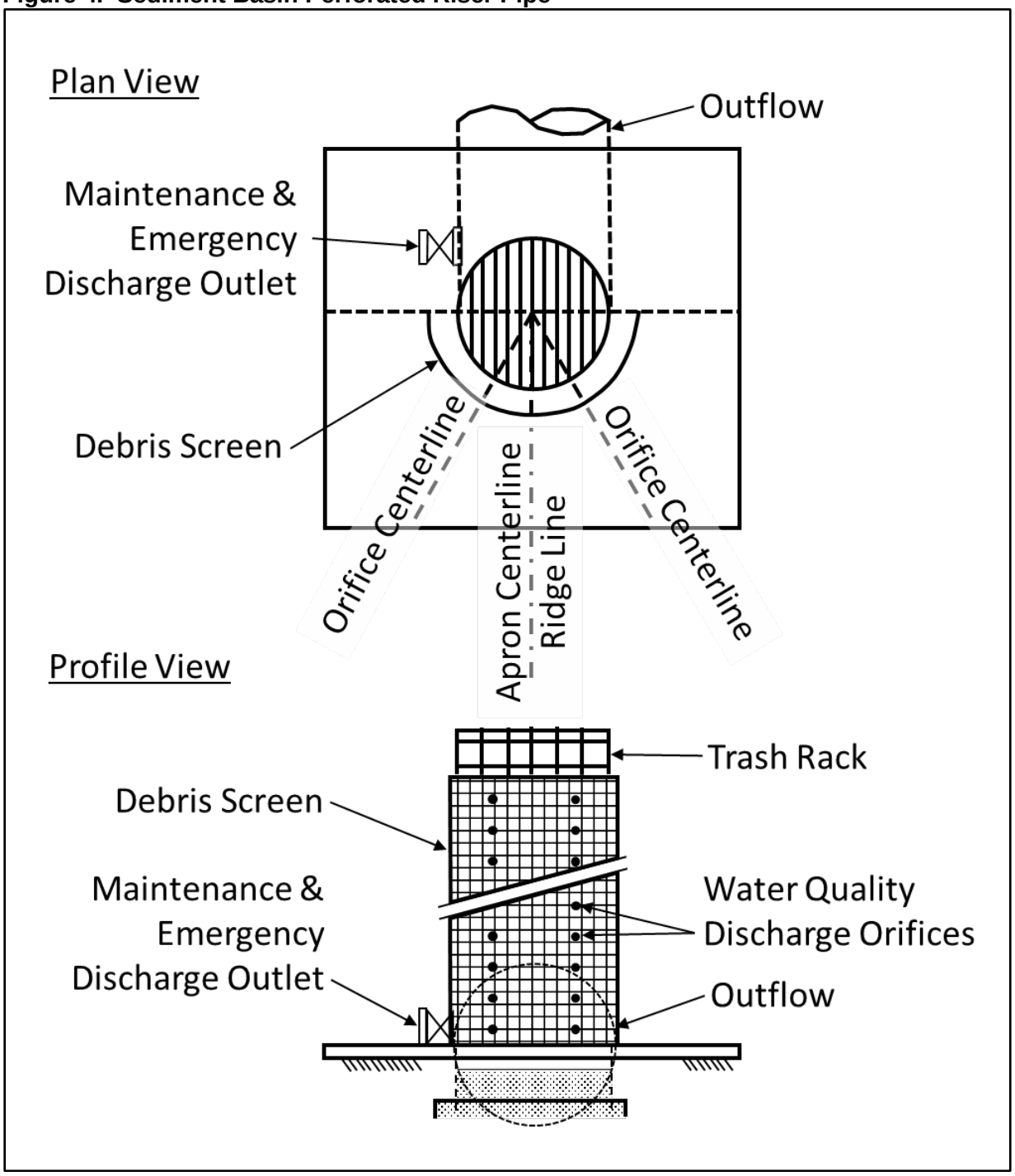
Source: DelDOT, 2013.

Figure 3. Floating Skimmer—Side and Profile Views



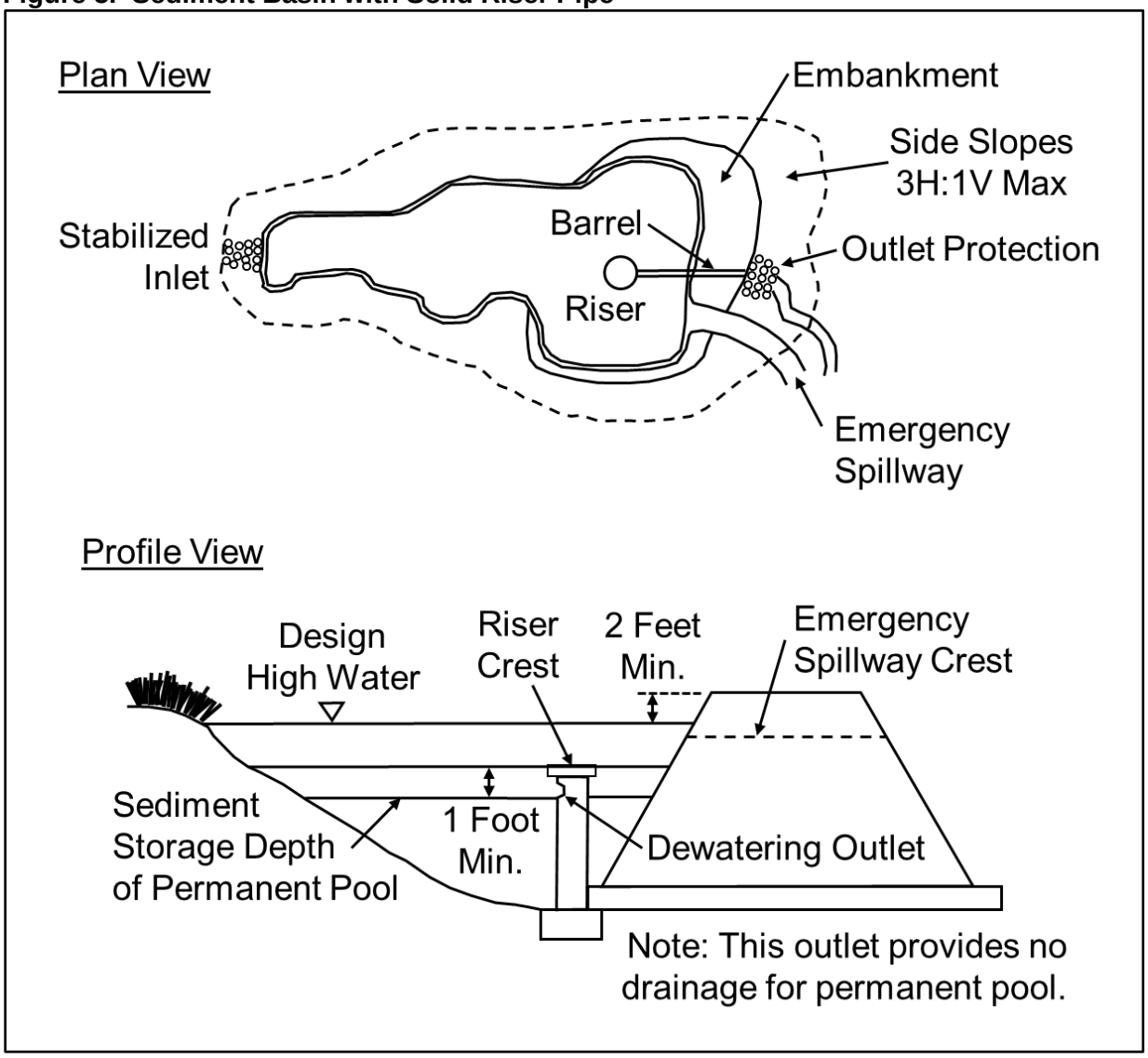
Source: DelDOT, 2013.

Figure 4. Sediment Basin Perforated Riser Pipe



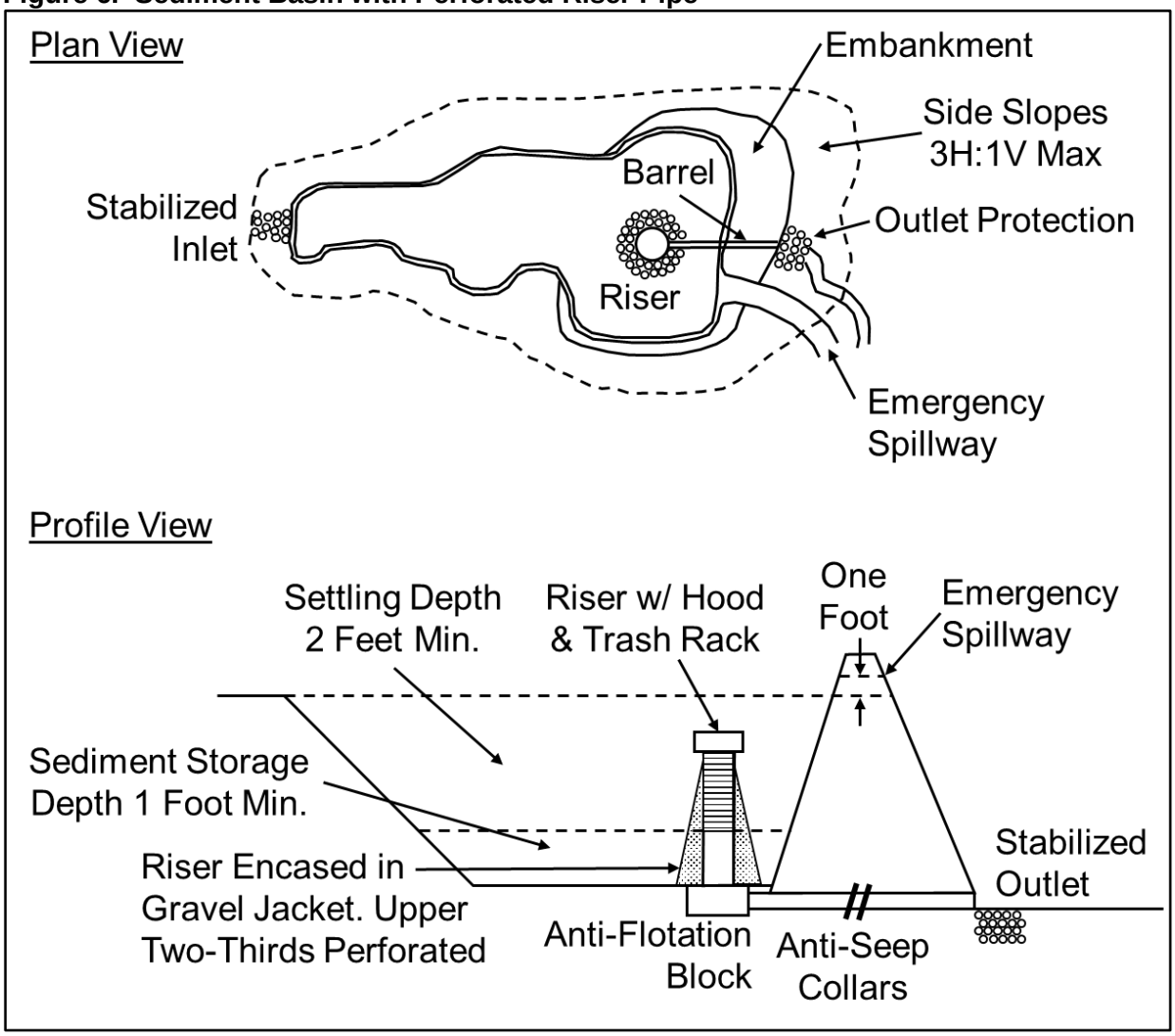
Source: Caltrans, 2003.

Figure 5. Sediment Basin with Solid Riser Pipe



Source: Caltrans, 2003.

Figure 6. Sediment Basin with Perforated Riser Pipe



Source: Caltrans, 2003.

Riparian Buffer

Definition

A riparian buffer is a zone of permanent vegetation immediately adjacent to a stream or other water body. The buffer can consist of existing or planted vegetation, or both. Buffer vegetation can be grasses, shrubs, trees, or other types, in any combination. Buffers are meant to be relatively undisturbed; activities within buffers should be limited to maintenance, or other approved activities that do not impede buffer functionality. This best management practice (BMP) includes descriptions of multi-zone buffers, and the filter strip as a specialized buffer type.

Description & Purpose

Pollutants Controlled

- Sediment
- Nutrients
- Pesticides
- Temperature
- Erosion

Treatment Mechanisms

The riparian buffer is designed to intercept runoff as sheet flow before it enters the adjacent water body. The mechanisms include slowing down runoff, allowing any infiltration to occur, allowing uptake of water and nutrients by vegetation, allowing any sediment to settle out, and be physically intercepted by buffer vegetation. Tall woody vegetation (trees and shrubs) provides shade, which can lower stream temperatures and provide fish cover.

Pollutant Removal Efficiency

Several researchers have measured reductions in sediment and nitrate concentrations of greater than 90 percent. Riparian buffers do a reasonably good job of removing phosphorus attached to sediment, but are less effective at removing dissolved phosphorus (Gilliam, 1994). Riparian buffers also slow runoff, allowing more rainwater to infiltrate and be absorbed by plants. A number of sources provide summaries of riparian buffer pollutant removal efficiencies (USEPA, 2005; Southeastern Wisconsin Regional Planning Commission, 2010).

Companion & Alternate Practices

A level spreader (North Carolina Cooperative Extension, 2010) or similar practice may be necessary to ensure that any concentrated flow is spread out into sheet flow before it enters a riparian buffer. This will protect the buffer from erosion, and from any short-circuiting of runoff through the buffer without receiving sufficient treatment. In pastureland, livestock exclusion fencing (USDA NRCS, 2011a) is often used to protect riparian vegetation from being grazed or

trampled. Stabilized, gated, fenced-off stream crossings (USDA NRCS, 2012) are also used in areas where livestock need to cross a stream to reach an adjacent pasture.

Advantages & Disadvantages

An advantage of riparian buffers of sufficient width and suitable vegetation types is the provision of habitat, which is described in more detail below.

Although riparian buffers provide numerous benefits to agriculture, primarily erosion control and the resulting soil conservation, some farmers may be reluctant to install riparian buffers due to the relative reduction in the amount of land that can be cultivated or used as pasture. Solutions to this problem include cost-share and rental payment programs, which reimburse farmers for the installation of riparian buffers (among other practices); examples of these include the Conservation Reserve Program, and Conservation Reserve Enhancement Program.

In more developed, urban or suburban areas, establishing riparian buffers can be complicated by the presence of existing development located immediately adjacent to or near water bodies, limiting the area available.

Location

Riparian buffers are located adjacent to streams or other water bodies. They are suitable for all land uses. They are especially important on steep slopes, for mitigating any potential erosion due to otherwise excessive runoff velocity. Minimize water body crossings or incursions into riparian buffers. Crossings at right angles to water bodies minimize the amount of riparian buffer disturbed, compared to crossings at oblique angles.

Design

Filter Strip

The filter strip is often used in the creation of riparian buffers, either as a stand-alone practice, or as part of a multi-zone system (described below). The United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) recommends a minimum filter strip width of 20 feet for controlling suspended sediment and associated runoff, or 30 feet for controlling dissolved contaminants in runoff (USDA NRCS, 2011b). They further recommend widening the filter strip, depending on land slope, soil type, and flow length (USDA NRCS, 2011c), up to a maximum of 216 feet. The United States Department of Agriculture (USDA) Revised Universal Soil Loss Equation version 2 (RUSLE2) can be used to help determine the minimum filter strip width based on contributing land conditions.

In multi-zone riparian buffers, the filter strip is the zone furthest from the water body. A filter strip may be necessary when a riparian buffer is adjacent to an area from which any storm water runoff requires additional pre-treatment, such as farm fields or impervious surfaces. A filter strip is not usually necessary as part of a multi-zone system where the adjacent land cover is grassland, forest, or other types that do not produce significant sediment, nutrients, pesticides, or other pollutants.

One source of guidance on selecting filter strip vegetation is the USDA NRCS *Filter Strip* practice standard (USDA NRCS, 2011b), which lists approximately 20 species, to be used individually, or in combination. While this guidance includes seven native species (Big Bluestem, Eastern Gammagrass, Indiangrass, Intermediate Wheatgrass, Little Bluestem, Switchgrass, and Tall Wheatgrass), it also includes Reed Canarygrass.

Though Reed Canarygrass species is neither restricted nor prohibited, and is still used in the state, it has been identified in a Michigan Department of Natural Resources (MDNR) invasive species document (MDNR, 2009) as sometimes problematic in certain areas. So, where feasible, when installing filter strips, consider suitable alternatives to Reed Canarygrass. Note that the MDEQ Nonpoint Source (NPS) Program will not fund the planting of Reed Canarygrass.

One useful resource for selecting potential filter strip vegetation is the Minnesota Pollution Control Agency's *Plants for Stormwater Design* (Shaw & Schmidt, 2003), which identifies both desired native species, and those to avoid (including Reed Canarygrass).

In considering particular plant species to be used as filter strip vegetation, check with the MDNR's prohibited and restricted invasive species list, to make sure the species of interest are not on this list.

Multi-Zone Riparian Buffer

A number of sources describe and recommend multi-zone riparian buffers. The USDA NRCS (2000) has a practice standard for riparian forest buffers, to be established primarily in open or agricultural land. Schueler (1995) describes a system more suited to developed, urban or suburban areas.

Described below is a synthesis of the various multi-zone systems, which ties together the various recommended minimum widths, vegetation types, land use restrictions, and allowances:

Zone 1. This is the innermost zone, closest to the adjacent receiving water body. It is also referred to as the 'streamside zone'. It is typically wooded, with trees or shrubs; mature trees are preferred. Neither livestock access nor timber harvesting are recommended.

In more developed areas, the recommended minimum width is 25 feet, and recommended land uses should be limited to footpaths or watercourse crossings.

Zone 2. This zone is also referred to as the 'middle zone'. Like Zone 1, it is typically wooded, ideally with mature trees. In some cases Zone 2 can be a managed forest, in which selected, minimal timber harvesting is allowed, primarily for maintaining the health of the stand, and as an economic incentive. No livestock access is recommended.

In more developed areas, recommended land uses should be limited to bike paths, storm water BMPs, or other low-impact recreational uses. The recommended minimum width in developed areas is 50 feet, increasing to include the 100-year floodplain, steep slopes, adjacent wetlands, or higher-order streams.

Zone 3. This zone, furthest from the stream, is also referred to as the 'outer zone'. In agricultural areas, this zone typically consists of a filter strip (described above). In agricultural areas where there are no streamside trees, filter strips are still often

established adjacent to water bodies, in which case this practice comprises the entire riparian buffer. Conversely, in areas with existing riparian forest buffers (i.e., Zones 1 and 2), if the adjacent up-slope land is grassland, forest, or other area that does not produce sediment, nutrients, pesticides, or other pollutants, then a filter strip may not be necessary. As described above, the recommended minimum filter strip width ranges from 20 to 216 feet, depending on a number of factors.

In more developed areas, the minimum recommended width is 25 feet. In residential areas, the vegetation in this zone often consists of turf grass (such as a back yard). Property owners should be encouraged to plant other dense herbaceous species to provide increased filtering capacity.

Figure 1 contains a schematic cross-sectional view of a hypothetical multi-zone riparian buffer, including recommended vegetation types, minimum widths, and land uses.

Other Riparian Buffer Width Criteria

While primary design criteria for filter strip and multi-zone riparian buffers are discussed above, other riparian buffer width criteria, some regulatory, others simply recommended, are as follows.

The 16 designated Natural Rivers in Michigan have riparian buffer requirements, in some cases exceeding the recommendations given above. Refer to Table 1 for the minimum required vegetated riparian buffer widths on private land along the main stems of the listed rivers. A given width is measured outward horizontally starting at the ordinary high water mark, on both sides of the river. Note that buffers along tributaries, on state land, or in other cases can have different requirements. For specific guidance, refer to the individual plans for each designated Natural River, or consult the MDNR Natural Rivers Program.

Table 2 summarizes the results of a literature search for minimum recommended buffer widths for the protection of the listed terrestrial animal species. These studies made conclusions by correlating the relative amount of habitat provided by buffers of various widths with the number of animals encountered.

Schueler (1995) recommends a minimum overall urban riparian buffer width of 100 feet.

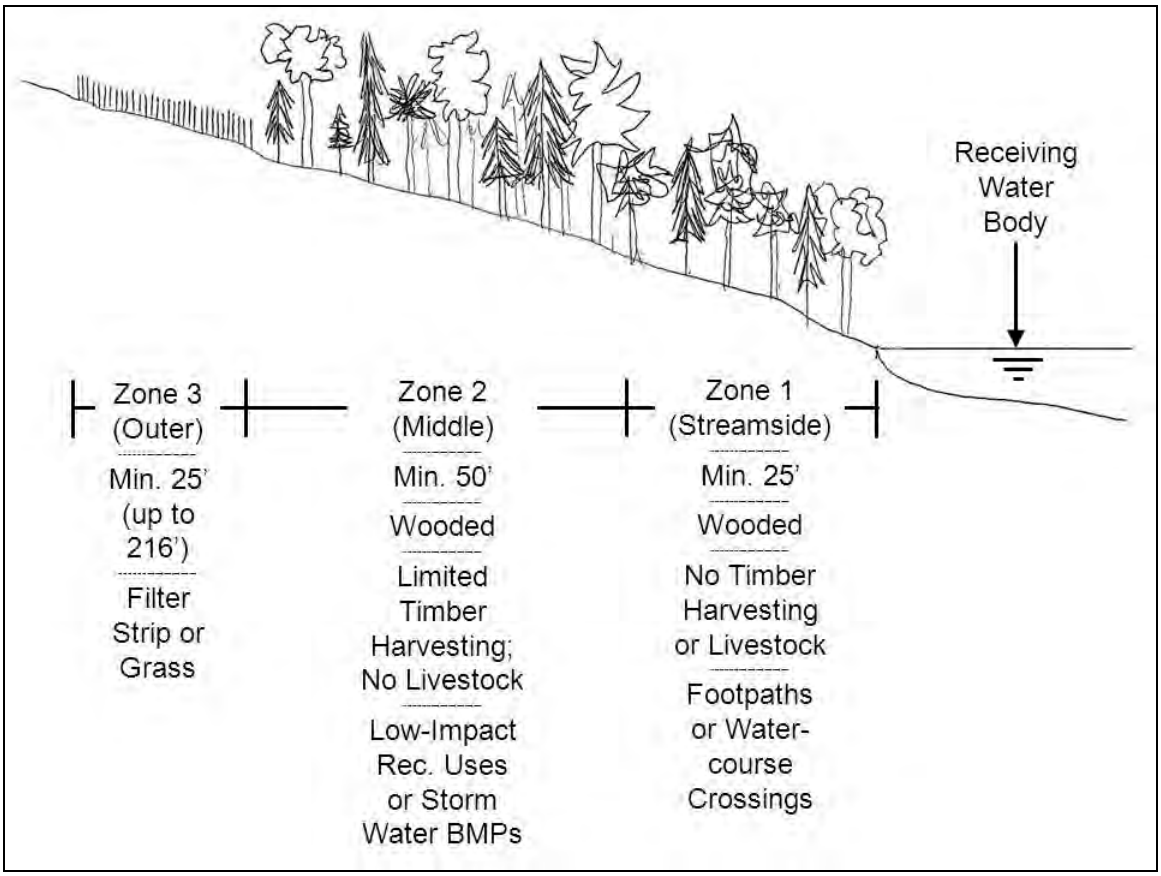


Figure 1. Multi-Zone Riparian Buffer

Table 1. Michigan Natural River Buffer Requirements

Min. Vegetated Buffer (feet)	River
100	Fox, Two Hearted, Jordan, Pigeon, Pine
75	Au Sable, Pere Marquette, Rifle, Upper Manistee
50	Betsie, Boardman, Huron, Lower Kalamazoo, Rogue, White
25	Flat

Source: MDNR, 2004.

Table 3 summarizes the results of a literature search of riparian buffer studies that considered various water quality parameters and aquatic animal species.

Performance Enhancers

Native plant species are preferred over introduced species for a number of reasons. First, they are often more acclimated to the local climate, making them hardier and more drought-tolerant. Second, many native plant species have deeper root structures, which can facilitate increased infiltration, and the take-up of more runoff.

Table 2. Recommended Riparian Buffer Width to Support Listed Animal or Taxon

Animal or Taxon	Riparian Buffer Width, feet	Source
Amphibians & Reptiles	>99	Rudolph & Dickson, 1990.
Birds, breeding	>50	Premo, 1995
Mammals	Narrow buffer w/ well-developed herbaceous vegetation better than wider buffer w/ sparse vegetation	Dickson & Williamson, 1988
	>400 for coniferous buffers	
Squirrels	>99 minimum	Dickson & Huntley, 1987
	>165 for abundance	
Turkeys	>150	Burk et al, 1990

Table 3. Water Quality-Related Riparian Buffer Literature Search Summary

Parameter(s) Studied	Study Location	Conclusions/ Recommendations	Source
Gully Erosion	LA	Buffers did not stop gully erosion that started up-slope of buffers. All 1,584 sites studied had developed gullies.	Farrish et al, 1993
Macro-invertebrates	CA	Streams with riparian buffer widths less than 30 meters (98.4 feet) showed same response as streams logged without buffers. Changes caused by decreased canopy density, and increased: primary production, stream flow, temperature, and sediment.	Erman et al, 1977
	New Zealand		Graynoth, 1979
Nutrients, Turbidity	WV	In streams with riparian buffers of widths 10 to 20 meters (32.8 to 65.6 feet), both turbidity and nutrients increased during and after logging.	Aubertin & Patrick, 1974
Temperature	OR	For the streams studied, max. shading ability was reached within 80 feet, and 90% of max. was reached within 55 feet. Angular canopy density also needs to be factored into buffer width determination.	Brazier & Brown, 1973
Turbidity, Sedimentation	PA	Recommends buffer widths of 23 to 30 meters (75 to 98 feet).	Corbett et al, 1978
		Recommends buffer widths of 30 meters (98 feet).	Lynch & Corbett 1981
		Recommends buffer widths of 100 feet, or 1.5 times average tree height.	Lynch & Corbett, 1990
Water Yield	MN	Clear-cutting aspen and pine forests increased annual water yield 9 to 20 cm, a 30% to 80% increase, taking 12 to 15 years to return to pre-harvest levels.	Verry, 1986

For the transitions between vegetation types in multi-zone riparian buffers, the more variation in vegetation types, the greater the habitat variability, and greater potential for biodiversity.

Construction

Install any necessary temporary or permanent upland BMPs.

Prepare the site. If grading is necessary, consider the **Land Clearing** and **Grading Practices** BMPs. Never grade to the edge of a water body without proper soil erosion and sedimentation controls in place. Consult the **Soil Management** BMP for any necessary soil amendments, such as fertilizer.

For vegetation establishment, refer to the **Seeding**, **Sodding**, **Mulching**, and **Trees, Shrubs, and Ground Covers** BMPs. Consider using mulch between and around any trees or shrubs, to keep soil on site, retain moisture, and promote infiltration.

Maintenance

General

Maintain any temporary upland BMPs until riparian buffer vegetation is sufficiently established (i.e., a minimum of 90 percent coverage). Filter strip grass or other vegetation should be at least four inches tall.

Leave riparian buffers undisturbed except for the land uses listed previously. Do not use heavy equipment or run vehicles on riparian buffers.

Vegetation

If a buffer is designed for nutrient removal, harvest and remove vegetation, and dispose of outside the buffer. Riparian buffer vegetation can also be managed with prescribed burns. Ensure that riparian buffer performance is maintained after any vegetation removal. For example, if harvesting vegetation, cut only the tops of plants, versus mowing down to the ground. Or, if conducting a prescribed burn, do so only on one part of the buffer at a time.

If grass fails to grow in a newly-established filter strip or 'Zone 3'/'outer zone' (of a multi-zone riparian buffer), determine the reasons for failure before reseeding. The **Lawn Maintenance** BMP includes information on unhealthy turf. Spot seed only when small areas are affected.

If insects or invasive species are damaging the filter strip, consider integrated pest management techniques presented in the **Pest Management** BMP to minimize the effects on any wildlife using the filter strip. Resort to chemical controls only after all other methods have been ruled out.

Collected Sediment

Remove any excess sediment that has accumulated in or adjacent to the buffer. Re-grade if necessary, to ensure runoff enters and passes through the buffer as sheet flow. Look in particular for sediment accumulated along the leading edge of the buffer, which can potentially concentrate flow, leading to gully erosion. Re-vegetate any areas that need it.

If sediment enters a buffer in amounts which cannot be removed by hand, or in amounts which cause damage, additional upland BMPs likely need to be installed or implemented.

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Water Resources Division

Dewatering

Description

Dewatering is the removal of ground or surface water from a construction site to allow construction to be done "in the dry" (as opposed to under wet conditions). Water is usually removed using well points and power-driven pumps. Dewatering of cofferdams and trenches is a common practice during the construction of bridges, culverts, or public utilities (see the Watercourse Crossings best management practice [BMP]). The water removed from dewatering is often sediment-laden, and can contain other pollutants, all of which needs to be properly treated prior to discharge.

Pollutants Controlled

Proper techniques of treating dewatering flows remove sediment, nutrients, oil, and other chemicals.

Location

Apply on any appropriate transportation, utility, urban, or other construction sites, or anywhere else dewatering is needed. Dewatering is often necessary in areas with high groundwater tables, or inadequate drainage. Dewatering at a site continues for as long as it is necessary for the groundwater table to be lowered, for construction sites to remain dry, or until all utility ditches or cofferdams are no longer needed. Place dewatering structures or components such as bags in upland areas. Include all drainage and dewatering structures and locations on any soil erosion and sedimentation control plans developed for a project.

Companion & Alternate Practices

Dewatering is often implemented in conjunction with Watercourse Crossings. Consider using Sediment Basins, Silt Fence, or Storm Sewer Inlet Protection, to filter dewatering flow before it's discharged to any receiving water. Polyacrylamide can be used in conjunction with dewatering, for flocculating suspended solids, facilitating its removal from pumped water.

Design

1. Assure that dewatering discharge doesn't cause scouring of the receiving area. Base the design of any structural BMPs (i.e., basins or sumps) that are to receive dewatering discharge on the anticipated flow rate from the dewatered area.

2. Prior to discharging to any surface water, pump sediment-laden water from cofferdams, trenches, or any areas being dewatered through a geotextile material filter bag. Refer to the Silt Fence and Storm Sewer Inlet Protection BMPs. Dispose of the filter bag at an upland site.

3. Obtain permission from either the drain commissioner or drain board prior to discharging treated dewatering flows to any county or inter-county drains.

4. Refer to the guidance document *Dewatering FAQ* (MDEQ, 2007) for additional information regarding the subject, as it relates to county ordinances; the public health code; the well construction code; the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended; and other considerations.

5. The quality of the discharge from dewatering operations determines whether or not a National Pollutant Elimination Discharge Elimination System (NPDES) permit is required. In general, the discharge of clean water will not require an NPDES permit. Consult the appropriate Michigan Department of Environmental Quality (MDEQ) district office staff person with any questions regarding the need for an NPDES permit.

6. A discharge from dewatering operations to a regulated municipal separate storm sewer system (MS4) must comply with the illicit discharge definition (i.e., the discharge cannot be contaminated). Obtain approval from the MS4 owner or operator prior to discharging to their system from any dewatering operation.

Maintenance

Inspect the dewatering site several times daily to ensure that the pumping is adequately controlling the excess water and drawing from the top of the water column if possible, any filter bags are not clogged, ripped, or torn, that any vegetative filters are still retaining sediment, and that the discharge point to a wetland or water body, if applicable, is free of visible evidence of suspended sediment from the dewatering effort. If any filter bags become clogged, replace them with new ones. If sediment basins are used, follow maintenance procedures described in the Sediment Basin BMP.

Literature Cited

MDEQ. 2007. *Dewatering FAQ*. Environmental Assistance Program.

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For information or assistance on this publication, please contact the (name of division/office, program), through the DEQ Environmental Assistance Center at 800-662-9278. This publication is available in alternative formats upon request.

Water Resources Division

Equipment Maintenance and Storage

Definition

This practice deals with the confinement of the maintenance, repair, cleaning, and storage of construction machinery, vehicles, and equipment, to areas specifically designed and designated for those purposes. It is applicable to both temporary and permanent sites and facilities, whether open or covered. It emphasizes the importance of controlling runoff from these areas.

Pollutants Controlled

Equipment maintenance and storage areas which properly control runoff will prevent oil, grease, solvents, hydraulic fluids, sediment, wash water, and other pollutants from being carried off the areas and into surface waters. This practice also prevents pollutants from filtering into the ground.

Location

Where possible, locate maintenance and storage areas on flat ground, to prevent surface runoff from entering or leaving the areas.

Implement this practice at all existing or planned equipment maintenance and storage areas, including construction sites at which equipment will be stored, serviced, maintained, or repaired. Prior to construction, identify appropriate locations for equipment maintenance and storage.

Companion and Alternate Practices

Where possible, identify appropriate locations for maintenance and storage areas prior to any construction being done on a site. Consider using diversion to keep runoff from entering maintenance and storage areas. Handle, store, and dispose of pesticides according to specifications in the Pesticide Management best management practice (BMP). Dispose of smaller quantities (i.e., one (1) gallon or less) of hazardous waste following the specifications in the Household Hazardous Waste Disposal BMP. For disposing of larger quantities of hazardous waste, consult the MDEQ's Office of Waste Management and Radiological Protection at 517-284-6857.

General Characteristics

Planning Considerations for New Areas

Determine site selection based on the following considerations.

If equipment is to be maintained and stored outdoors temporarily:

- Do not locate sites within the drip line of trees.

- Do not locate sites within 100 feet of watercourses or wetlands. Divert runoff away from watercourses and wetlands.

If equipment is to be maintained and stored indoors:

- Do not locate buildings within 100 feet of watercourses.

- Do not construct buildings on or within 100 feet of wetlands.

- Do not under any circumstances locate buildings or equipment in floodplains, stream beds, or the channels of any watercourses.

General Considerations for All Equipment Maintenance and Storage Areas

- Direct runoff from equipment maintenance and storage areas to stabilized outlets designed to adequately convey the volume discharged to them. See the Stabilized Outlets BMP.

- Keep heavy equipment well maintained to prevent leaks.

- Do not wash vehicles or other equipment at locations where the runoff will flow directly into a watercourse or separate storm sewer. Refer to the Charity Car Wash BMP for additional information on vehicle washing.

- Store, cover, and isolate construction materials, including topsoil and chemicals, to prevent runoff of pollutants and contamination of groundwater, following the design guidance below.

- Develop a waste management plan. Empty canisters, cans, or other chemical containers (e.g., hydraulic fluids, etc.), scrap wood, scrap metal, and all other waste materials are to be disposed of daily or kept in sealed waste containers until they can be properly disposed of off-site, such as in a landfill. Do not bury waste materials on-site.

- Designate and maintain specific areas for employee parking.

Indoor Equipment Maintenance and Storage Areas

- Plug and seal all floor drains which discharge to storm sewers. Design all new floor drains to discharge to the sanitary sewer.

- Construct all floors of cement or other impervious materials, to prevent contaminants from leaching into the soils or groundwater.

- Discharge runoff from equipment wash areas to the sanitary sewer. Depending on the amount of oil, grease, or other pollutants, pre-treatment of runoff may be necessary before it enters the sanitary sewer.

- If washing muddy trucks or equipment indoors, send any wash water to the sanitary sewer. Do not under any circumstances send any wash water to separate storm sewers.

Outdoor Equipment Maintenance and Storage Areas

- Ideally, conduct all maintenance on impervious areas surrounded with impervious berms. Where this is not possible, use pads designed to contain the pollutants, which could otherwise leak or spill during maintenance operations. Impervious pads are particularly important on sandy and other course soils where spilled materials can easily leach into the groundwater.

- Construct wash areas out of two- to three-inch stone or other approved material, with a minimum six-inch base. Underlay the stone with geotextile materials, and protect using berms or Diversions to prevent the runoff water from leaving the site. Do not allow any wash water to enter rivers, lakes, or wetlands. If planning to discharge wash water directly to the ground, be aware of the groundwater permit rules, when considering any outside vehicle washing, or power washing in general.

- Never store equipment within the drip lines of trees.

- Store topsoil following specifications in the Spoil Piles BMP.

Proper Chemical Storage, Use, and Disposal

- Follow all federal, state and local laws regarding hazardous material storage. In general:

  - Store all hazardous chemicals in sealed containers. Incorporate secondary containment into the designs of maintenance and storage facilities, to contain spills from all hazardous materials.

  - Store pesticides according to the guidelines in the Pesticide Management BMP.

  - Keep labels on all products so that they are readable. Do not use unlabeled products.

  - Maintain records of the use and application of all products stored on site.

  - Maintain proper ventilation. Post "no smoking" and other signs to warn of potential dangers. Keep storage areas locked.

- Develop a spill response plan, to include the steps that will be taken to contain and clean up any spills. Familiarize everybody working with chemicals with the spill response plan. For hazardous material spills which cannot be contained on-site, or when there is a known or potential impact to surface or ground water or soils, immediately contact the MDEQ through the Pollution Emergency Alerting System (PEAS) hotline at 1-800-292-4706.

- Keep on site absorbent materials, such as hay bales, cat litter, or absorbent pads, to prevent the migration of pollutants which are spilled on imperious areas.

- Dispose of small quantities of material (i.e. less than one (1) gallon) based on the type of pollutant absorbed:

  - Dispose of pesticides following specifications in the Pesticide Management BMP; or follow specifications in the Household Hazardous Waste Disposal BMP for small quantities of hazardous wastes (one (1) gallon or less).

  - For other hazardous wastes, or wastes in excess of one (1) gallon, contact the MDEQ's Office of Waste Management and Radiological Protection at 517- 284-6857 for additional information.

  - Contact the MDEQ's Remediation and Redevelopment Division at 517-284-5087 for information on the Right-to-Know Law and for information on underground storage tanks.

Additional Considerations

The Part 21 Rules of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, require construction permittees to provide facilities for containing any accidental losses of oil or other polluting substances, and Part 5 Rules require compliance with reporting procedures for spills from these facilities.

Maintenance

Inspect outside equipment maintenance and storage areas daily to ensure equipment isn't being stored within the drip line of trees, and that vehicles and equipment aren't leaking. Also make sure waste materials are being properly disposed of. Conduct periodic checks of equipment wash areas to ensure they're operating properly. Additional stone may be needed to maintain wash areas.

Periodically inspect equipment maintenance and storage area structures, checking for cracks in the floor, or other structural flaws. Inspect floor drains to ensure they're not discharging to separate storm sewers.

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Water Resources Division

Grading Management

Definition

Grading is the temporary or permanent reshaping of the ground surface to planned elevations determined by engineering survey evaluation and layout. Grading is also sometimes referred to as earthmoving, or earth change activity. The purpose of this best management practice (BMP) is to show how to conduct grading activities while minimizing soil erosion and controlling storm water runoff, in a manner that reduces the risk of damage to natural resources, adjoining properties, or human health. This BMP covers both basic grading management concepts and specific types of grading-related practices that can be used to reduce erosion.

Pollutants Controlled

The objective of properly managing grading activity is to keep sediment on-site, minimize sediment suspended in runoff, stabilize slopes, and decrease runoff velocity. A pilot study (Caltrans, 2000) of test plots compared the soil erosion and runoff rates of a smooth slope of bare soil, with four slopes that were roughened through various methods. The study showed measured reductions in erosion rates of 12 percent, 52 percent, 55 percent, and 76 percent, depending on the method used. At the same time, the study also noted decreased runoff rates of 4 percent and 19 percent for two of the methods, and increased runoff rates of 2 percent and 12 percent for the other two methods. The increases were believed to be caused by soil compaction.

Location

Apply these practices wherever earth moving or other land changes occur, or where construction activities result in grades which may increase erosive velocities or off-site sedimentation.

Companion & Alternate Practices

Consider using Diversions to prevent run-on from causing erosion on exposed soil and runoff from entering waters of the state. To prevent off-site sedimentation, control measures such as Silt Fencing, Grade Stabilization Structures, or Sediment Basins may be needed around the perimeter of construction sites, especially on the downslope side. Stage and Schedule all projects to minimize the area of a site being exposed at any one time. Surface roughening (which is also referred to as scarification) is a grading practice that can be used to reduce erosion from a construction site. This practice is described below.

Grading activity has the potential to trigger the need for a number of Michigan Department of Environmental Quality (MDEQ) permits. Please see the Permit Information Checklist for information about which permits may be applicable to your particular grading activity, and who to contact to determine how to obtain a permit.

Specifications

Planning Prior to Commencement of Grading

1. Make decisions regarding the steepness of cut and fill slopes and how the slopes will be protected from runoff, stabilized, and maintained.

2. Plan all grading to complement the natural contours of the landscape.

3. Minimize the depth of grading to prevent exposing extensive amounts of subsoil. Stockpile and re-spread any topsoil removed from a graded area.

4. Develop a grading plan to establish drainage areas, direct drainage patterns, and decrease runoff velocities. Coordinate the grading plan with the soil erosion and sedimentation control (SESC) and storm water plans.

5. Set the slopes of any areas which in the future will be mowed at or below 3H:1V.

6. Determine when grading will begin and when it will cease. Land grading should be a key consideration of construction staging and scheduling with the goal of exposing the smallest amount of soil for the shortest time period possible. Plan grading so that it's performed in stages according to the implementation schedule. Refer to the Staging and Scheduling BMP.

7. Determine where spoil piles will be placed and protect spoil piles following specifications in the Spoil Piles BMP.

8. To ensure even settling, ensure that any fill to be used is free of objectionable material, such as logs, rocks, or stumps. Do not use frozen or mucky material for fill.

9. Do not place fill adjacent to channel banks, which could possibly cause bank failure or result in downstream sediment deposition.

10. Evaluate the proposed final grading plan to ensure that changes to storm water runoff will not cause unnatural discharge to or otherwise negatively affect any neighboring properties.

During Grading

1. Prior to beginning grading, install and/or construct all erosion and sedimentation control practices.

2. Remove vegetative matter in accordance with Land Clearing specifications. If topsoil must be removed, store it in temporary Spoil Piles until final grading. To prevent erosion, place temporary Spoil Piles away from wetlands, streams, or lakes. If such placement is not feasible, ensure that Spoil Piles located near any of these water bodies are temporarily seeded and protected with a perimeter SESC practice, such as Silt Fence.

3. Do not grade to the edge of watercourses. If a natural, vegetated, appropriately-sized Riparian Buffer maintained at a width and condition identified in the BMP cannot be left in place and/or upon direction by the SESC plan or by the SESC permitting agency, construct a berm or place Silt Fence adjacent to the watercourse or wetland.

4. Divert runoff to stabilized areas, according to the grading plan, and/or SESC plan.

5. Finish grade and compact according to the intended use of the area. Refer to the appropriate BMP for additional information on the finish grading procedures and the degree of compaction needed.

6. To retain water, increase infiltration, and facilitate vegetative growth on slopes, use one of the techniques described below:

    a. Surface Roughening/Scarification: Use this method in any areas which can safely accommodate disks, tillers, spring harrows, or the teeth of a front-end loader bucket. In areas which will not be mowed, use equipment to create grooves perpendicular to the slope. Grooves should not be less than 3 inches deep, nor more than 15 inches apart. In cuts, fills, and areas that will be mowed, grooves should be less than 10 inches apart and not less than 1 inch deep. Irregularities in the soil surface catch rainwater, and retain seed and nutrients when applied. Refer to Figure 1 for an example of ground that has been grooved. Another method is to run tracked machinery (such as a bulldozer) up and down slopes to leave depressions in the soil perpendicular to the direction of flow. To avoid undue soil compaction, use this method only on sandy soils. Do not back-blade during final grading. Refer to Figure 2 for an example of a bulldozer tracking a slope;

    b. Stair-Step Grading: Use this method on slopes steeper than 3H:1V which have material soft enough to be bulldozed and which will not be mowed in the future. Make the vertical cut less than the horizontal distance, and do not exceed two (2) feet in soft material and three (3) feet in rocky material. Grade the stair steps so that the 'treads' (i.e., the parts of stairs typically horizontal) are actually tiled back slightly, so any runoff on the 'tread' actually flows into the 'riser' (i.e., the part of stairs typically vertical).

7. Use proper Tree Protection techniques to maintain the health and integrity of the trees. Excavate as far away from the drip line as possible.

8. When raising the grade around trees:

    a. Protect the trees by constructing tree wells around the trees, at or outside the drip line, to protect the natural soil in the area of the feeder roots, and to protect the trunk and branches from potential damage through direct contact. Refer to the Tree Protection BMP.

    b. Design the tree well to allow drainage within the well and around the root system inside the drip line.

9. When lowering the grade around trees:

    a. Protect the trees by constructing tree walls made of large stones, brick, building tile, or concrete or cinder block. To protect tree roots, locate the walls at or outside of the drip line. Refer to the Tree Protection BMP.

    b. Include adequate drainage through the wall.

After Construction

1. As soon as grading is completed, in a timeframe not to exceed five (5) days, or when work is interrupted for fourteen (14) or more working days, stabilize all disturbed areas by initiating the establishment of vegetation with Seeding and Mulching, or by placing crushed stone, riprap, or other ground cover, or by installing Slope/Shoreline Stabilization structures;

2. Stabilize slopes in excess of 2H:1V using the specifications in the Critical Area Stabilization BMP;

3. Mulching can be used to temporarily stabilize areas where final grading is being delayed.

4. Maintain whatever temporary SESC measures are needed until final, permanent stabilization is achieved.

Maintenance

Desired grades must be maintained until the proposed land use is established with a structure, pavement, or vegetation. In addition, any BMPs installed in association with the grading must be maintained until the graded area is permanently stabilized.

Literature Cited

California Department of Transportation (Caltrans). 2000. *District 7 Erosion Control Pilot Study*. Caltrans Document No. CTSW-RT-00-012.

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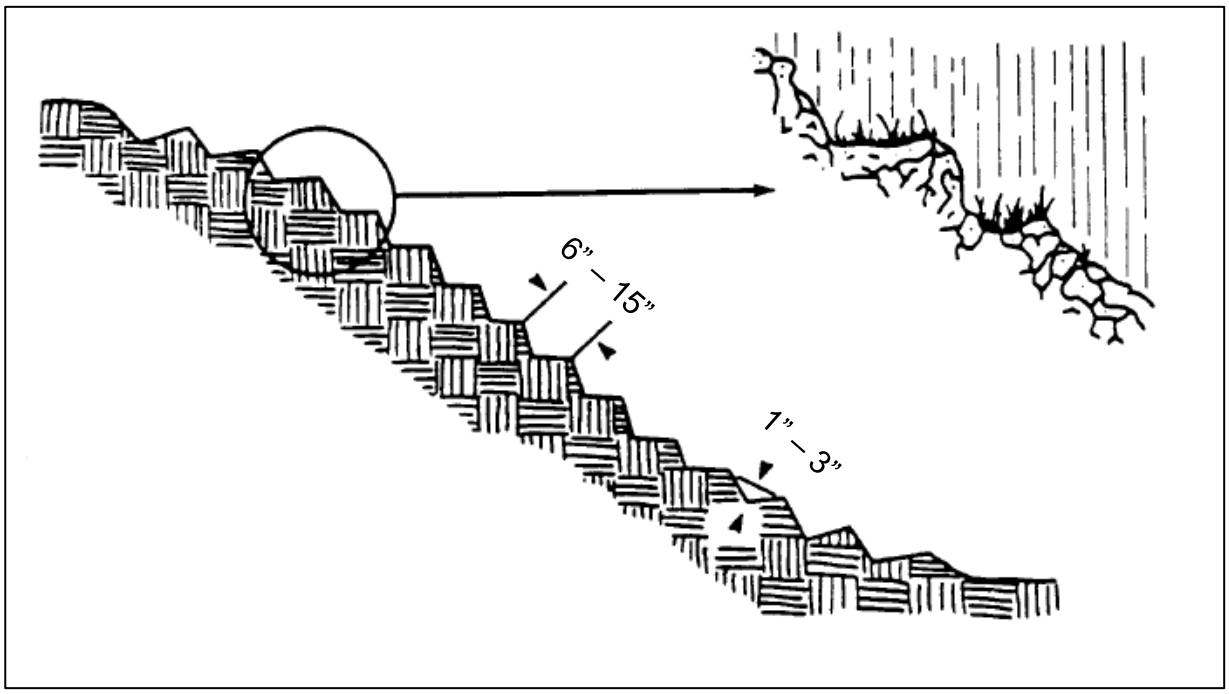

Figure 1. Side View of a Grooved Slope, Shown Catching Rainwater, Seed, and Nutrients

Source: VDEQ, 1992.

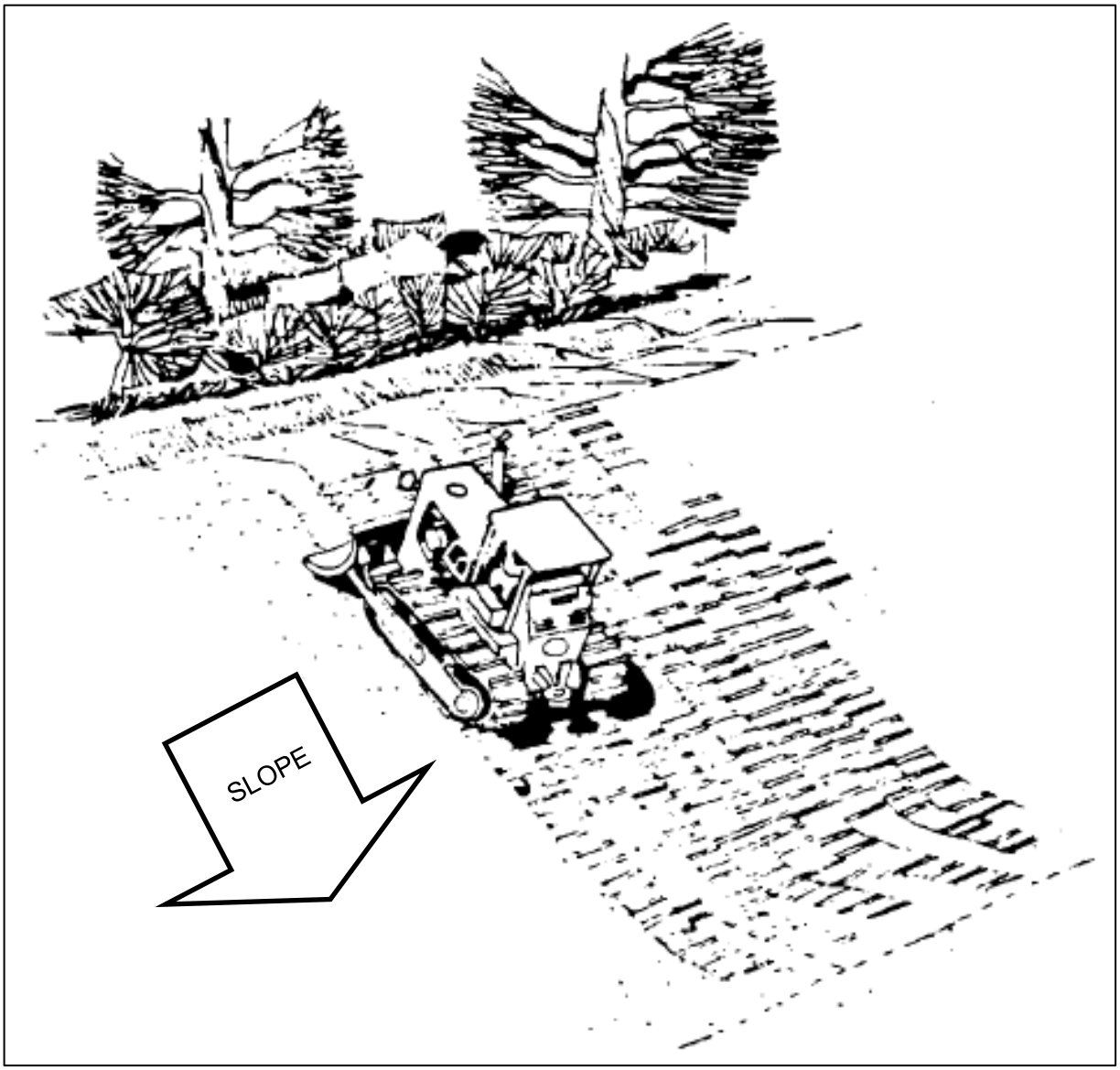

Figure 2. Bulldozer Tracking Soil Perpendicular to Ground Slope

Source: MDNR, 1975

Draft

Appendix D
Soil Erosion and Sedimentation Control Inspection Form

SOIL EROSION & SEDIMENTATION CONTROL/CONSTRUCTION STORM WATER INSPECTION LOG

Project Name or Description: *NPDES Number (if applicable):* _____ *Page* _____ *of* _____

_____

Date: _____ *Time:*_____ *Reason for Inspection:* ☐ *Weekly Inspection* ☐ *Inspection* ***within 24 hrs. of*** *Storm Water Runoff*

Current extent of the project work: _____

SESC measures installed since the last inspection and their location: _____

_____

Are SESC measures installed according to the SESC Plan? ☐ ***Y*** ☐ ***N*** *Are there other potential areas of concern?* ☐ ***Y*** ☐ ***N***
If ***NO****, identify measures, locations, and actions needed below.*

Are the SESC measures: Properly installed? ☐ ***Y*** ☐ ***N*** *Maintained?* ☐ ***Y*** ☐ ***N*** *Appropriate for site conditions?* ☐ ***Y*** ☐ ***N***
Failed? ☐ ***Y*** ☐ ***N***
If ***NO****, identify measure locations and actions needed below.*

Are additional SESC measures recommended? ☐ ***Y*** ☐ ***N*** *Are there other concerns or improvements noted for the site?* ☐ ***Y*** ☐ ***N***
If ***YES****, identify locations and recommendations below.*

Corrective Actions Taken/Needed ***to repair or improve the prescribed control measures****:*

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Certified Operator *Signature:*_____ *Operator Number:* _____

*Print Name:*_____

The details included in this report were provided to: *Date:* *By method of delivery:*

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Remedial Action Completion Report:
   a. Submit draft version of the Remedial Action Completion Report (RACR) to the Owner within 30 days of final demobilization from the site.
   b. Submit final version of the RACR within 30 days of receipt of comments from the Owner.
   c. Submit draft and final versions of the RACR in PDF format, or as otherwise acceptable to Owner. Also provide a Microsoft Word version of the draft report.
   d. In preparation of the RACR, meet the requirements of Close Out Procedures for National Priorities List Sites, OSWER Directive 9320.2-22.
   e. At a minimum, include the following sections in the RACR:
      1) Introduction and Site Overview.
      2) Record of Decision.
      3) Remedial Action Objectives.
      4) Remedial Actions.
      5) Chronology of Events.
      6) Demonstration of Completion.
      7) Ongoing Activities.
      8) Community Relations.
      9) Certification Statement.
      10) Appendixes, as necessary.
   f. If the RA is completed over multiple construction seasons, a separate RACR will be prepared and submitted for each construction season. At the Owner's request, the RA Contractor will consolidate the RACR(s) prepared after the initial construction season with the previous RACR(s) into a single report.

B. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: All remaining record documents not previously submitted.

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b. Approved Shop Drawings and Samples: As required in the General Conditions.
c. Special bonds, Special Guarantees, and Service Agreements.
d. Consent of Surety to Final Payment: As required in General Conditions.
e. Releases or Waivers of Liens and Claims: As required in General Conditions.
f. Releases from Agreements.
g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
h. Extra Materials: As required by individual Specification sections.
i. Summary of communications with OSHA.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Owner's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Owner to recommend whole or any part of RA Contractor's Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where RA Contractor's operations have not been kept within the Owner's construction right-of-way.

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B. In the event RA Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct RA Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should RA Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from RA Contract Price, or require RA Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with RA Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) RA Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that RA Contractor has failed to fulfill terms of side agreement or special easement, or (ii) RA Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of RA Contract Times, secure from Owner at no cost to RA Contractor, one complete set of RA Contract Documents.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Owner.

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C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   b. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   c. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Owner's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
   b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to RA Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to RA Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.
2. Clean all heavy equipment with power washer before leaving the site.

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3. Remove all stockpiles of dirt and debris from the site, which may have been accumulating during construction activities.
4. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
5. Broom clean exterior paved driveways and parking areas.
6. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
7. Leave no traces of sediment on the tracks, haul roads, and public access roads.
8. Leave water courses, gutters, and ditches open and clean.
9. Prior to RA Contractor receiving approval for the notice of completion all work will be inspected and signed off by the Owner.

3.03 FINAL TOPOGRAPHIC SURVEY

A. As required in Section 01 31 13, Project Coordination.

END OF SECTION

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SECTION 02 40 00
SEDIMENT RESUSPENSION CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. Work covered under this Section includes providing materials, equipment, labor, and performing operations necessary to:

1. Develop a correlation between total suspended solids (TSS) as analyzed by laboratory and nephelometric turbidity units (NTUs) as measured real-time by instruments.
2. Provide and maintain sediment resuspension controls to comply with the resuspension performance standards for the Work area.
   a. Turbidity curtains, as needed.
   b. Other controls, as needed.
3. Provide and maintain other sediment resuspension controls to comply with requirements outlined in the substantive requirement document (SRD).

1.02 REFERENCES

A. USACE, 2005. Turbidity Curtains as a Dredging Project Management Practice. ERDC TN-DOER-E21, September 2005.

1.03 SUBMITTALS

A. Action:

1. Turbidity and Resuspension Management Plan:
   a. Within 21 days after Notice of Award, submit a Turbidity and Resuspension Management Plan for approval. Turbidity and Resuspension Management Plan will address control of migration of suspended solids to comply with SRD requirements and meet water quality requirements in Part 3. This submittal will be consistent with Water Quality Management and Monitoring in Part 3 and will consist of:
      1) Methods and Best Management Practices (BMPs) of turbidity control including material, equipment, design and placement, and response actions to noncompliance.
      2) Final design of turbidity control including anchoring systems.

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3) Final design of any floating debris and oil booms.
4) Description of materials used.
5) Methods for installing, inspecting, and maintenance of turbidity controls.
6) Performance monitoring plan.
7) Contingency measures to control turbidity from sheet pile driving operations and other in-water activities.
8) Schedule for submittal of turbidity sampling results.
9) RA Contractor will provide all data recorded, whether listed or not.

B. Informational: RA Contractor will provide to Owner operational water quality data generated by RA Contractor during performance of the work.

1.04 RESUSPENSION PERFORMANCE MONITORING STANDARDS

A. At the start of the project, RA Contractor will be responsible for developing a correlation between TSS as analyzed by laboratory and NTUs as measured real-time by instruments.

B. Turbidity, as an indicator of TSS, will be the parameter of interest for resuspension performance monitoring. The SRD will outline turbidity monitoring requirements.

1.05 PERFORMANCE MONITORING STATIONS

A. The locations of performance monitoring stations will be located in accordance with the SRD.

1. The monitoring stations record turbidity within the river and will be furnished, operated and maintained by RA Contractor.

1.06 SEDIMENT RESUSPENSION CONTROL

A. Approved sediment resuspension control measures, as described in the Turbidity and Resuspension Management Plan, will be implemented to meet resuspension performance monitoring standards. Best Management Practices (BMPs) should be implemented to minimize resuspension during in-water operations.

B. An example of a sediment resuspension control measure is a turbidity curtain. If necessary, turbidity curtains may be deployed within the Work area to reduce the transport of sediment into and out of the Work area. If turbidity curtains are deployed, they will be deployed to a depth in the river channel to allow mudflow beneath the turbidity curtain and meet resuspension standards for the Work area. USACE (2005) suggests that extra curtain width (10 to

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20 percent) may be necessary to accommodate deflection from current flow. The exact location for the deployment of turbidity curtains will be at the discretion of RA Contractor, if used as the sediment resuspension control measure.

C. Contingency resuspension control measures and oil booms will be stored on site, for emergency use in the event of resuspension control measures failure, visible sheen, or exceedance of resuspension performance standards.

D. The type and configuration of resuspension control measures will be defined in RA Contractor's Turbidity and Resuspension Management Plan and shall be able to meet the resuspension performance standards for the Work area and SRD requirements. Within RA Contractor's Turbidity and Resuspension Management Plan, contingency measures will be included that describe how the resuspension control measures will be managed during low, average, and high flow conditions and what contingency measures will be implemented in the event resuspension performance standards are not met. The USACE Dredging Operations and Environmental Research (DOER) Program publication, *Silt Curtains as a Dredging Project Management Practice - ERDC TN-DOER-E21* (USACE, 2005), recommends that turbidity curtains will only be deployed when river flow velocities are below 1.5 knots (2.5 ft/s). This velocity is deemed the maximum velocity at which the use of turbidity curtains is considered effective.

PART 2 PRODUCTS

2.01 TURBIDITY CURTAIN SYSTEM

A. Turbidity curtain shall be a containment system consisting of floating boom with flotation media, filtration curtain, impermeable skirt capable of creating a bottom seal, load bearing members, mooring lines and anchoring system. Turbidity curtain shall be designed to be effective and stable in the flow velocities of the Pine River.

1. Flotation shall be an integral part of the curtain. Flotation media shall be polystyrene buoyant units attached to the filtration media. Buoyancy provided shall be sufficient to support the weight of the curtain under load and maintain a freeboard of at least 6 inches above the water.
2. Filter media shall consist of oleophilic materials that are UV-stabilized, biofouling-resistant, nontoxic and performance tested in aquatic environments. Impermeable material used in the hood and skirt shall be Polyester based, copolymer strengthened, nontoxic and performance-tested in aquatic environments.

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3. The bottom of the turbidity curtain shall be comprised of inverted 'Y' shaped skirt. The skirt shall be an impermeable barrier capable of sealing the bottom of the curtain with the bottom of the water body while conforming to the natural bottom contours. The outer edge of each skirt of the bottom seal shall be ballasted with chain to maintain the filter barrier and bottom contact.
4. Load bearing members must be fabricated into the top and bottom of the filter barrier. The top and bottom load member shall consist of woven webbing that shall have break strength in excess of 10,000 pounds. Additional load bearing members shall be located at the base of the curtain above the skirt and at the end of each skirt; these shall consist of a chain of sufficient weight to serve as ballast and to hold the curtain in a vertical position throughout seiche cycles. Connections of the load bearing members shall be of equal or greater breaking strength of the load bearing members.
5. An anchoring system shall be designed to keep the turbidity curtain in place during peak flows and seiche extremes. Type and size of anchors shall be site specific and installed by qualified personnel to fully support the loads described below and as recommended by the manufacturer.

B. Performance Criteria:

1. Turbidity curtain shall control silt and turbidity such that the requirements of the Order of Conditions, USACE, 2005 and 401 Water Quality Certificate are met.
2. Turbidity curtain shall be designed to remain in place for the duration of the Work in that location.
3. The turbidity curtain shall be installed and maintained in a manner that will contain silt and turbidity within the work area, and prevent turbidity, or impacts to water quality in the Pine River that violate the State of Michigan Surface Water Quality Regulations; Federal Clean Water Act Regulations; requirements of the Project-specific Permits, the 401 Water Quality Certificate or Order of Conditions; or result in degradation of water quality beyond conditions existing in the Pine River prior to construction.
4. Structure of system shall be designed to resist maximum loading. Minimum requirements of the system are as follows:
   a. Be fully functional in wave action up to 3 feet.
   b. Load resistance of up to 10 pounds per square foot.
   c. Be fully functional during storm events or wind generated water currents of 2 feet per second.
   d. Be fully functional during seiche changes of up to plus or minus 3 feet.

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5. The system shall be designed and stamped by a registered Professional Engineer with direct experience in the design and deployment of turbidity curtains. The Professional Engineer shall provide structural calculations proving the criteria are met.

2.02 TURBIDITY CURTAIN MATERIALS

A. Nonwoven (interior) Curtain Fabric Material: Interior filter fabric shall be nonwoven comprised of 100 percent polypropylene filaments, needle punched and heat set. Nonwoven fabric shall have the following minimum properties:

Properties	Results
Weight	10.0 oz/yd^2
Tensile Strength	250 lbs
Elongation @ Break	50 %
CBR Puncture Strength	700 lbs
Trapezoidal Tear	100 lbs
AOS – US Std Sieve	100
Permittivity	1.2 sec^{-1}
U.V. Resistance	70% (500 hrs)

B. Woven (exterior) Curtain Fabric Material: Exterior filter fabric shall be woven comprised of 100 percent polypropylene filaments, needle punched and heat set. Woven fabric shall have the following minimum properties:

Properties	Results
Weight	6.0 oz/yd^2
Tensile Strength	360 lbs
Elongation @ Break	24%
CBR Puncture Strength	650 lbs
Trapezoidal Tear	110 lbs
AOS – US Std Sieve	30
Permittivity	2.1 sec^{-1}
U.V. Resistance	90% (500 hrs)

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C. Impermeable Fabric Material: Impermeable material used for flotation hood, curtain components or bottom-seal skirts shall be Polyester based copolymer strengthened and have the following minimum properties:

Properties	Results
Fabric Weight	6 oz/yd^2
Coated Weight	28 oz/yd^2
Grab Tensile Strength	625 lbs
Thickness	30 mils
Ply Adhesive	15 lbs/in
Tongue Tear	150 lbs

D. Anchoring System:

1. Bottom chain shall be incorporated into a chain pocket at the bottom of the curtain and at the bottom of both skirts. Chain shall be 1/2 inch, galvanized.
2. Mooring attachment points shall be comprised of galvanized D-ring plates with D-rings of no less than 3/8-inch diameter, installed every 10 feet along the curtains. D-ring plates shall be fasted through load bearing member with 3/8-inch stainless steel carriage bolts with stainless steel washers and a stainless steel Nylok nut. Lower anchoring connection points shall be tied into vertical load bearing members each 10 feet as well as into the chain at the end of the Y-skirt.

2.03 RESUSPENSION CONTROL MEASURES

A. Resuspension control measures of sufficient size and quantity shall be made available by the RA Contractor as a contingency in the event sediment resuspension controls fail to meet performance standards.

2.04 OIL BOOMS

A. Oil booms of sufficient size and quantity, shall be available by the RA Contractor as a contingency measure for maintaining environmental quality. The booms will be stored in such a manner that they may be deployed on a moment's notice.

PART 3 EXECUTION

3.01 OPERATION

A. Best management practices will be implemented during construction activities to minimize sediment resuspension.

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B. Sediment resuspension controls and contingency measures will not alter the regular flow through the river channel that could result in erosion of sea walls/embankments, scour of riverbed, scour of bridge abutments, or other deteriorating effect on structures or facilities in the vicinity of the project area.

3.02 TURBIDITY CURTAINS

A. Work may not be performed without the use of turbidity curtains.

B. During in-water construction activities, if the water quality exceedances are a pervasive problem, the RA Contractor may be required to revise operations to include turbidity curtains, as directed by Owner.

C. RA Contractor will maintain the turbidity curtain/boom systems and associated markings/lighting in good and effective operating condition by performing daily inspections to determine condition and effectiveness, by repairing resuspension control materials, and by other protective measures.

3.03 CORRELATION DEVELOPMENT

A. For 5 consecutive days after in-water activities start, RA Contractor will simultaneously measure real-time in-water turbidity and collect water samples and have them analyzed for TSS in order to develop a correlation between the two parameters. The paired turbidity meter monitoring reading and the water sample collected for laboratory analysis will be collected at 10 locations each day, the first location upstream of the project area to represent background, the second location close to the project area, and the remainder at locations at intervals 100 feet downstream of the proceeding location, so the furthest downstream location is 800 feet downstream from the project area.

B. RA Contractor will use a statistical analysis to develop the correlation.

C. RA Contractor will provide all data collected as part of this correlation development to Owner.

3.04 WATER QUALITY REQUIREMENTS

A. Monitor turbidity with real time monitoring equipment and report results with Daily Report. RA Contractor to conduct weekly calibrations and provide to Owner for review.

B. Turbidity will not exceed a TSS concentration in accordance with SRD requirements and at one-half water column depth.

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C. In-water construction activities will be stopped if water quality criteria exceed established criteria at monitoring location. A revised Turbidity and Resuspension Management Plan will be submitted to address turbidity problems. No in-water construction activities will occur until revised plan has been reviewed and approved.

3.05 MONITORING

A. The RA Contractor will deploy a water quality monitoring devices in accordance with the SRD to measure real-time turbidity.

B. Locate the water quality monitoring devices in compliance with SRD requirements.

C. Turbidity readings will be collected and logged in accordance with the SRD..

D. Data from the upstream and downstream monitoring stations will be used to evaluate the water quality with respect to the performance monitoring standard.

E. RA Contractor will notify Owner if water quality criteria have been exceeded.

F. All RA Contractor water quality monitoring data will be provided to Owner.

3.06 EVALUATION OF EXCEEDANCE

A. Early alerts will be sent to notify the RA Contractor to investigate turbidity spikes. Formal regulatory notification, corrective measures, and additional monitoring will be implemented as required in the SRD.

B. If turbidity increases are not caused from project-related activities, Work will continue.

C. If the turbidity is elevated due to the project-related activities, RA Contractor will re-assess the effectiveness of the BMPs and take corrective measures to mitigate an SRD exceedance.

D. If Owner determines that project-related activities are responsible for a turbidity spike, work will stop until RA Contractor can demonstrate that corrective measures have been taken and turbidity levels are within the limits defined in the SRD.

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3.07 CORRECTIVE MEASURES

A. Corrective measures to minimize turbidity proposed by RA Contractor will be reviewed by the Owner. Authorization will be provided by Owner prior to implementation.

END OF SECTION

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SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Informational Submittals: Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.

1.04 DELIVERY, STORAGE, AND HANDLING

A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60.

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2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Centralizers: Plastic.

1. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify EPA when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

3.02 INSTALLATION

A. Splicing:

1. Minimum length of lap splices shall comply with ACI 318-19.
2. Use lap splices, unless otherwise shown or permitted in writing by EPA.

B. Unless permitted by EPA, do not cut reinforcing bars in field.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance: As required in Section 01 45 16.13 RA Contractor Quality Control.

B. RA Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, RA Contractor Quality Control.

END OF SECTION

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 305.1, Specification for Hot Weather Concreting.
   d. 306.1, Standard Specification for Cold Weather Concreting.
   e. 308R, Guide to External Curing of Concrete
   f. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   g. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
2. ASTM International (ASTM):
   a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   b. C33/C33M, Standard Specification for Concrete Aggregates.
   c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   f. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   g. C150/C150M, Standard Specification for Portland Cement.
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
   j. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   k. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
   l. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

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m. C595/C595M, Standard Specification for Blended Hydraulic Cements.
n. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
o. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
p. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
q. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
r. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
s. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
t. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
u. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
v. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
w. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
x. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
y. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
z. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
cc. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
dd. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
ee. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

3. National Ready Mixed Concrete Association (NRMCA).

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1.02 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. RA Contractor's Licensed Design Engineer: Individual representing RA Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.

C. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

D. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

E. Hot Weather: As defined in ACI 305.1.

F. Hydraulic Structure: Liquid containment structure.

G. New Concrete: Less than 60 days old.

1.03 SUBMITTALS

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. Action Submittals:

1. Mix Designs:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer's Certificate of Compliance for the following:
      1) Portland cement.
      2) Fly ash.

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3) Slag cement.
4) Silica Fume.
5) Aggregates, including specified class designation for coarse aggregate.
6) Admixtures.
7) Concrete producer has verified compatibility of constituent materials in design mix.

d. Test Reports:
1) Cement: Chemical analysis report.
2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
3) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

e. Aggregates:
1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
3) Combined gradation for coarse and fine aggregates. List gradings and percent passing through each sieve**.**
4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
6) Test Reports:
a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.

f. Admixtures:
1) Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.

2. Product Data: Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
c. Methods for temperature protection during placement.

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d. Types of covering, insulation, housing, or heating to be provided.
e. Curing methods to be used during and following protection period.
f. Use of strength accelerating admixtures.
g. Methods for verification of in-place strength.
h. Procedures for measuring and recording concrete temperatures.
i. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
5. Owner-selected portion of as-cast surface on one Test Pile with S-1 finish, as specified below in Concrete Finishes.
6. Concrete repair techniques, as needed.

C. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent, if needed.
3. Manufacturer's Certificate of Compliance to specified standards:
   a. Bonding agent, if needed.
   b. Repair materials, if needed.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Field test reports.
6. Recorded temperature data from concrete placement where specified.
7. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.

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c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.04 QUALITY ASSURANCE

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.

C. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is RA Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   a. Where field testing is required of RA Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Test Pile:

1. Finish concrete in accordance with finish Type S-1.
2. Before beginning concrete work for piles, construct initial test pile (to be included in Work) with specified materials, forming systems, reinforcing details, and leakage prevention techniques.
3. The initial pile shall be approved by Owner before continuing concrete work on subsequent piles.
4. Approved pile shall establish standards of quality by which Work will be judged.

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5. Use Owner-selected portion of as-cast surface to develop and test patching techniques and mixes, as needed.
    a. Obtain Owner approval prior to using material to repair project structures.
    b. Demonstrate application, curing, and finishing procedures of repair material.
    c. Approved repairs shall establish standards of quality by which Work will be judged.

E. Preinstallation Conference:

1. Required Meeting Attendees:
    a. RA Contractor, including pumping, placing and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Testing and sampling personnel.
    e. Engineer who authored Statement of Special Inspection Plan or Engineer's designee.
    f. Owner.
    g. Owner's Representative.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Owner of location and time.
3. Agenda shall include:
    a. Admixture types, dosage, performance, and redosing at Site.
    b. Mix designs, test of mixes, and Submittals.
    c. Placement methods, techniques, equipment, consolidation, and form pressures.
    d. Slump and placement time to maintain slump.
    e. Finish, curing, and water retention.
    f. Protection procedures for weather conditions.
    g. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cementitious Materials:

1. Cement:
    a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.

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b. Blended Hydraulic Cement:
   1) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
   2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
c. Furnish from one source.

2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan): Class F and Class Cfly ash in accordance with ASTM C618, except as modified herein:
      1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials**.**
      2) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
      1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
   c. Silica Fume: ASTM C1240.

B. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.

1. Normal-Weight Aggregates:
   a. In accordance with ASTM C33/C33M, except as modified herein.
      1) Class Designation: 4Sunless otherwise specified.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Alkali Silica Reactivity: See Article Concrete Mix Design.
2. Fine Aggregates:
   a. Clean, sharp, natural sand.
   b. ASTM C33/C33M.
   c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
      1) Limit material finer than 75-µm (No. 200) sieve to 3 percent mass of total sample.
      2) Limit coal and lignite to 0.5 percent.
3. Coarse Aggregate:
   a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

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C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.

1. Characteristics:
   a. Compatible with other constituents in mix.
   b. Contain at most, only trace amount chlorides in solution.
   c. Do not use admixtures known to be toxic after concrete is 30 days.
   d. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
2. Air-Entraining Admixture: ASTM C260/C260M.
3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
   a. Manufacturers and Products:
      1) BASF Admixtures Inc., Shakopee, MN; Pozzolith Series or PolyHeed Series.
      2) Euclid Chemical Co., Cleveland, OH; Eucon Series.
      3) W. R. Grace & Co., Cambridge, MA; Daracem Series or Mira Series.
4. Retarding Admixture: ASTM C 494/C 494M, Type B.
5. Accelerating Admixture: ASTM C 494/C 494M, Type C.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
   a. Manufacturers and Products:
      1) BASF Admixtures Inc., Shakopee, MN; Glenium Series, PS 1460, or Rheobuild 1000.
      2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
      3) W. R. Grace & Co., Cambridge, MA; ADVA Series, Daracem Series, or EXP 950.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
8. Corrosion Inhibiting Admixtures: ASTM C1582/C1582M.
9. Shrinkage Reducing Admixture:
   a. Manufacturers and Products:
      1) BASF Admixtures Inc., Shakopee, MN; Tetraguard AS20.
      2) Euclid Chemical Co., Cleveland, OH; Eucon SRA Series.
      3) W. R. Grace & Co., Cambridge, MA; Eclipse Series.
10. Antiwashout Admixture for Tremie Concrete:
    a. Specially developed to prevent cement washout of concrete placed under water.]
    b. Manufacturer and Product: BASF Admixtures Inc., Shakopee, MN; Rheomac UW 450.
11. Color Pigment: ASTM C979/C979M, inert, synthetic mineral or metaloxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
    a. Color: As indicated by manufacturer's designation.
12. Do not use calcium chloride as an admixture.

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D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.

1. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
   a. Chloride Content: 500 ppm.
   b. Sulfate Content as SO_4: 3,000 ppm.
   c. Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
   d. Total Solids by Mass: Less than 50,000 ppm.

2.02 ANCILLARY MATERIALS

A. Bonding Agent: Unless otherwise specified, in accordance with the following:

1. ASTM C881/C881M, Type V.
2. Two-component, moisture insensitive, 100 percent solids epoxy.
3. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
4. Manufacturers and Products:
   a. BASF Building Systems Inc., Shakopee, MN; Concresive Standard LVI.
   b. Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
   c. Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
   d. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products:
   a. BASF Building Systems Inc., Shakopee, MN; EMACO S-Series products.
   b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop-Series.

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2.03 CONCRETE MIX DESIGN

A. General:

1. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.
2. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
3. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
4. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
5. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
6. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.
7. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
8. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
9. Unless otherwise specified, desired fresh properties of concrete shall be determined by RA Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of RA Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of RA Contract Documents.
10. RA Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials, aggregate packing, and self-consolidating concrete.
11. Color Pigment: Where required in Supplement, add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with approved mockup.

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B. Potential alkali-aggregate reactivity of concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.
   a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.
   b. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.
   c. Use low-alkali cement or incorporate pozzolans into concrete mixture as necessary to satisfy testing for potential alkali reactivity.

C. Proportions:

1. Design mix to meet aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Slump Range at Site:

1. Unless otherwise permitted, target slump value is 4 to 6 inches at point of delivery, for concrete without high-range, water reducing admixture.
2. Design mixes that include a high-range, water-reducing or a plasticizing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
3. Slump tolerance shall meet requirements of ACI 117.

E. Combined Aggregate Gradation:

1. Combined Gradation Limits: Limits shown are for coarse aggregates and fine aggregates mixed together (combined).

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Sieve Sizes	3/4" Max.
2"	-
1-1/2"	-
1"	100
3/4"	92 - 100
1/2"	68 - 86
3/8"	57 - 74
No. 4	38 - 57
No. 8	28 - 46
No. 16	20 - 36
No. 30	14 - 25
No. 50	5 - 14
No. 100	0 - 5
No. 200	0 - 2

2.04 CONCRETE MIXING

A. General: In accordance with ACI 301, except as modified herein.

B. Truck Mixers:

1. For every truck, test slump of samples taken per ASTM C94/C94M, paragraph 12.5.1.
2. Where specified slump is more than 6 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.05 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Owner shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

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PART 3 EXECUTION

3.01 PLACING CONCRETE

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. Preparation: Meet requirements ACI 301, except as modified herein.

C. Inspection: Notify Owner and Special Inspector at least 1 full working day in advance before starting to place concrete.

D. Placement into Formwork:

1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
3. Use placement devices, for example chutes, pouring spouts, and pumps to prevent segregation.
4. Vertical Free Fall Drop to Final Placement:
   a. Forms 8 Inches or Less Wide: 5 feet.
   b. Forms Wider than 8 Inches: 8 feet, except as specified.
5. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
   a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
6. Do not use aluminum conveying devices.
7. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
8. Cure concrete in accordance with in ACI 308R, Guide to External Curing of Concrete.

E. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
   a. Approved by Owner.

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b. Wipe clean with device that does not allow mortar to adhere to belt.
c. Cover conveyor belts and chutes.

F. Retempering: Not permitted for concrete where cement has partially hydrated.

G. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

H. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Vibrate concrete in vicinity of joints to obtain impervious concrete.

I. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   a. Maintain concrete temperature below 90 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: In accordance with ACI 308R, Guide to External Curing of Concrete.

J. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
   a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.

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b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Owner.
c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
f. Cure concrete in accordance with ACI 308R, Guide to External Curing of Concrete..
1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 4,000 psi or design compressive strength if less than 4,000 psi.

2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
4. Maintain curing conditions in accordance with ACI 308R, Guide to External Curing of Concrete.

K. Finish: Provide Type S-1 concrete surface finish as described in Article Concrete Finishes.

3.02 PLACING TREMIE CONCRETE SEALS

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. Place concrete when water level inside area to be filled with concrete is equal to groundwater elevation outside.

C. Maintain relation of water levels until concrete design strength is obtained.

3.03 REPAIRING CONCRETE

A. General:

1. Repair defective areas of concrete.

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2. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Owner prior to use.
3. Develop repair techniques with material manufacturer on Owner-approved surface of Work, or on mockup panel prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Owner.
4. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
5. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Owner.

B. Exposed Metal Objects:

1. Remove metal objects not intended to be exposed in as built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair area of chipped out concrete as specified for defective areas.

C. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.04 CONCRETE FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish concrete surface in accordance with specified concrete surface finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete in accordance with ACI 308R, Guide to External Curing of Concrete.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.

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3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
5. Provide light steel-troweled finish (two trowelings) at air-entrained concrete. Provide hard steel-troweled finish (ringing sound from the trowel) for non air-entrained concrete.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
   a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
   b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots on surface.
   c. Do first steel troweling for S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish concrete to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-5 (Broomed Finish): Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.

3.05 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.06 FIELD QUALITY CONTROL

A. General:

1. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

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2. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
3. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
4. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
    a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
5. Evaluation will be in accordance with ACI 301 and Specifications.
6. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
7. Frequency of testing may be changed at discretion of Owner.
8. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
9. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of RA Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of RA Contract Documents. Concrete that has failed to meet requirements of RA Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Owner.

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C. High-Range, Water-Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on Project.

1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

D. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal or for prestressing.

3.07 MANUFACTURER'S SERVICES

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
   a. Observe how concrete mixes are performing.
   b. Be present during first placement of each type of concrete mix.
   c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   d. Establish control limits on concrete mix designs.

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e. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.

2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.08 PROTECTION OF INSTALLED WORK

A. Meet requirements specified in Section 31 63 29, Drilled Concrete Piers.

B. After curing as specified, and in accordance with ACI 308R, Guide to External Curing of Concrete, and after applying final finish, cover concrete surface with plywood or particle board or plastic sheeting or other material to keep clean and protect it from material and damage as a result of other construction work.

C. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.09 SCHEDULE OF CONCRETE FINISHES

A. Tolerances: As specified in Section 31 63 29, Drilled Concrete Piers.

B. Unless otherwise permitted, provide S-1 concrete finish.

3.10 SUPPLEMENTS

A. Requirements of concrete mix designs following "End of Section," are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4500F2S1P1C1.
2. Concrete Mix Design, Class TC00F0S1P1C1.

END OF SECTION

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CONCRETE MIX DESIGN, CLASS 4500F2S1P1C1

A. Mix Locations: Where specified in RA Contract Documents.

B. Exposure Categories and Classifications: F2S1P1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days and 4,500 psi at 56 days.
   a. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.

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b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
   1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Regardless of assigned C Exposure Class, for prestressed and post-tensioned concrete: 0.06 percent.
   b. Limits are stated in terms of chloride ions in percent by weight of cement.
   c. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

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CONCRETE MIX DESIGN, CLASS TC00F0S1P1C1

A. Mix Locations: Tremie concrete.

B. Exposure Categories and Classifications: F0S1P1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days and 4,500 psi at 56 days.
3. Use natural round gravel.
4. Fine Aggregate Range: 40 percent to 50 percent of total aggregates by weight.
5. There are no restrictions on air content.
6. Proportion mix for design strength and slump range of 6 inches to 9 inches with maximum water-cement ratio.
7. Use high-range, water-reducing admixture or plasticizing admixture.
8. Use anti-washout admixture in accordance with manufacturer's recommendations.
9. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
   c. ASTM C595/C595M Type IP or Type IS (less than70), tested to comply with moderate sulfate resistance option (MS).
      1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
10. Unless otherwise permitted, minimum cementitious materials content in mix design shall be 600 pounds per cubic yard.
11. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
    a. Regardless of assigned C Exposure Class, for prestressed and post-tensioned concrete: 0.06 percent.

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b. Limits are stated in terms of chloride ions in percent by weight of cement.
c. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

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SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

A. Obtain Owner's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 1 acre.

B. The USFWS-provided official species list, dated August 21, 2023 and provided in Supplement 1 identifies any Federally threatened, endangered, proposed and candidate species that may occur within the boundary of the

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project or may be affected by the project. This species list expires after 90 days. The time frames and Conservation Measures (CMs) listed herein reflect those current on August 21, 2023 and provided in the August 21, 2023 Verification letter provided by USFWS in response to an official query for the Project through the USFWS' Information for Planning and Conservation (IPaC) system (Supplement 1). A new or updated IPaC consultation will be required for any Project activities that occur after Sunday, November 19, 2023. Current time frames and CMs related to species with potential to be affected by the project are described below.

C. Clearing and grubbing are to be performed on or between August 16 and March 14. If any clearing and grubbing must be performed outside these dates (i.e., on or between March 15 and August 15, obtain approval from the Owner, and consult with USFWS regarding the potential presence of protected species, including bats and migratory birds. Based on a June 21, 2023 general habitat assessment, potential roost trees for bat species and potential habitat for breeding migratory birds are present along the banks of the Pine River. Prior to any ground disturbing activities or removal of any trees or shrubs on or between March 15 and August 15, obtain approval from the Owner and inspect for bird nests. Complete Supplement 2 – Migratory Bird Field Assessment Checklist and Supplement 3 – Velsicol Nest Protocol, and follow USFWS Nationwide Standard Conservation Measures guidance (https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf). The inspection shall be performed during the Preconstruction Conference and again within 24 hours prior to clearing in consultation with the Owner. If bird nests are found in areas to be disturbed, the nests shall be inspected for the presence of eggs or hatchlings. Written documentation of the inspection shall be provided to the Owner. If eggs or hatchlings are present, do not disturb the nest; halt the clearing and consult with the Owner and the Lansing Field Office of the USFWS to ensure compliance with the Migratory Bird Treaty Act.

D. The Project is within the known range of the eastern massasaugas (=rattlesnake) (EMR). EMR are found in a variety of habitats including wet areas such as wet prairies, marshes and low-lying areas along rivers and lakes. USFWS provides guidance for projects "within the known range" of EMR (Supplement 3). To ensure the Project will not affect EMR, the following Conservation Measures (CMs) will be incorporated:

1. Use wildlife-safe materials for erosion control and site restoration. Eliminate the use of erosion control products containing plastic mesh netting or other similar material that could entangle EMR. Several products for soil erosion and control exist that do not contain plastic netting including net-less erosion control blankets (for example, made

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of excelsior), loose mulch, hydraulic mulch, soil binders, unreinforced silt fences, and straw bales. Others are made from natural fibers (such as jute) and loosely woven together in a manner that allows wildlife to wiggle free.

2. Increase human safety and awareness of EMR. Those implementing the project must first review the EMR factsheet (available at https://www.fws.gov/media/eastern-massasaugarattlesnake-fact-sheet), and watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://www.youtube.com/watch?v=-PFnXe_e02w).
3. Require reporting of any EMR observations, or observation of any other listed threatened or endangered species, during project implementation to USFWS within 24 hours.
4. Ensure that the project does not result in permanent loss of more than one acre of wetland or conversion of more than 10 acres of EMR upland habitat (uplands associated with high quality wetland habitat) to other land uses.
5. Ensure that the project will not include temporary or permanent lighting of roadway(s), facility(ies), and/or parking lot(s).

   If these CMs cannot be followed, the RA Contractor is required to consult with USFWS to evaluate potential impacts, determine and develop appropriate avoidance/mitigation measures and ensure that these measures are implemented.

E. Best management practice (BMP) recommendations for monarch butterfly (*Danaus plexippus*) and other pollinators should be incorporated to the extent possible. These include: planting a diverse group of native plant species and wildflowers; leaving some areas unmowed or minimizing the impacts from mowing (e.g., decreasing frequency, increasing vegetation height) in spring and summer and leaving areas unraked and leave stems standing in the fall; and, avoiding or limiting pesticide use.

F. Potential habitat for bald eagle (*Haliaeetus leucocephalas*) is present in the general project area particularly in the wooded riparian areas downstream along the Pine River. If the Project may impact bald or golden eagles, additional coordination with the USFWS under the Bald and Golden Eagle Protection Act may be required.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for construction activities within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

C. Ensure that stormwater runoff control is installed and erosion and sediment controls are in place according to the SESC Plan and best management practices prior to clearing or grubbing. Stormwater runoff controls will, at a minimum, prevent migration to storm sewers, street gutters, streets, and sidewalks, where applicable.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation 10 feet beyond top of cut slopes.
2. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping 2 feet beyond toe of permanent fill.
3. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat finished appearance.
4. Roadways: Clearing and stripping 10 feet from roadway shoulders**.**

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

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E. Conduct the clearing in a manner that prevents, to the extent possible, soil or soil- like material from being collected with the cleared material.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 STRIPPING

A. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

B. Stockpile strippings, meeting requirements of Section 32 91 13, Soil Preparation, for topsoil, separately from other excavated material.

3.06 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite at an appropriate disposal facility as approved by the Owner.
2. Burning of debris onsite will not be allowed.
3. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite at an appropriate disposal facility as approved by the Owner.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified.

3.07 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

1. Supplement 1: August 21, 2023 IPaC Species List and Verification Letter
2. Supplement 2: Migratory Bird Field Assessment Checklist.
3. Supplement 3: Velsicol Nest Protocol.

END OF SECTION

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U.S. Fish & Wildlife Service

IPaC Project Design Guidelines

Eastern Massasauga (=rattlesnake)

Generated June 26, 2018 09:53 AM MDT, IPaC vunspecified

IPaC - Information for Planning and Consultation (https://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish and Wildlife Service environmental review process.

Environmental Screening for Eastern Massasauga Rattlesnake in Michigan

March 14, 2017

Background

The Eastern Massasauga Rattlesnake (EMR) is listed as a threatened species under the U.S. Endangered Species Act (Act). The Act protects the EMR and their habitat by prohibiting "take" and may require agencies to coordinate with the U.S. Fish and Wildlife Service (Service) before authorizing or funding an activity affecting the species. To streamline coordination, the Service's Michigan Ecological Services Field Office has developed a set of Best Management Practices (BMPs) for specific activities potentially impacting EMR in Michigan. These BMPs are voluntary and just one of the ways that compliance with the Act may be achieved.

Projects may…

- have no effect to EMR and no need for additional ESA compliance considerations.
- have potential for adverse effects, but use BMPs to avoid adverse effects (i.e., "not likely to adversely affect" EMR) or minimize the adverse effects.
- use surveys to confirm probable absence of EMR (contact the Service for survey guidance).
- use "Informal Consultation" with Service (for actions requiring a Federal permit or funding).
- use "Formal Consultation" with Service (for actions requiring a Federal permit or funding).
- develop a Habitat Conservation Plan and seek an ESA permit, if adverse effects cannot be avoided.

For activities not listed in the BMPs, please contact the Service for project-specific recommendations. In some cases implementation of BMPs may not be sufficient to avoid all adverse impacts to EMR and additional consultation with the Service may be required. The Service can assist planners in determining whether adverse effects are likely as a result of proposed projects, and whether implementation of BMPs is sufficient to remove the risk of adverse effects.

Additional information on compliance with the Act can be found:

For Federal actions/section 7 consultation:
https://www.fws.gov/midwest/Endangered/section7/s7process/index.html

For non-Federal actions:
https://www.fws.gov/midwest/endangered/permits/index.html

For questions or comments you may contact the Service below:

U.S. Fish and Wildlife Service
Michigan Ecological Services Field Office
2651 Coolidge Road, Suite 101
East Lansing, MI 48823
Phone: (517)351-2555
Email: eastlansing@fws.gov

Definitions

Active Season: The active season begins in the spring when snakes emerge from hibernation, generally when maximum air temperatures are above 50°F, and ends in the fall when EMR have returned to their hibernacula and temperatures are consistently below 45°F. In Michigan, the active season is generally April through October. The active season dates will vary by location and weather. **Contact the Service for project-specific dates based on location when work in EMR habitat is planned near the start or end of the active season**.

Affecting hydrology: We consider "affecting hydrology" to include projects that are likely to appreciably change the elevations of surface water upstream or downstream, or in the local ground water (as estimated pre-project vs. post-project). The concern is for changes to local hydrology (e.g., creating new ditches, creating a new impoundment) that might harm EMR hibernating at or near ground water, or actions that significantly alter available suitable habitat either through flooding or drying of EMR wetlands.

Hibernacula: Areas suitable for EMR to overwinter. For most EMR populations, the locations of hibernacula are not known, but these areas are critical to protect. Unfortunately, we lack information on how to reliably identify these areas. EMR usually hibernate below the frost line in crayfish or small mammal burrows, tree root networks or rock cervices in or along the edge of wetlands or in adjacent upland areas with presumably high water tables (areas where the soil is saturated but not inundated). Following egress from hibernacula in the spring, EMR typically remain aboveground in the vicinity for a week or two, and return to these areas in the fall for several weeks prior to entering hibernation. Surveys in the spring (shorting following egress) or fall (prior to ingress) when snakes are congregating in the vicinity may help identify these important areas. Maintaining stable hydrology of these areas is important during the inactive season.

IPaC: "Information for Planning and Conservation" is a project planning tool available on-line to the public that streamlines the Service's environmental review process.

EMR Habitat: "Eastern Massasaugas have been found in a variety of wetland habitats. Populations in southern Michigan are typically associated with open wetlands, particularly prairie fens, while those in northern Michigan are known from open wetlands and lowland coniferous forests, such as cedar swamps. Some populations of Eastern Massasaugas also utilize open uplands and/or forest openings for foraging, basking, gestation and parturition (i.e., giving birth to young). Massasauga habitats generally appear to be characterized by the following: (1) open, sunny areas intermixed with shaded areas, presumably for thermoregulation; (2) presence of the water table near the surface for hibernation; and (3) variable elevations between adjoining lowland and upland habitats." From Michigan Natural Features Inventory (Website: mnfi.anr.msu.edu)

Tier 1 Habitat: Areas known to be occupied by EMR or highly likely to be occupied by EMR.

Tier 2 Habitat: Areas with high potential habitat and may be occupied by EMR.

Within the known range: EMR can occur throughout the Lower Peninsula and on Bois Blanc Island in Mackinac County. Areas within the known range but outside of Tier 1 and Tier 2 are considered less likely to be occupied. EMR is highly secretive and cryptic in nature, and can persist in low densities, which makes them difficult to detect. Further, there are extensive areas of the state that have never been surveyed. It is likely that there are additional and yet-unknown occurrences throughout the Lower Peninsula of Michigan. Mapped habitats are subject to change based on new information identifying current Tier 1 and 2 areas as unsuitable, or based on discovery of new EMR occurrences.

EMR Environmental Screening Step-wise Process

Step 1. Determine if EMR may be present in the action area

- ✓ Determine whether the project is in potential EMR habitat using https://ecos.fws.gov/ipac
  - You can search for your project location and define the action area by drawing a polygon or uploading a shapefile.
  - IPaC will give you a list of species that may be present in the area you identified. If you click on the thumbnail for EMR, it will tell you if your project is within Tier 1 or Tier 2 habitat, or within the known range of EMR. If EMR is not listed, you do not need to consider this species. Effects to other listed species should also be considered; contact the Service if you need assistance.
  - If EMR is listed, it does not necessarily mean that the entire action area is potential habitat, only that some potential habitat is within the action area entered. For large-scale (e.g., county-wide or multi-county projects) consider coordinating the Michigan Ecological Services Field Office for direct assistance.

If your project is within the known range of EMR, including Tier 1 or Tier 2 habitat, continue to step 2:

Step 2. Determine if the project has the potential to affect EMR

Projects have no effect on EMR when…

- ✓ There is no suitable EMR habitat in the project area and no potential impact off-site (e.g., water discharge into adjacent EMR habitat). If project site conditions are determined to be wholly unsuitable for EMR (e.g., project is in regularly mowed turf grass, row crop, graveled lot, existing building, or industrial site), it is not suitable EMR habitat.
- ✓ The project occurs within suitable habitat, but the action will have absolutely no effect on the habitat or EMR.
- ✓ In suitable EMR habitat, but the site is entirely unoccupied by the species. This is typically confirmed through surveys (contact the Service for more information). In some cases it may be easier to assume EMR are present and use BMPs than to conduct surveys for the species.

For projects where there is a potential for effects to EMR, continue to the section of the document as follows:

For Tier 1 Habitat ..... Page 5

For Tier 2 Habitat ..... Page 6

Within the range of EMR ..... Page 7

For projects with a combination of Tier 1 and Tier 2 habitat, follow the instructions for Tier 1.

Tier 1 Habitat

Tier 1: Project will not affect EMR if all of the following apply:

1. Project will not result in any changes to suitable EMR habitat quality, quantity, availability or distribution, including changes to local hydrology
2. If EMR are present in the project area, they are not likely to have any response as a result of exposure to the action or any environmental changes as a result of the action
3. Project includes all General Best Management Practices:
   a. Use wildlife-safe materials for erosion control and site restoration (see Erosion Control Resources side panel). In Tier 1 habitat, immediately eliminate use of erosion control products containing plastic mesh netting or other similar material that could entangle EMR.
   b. To increase human safety and awareness of EMR, those implementing the project should first watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://youtu.be/-PFnXe_e02w), or review the EMR factsheet (available at https://www.fws.gov/midwest/endangered/reptiles/eama/pdf/EMRfactsheetSept2016.pdf or by calling 517-351-2555.
   c. Require reporting of any EMR observations, or observation of any other listed threatened or endangered species, during project implementation to the Service within 24 hours.

Tier 1: Project Not Affecting EMR Coordination Recommendation: No pre-project coordination with Service needed. Document the steps above for your records.

Tier 1: All Other Projects: For any other projects in Tier 1 habitat that may affect EMR or its habitat, contact the Service for assistance in evaluating potential impacts. Best Management Practices (starting on page 8) are included for many actions to help with project planning, but may not be sufficient to avoid all adverse impacts. The Service can determine whether additional measures are necessary after a project-specific review.

Erosion Control Resources

There are a variety of products that can be used for soil erosion and control requirements. These products may incorporate plastic mesh netting to help maintain form and function. This plastic netting has been demonstrated to entangle a wide variety of wildlife from birds to small mammals. In Michigan, soil erosion control netting has resulted in the documented mortality of a number of imperiled amphibian and reptile species including the EMR and the Eastern Fox Snake (State Threatened).

Several products for soil erosion and control exist that do not contain plastic netting including net-less erosion control blankets (for example, made of excelsior), loose mulch, hydraulic mulch, soil binders, unreinforced silt fences, and straw bales. Others are made from natural fibers (such as jute) and loosely woven together in a manner that allows wildlife to wiggle free. For more information regarding wildlife-safe erosion control measures contact the USFWS Michigan Ecological Services Field Office.

Tier 2 Habitat

Tier 2: Project is not likely to adversely affect EMR if all of the following apply:

1. Project does not impact more than 1 acre of wetland habitat and includes all applicable activity-specific BMPs (starting on page 8), and
2. Project will not appreciably affect hydrology
3. Project includes all General Best Management Practices:
    a. Use wildlife-safe materials for erosion control and site restoration (See Erosion Control Resources side panel, page 4). In Tier 2 habitat, eliminate the use of erosion control products containing plastic mesh netting or other similar material that could ensnare EMR as soon as is feasible but no later than January 1, 2018.
    b. To increase human safety and awareness of EMR, those implementing the project should first watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://youtu.be/-PFnXe_e02w), or review the EMR factsheet (available at https://www.fws.gov/midwest/endangered/reptiles/eama/pdf/EMRfactsheetSept2016.pdf or by calling 517-351-2555.
    c. Require reporting of any EMR observations, or observation of any other listed threatened or endangered species, during project implementation to the Service within 24 hours.

Tier 2: Project Not Likely to Adversely Affect EMR Coordination Recommendation: Informal consultation with Service for actions requiring a Federal permit or funding. For non-Federal projects, document the steps above for your records, but no pre-project coordination with the Service needed.

Tier 2: All Other Projects: Coordinate with the Service for a project-level review to determine potential impacts and whether additional conservation measures are needed to avoid adverse effects.

Within the known range of EMR

For projects within the known range of EMR, but outside of Tier 1 and Tier 2 habitat:

To help ensure your project is unlikely to affect EMR:

1. Project applies the General Best Management Practices:
    a. Use wildlife-safe materials for erosion control and site restoration (See Erosion Control Resources side panel, page 4). By January 1, 2019, eliminate the use of erosion control products containing plastic mesh netting or other similar material that could ensnare EMR (within the known range but outside of Tier1 or Tier 2 habitat).
    b. To increase human safety and awareness of EMR, those implementing the project should first watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://youtu.be/-PFnXe_e02w), or review the EMR factsheet (available at https://www.fws.gov/midwest/endangered/reptiles/eama/pdf/EMRfactsheetSept2016.pdf or by calling 517-351-2555.
    c. Require reporting of any EMR observations, or observation of any other listed threatened or endangered species, during project implementation to the Service within 24 hours.
2. Project will not have significant impacts to dispersal, connectivity, or hydrology of existing EMR potential habitat, i.e., filling less than 1 acre of wetland habitat or converting less than 20 acres of uplands of potential EMR habitat (uplands associated with high quality wetland habitat) to other land uses.

Within the Known Range, but Outside Tier 1 or 2 Coordination Recommendation:
Document the steps above for your records and no pre-project coordination with the Service needed. If you cannot implement the General Best Management Practices contact the Service for assistance in evaluating potential impacts.

Activity-Specific Best Management Practices

For Tier 1, BMPs are included; however, even with implementation of the BMPs, project-specific review may be needed to determine whether they are sufficient to avoid all adverse impacts

- In Tier 1 habitat, contact the Service regarding the potential applicability of surveys to determine EMR absence in suitable habitat. In Tier 2, surveys can be conducted to confirm the presence of suitable habitat and/or the presence/probable absence of EMR. If onsite habitat is determined to be wholly unsuitable via desktop analysis (e.g., entirely mowed lawn, row crop, graveled lot, and industrial site), then it can be classified as unoccupied and the BMPs will not be necessary.
- Minimize work in Tier 1 and Tier 2 EMR habitat. When feasible, do not route new construction projects, such as pipelines, facilities, or access roads, through potential EMR habitat. Implement the use of wildlife-friendly corridors (e.g., oversized culverts) into new road design to maintain or enhance habitat connectivity.
- Projects should be designed to minimize the potential for disturbance to EMR during project activities.

Maintenance Activities (includes nominal modifications to existing roads and infrastructure)

1. Ground Disturbing Activities
    a. All
        i. No known EMR hibernacula are destroyed or disturbed at any time of year. Because these areas are often not known:
            1. For Tier 1: contact the Service to determine whether adverse impacts are likely as a result of ground disturbing work in Tier 1 habitat.
            2. For Tier 2: when operating in potential hibernation areas (e.g., EMR wetlands and adjacent areas with crayfish burrows, rodent holes, small mammal burrows, etc.), work is conducted well within the active season (June – August) to avoid when snakes are likely to be present. During this time, they are most likely to be able to move out of the way of disturbance and have greater chances to find alternative hibernation sites. Destroying potential hibernacula may still impact snakes indirectly. Potential hibernation areas should be avoided to the extent possible.
    b. Grading
        i. When working during EMR active season, use exclusionary fencing to separate EMR habitat from the work site to prevent EMR from accessing the disturbance area. For example, in linear projects exclusionary fencing should run parallel to the disturbance, creating a barrier to snake movement. Each end of the exclusionary fencing should be angled away from the area of disturbance to direct snakes traveling along fencing away from the site. The

exclusionary fencing will typically be traditional silt fence that is set up outside of all areas of disturbance and other types of fencing (i.e., snow fence used to delineate the work zone). Do not use fencing materials that can entangle or injure snakes.

ii. Any areas using exclusionary fencing should first be "cleared" by a qualified individual[1] before beginning construction activities. Fencing should be installed a minimum of 1 day before construction activities occur and walked weekly to ensure the integrity of the fence. If snakes are seen within the work zone, activity should stop until the snake can be safely moved, and the fence examined for breeches.

iii. Revegetate all disturbed Tier 1 and Tier 2 habitat with appropriate plant species (i.e., native species or other suitable non-invasive species present on site prior to disturbance). Monitor all restoration plantings for proper establishment and implement supplemental plantings as necessary to ensure restorations are of equal to or better habitat quality than previous conditions.

iv. In Tier 1 and Tier 2, avoid spread of invasive species into EMR habitat by following best practices. This includes inspecting and cleaning equipment and vehicles between work sites as needed to avoid the spread of invasive plant materials.

c. Trenching

i. In Tier 1 and Tier 2, avoid trenching in EMR wetlands when possible. In Tier 1, if open trenching is required install exclusionary fencing (follow measures 1(b)(i)-(iv)) and ensure the area is clear prior to trenching.

d. Fill

i. In Tier 1 and Tier 2, ensure all imported fill material is free from contaminants or invasive species could affect the species or habitat through acquisition of materials at an appropriate quarry or other such measures.

ii. In Tier 1 and Tier 2, use exclusionary fencing around the area to be filled and have the site "cleared" prior to placing fill by a qualified individual (as in 1(b)(i)-(ii).

e. Ditching

i. For Tier 1 and Tier 2, conduct work well within the active season (June-August) when snakes are not likely to be near hibernation sites and can escape disturbance, or contact Service for project specific recommendations.

ii. For Tier 1, use exclusionary fencing around the area to be cleared/graded and have the site cleared by a qualified individual prior to construction activities.

iii. For Tier 1, contact the Service for work greater than 200' for project specific recommendations.

[1] A qualified individual is someone who has received training on the identification and life history of EMR.

2. Site Access with vehicles (both Tiers)
    a. Limit operating vehicles/equipment, clearing trees, etc., in EMR habitat to the inactive season when the ground is frozen. During this time, under these conditions, EMR are most likely underground and will not be impacted by these activities. When possible, use low-impact equipment such as light weight track mounted vehicles with low ground pressure. In Tier 1, if the ground isn't completely frozen (due to weather conditions during the inactive season or if working near seeps and springs that are less likely to freeze), or if working near potential hibernacula, manual access (on foot) may be required.
    b. Strictly control and minimize vehicle activity in known/presumed occupied EMR habitat to the extent possible. During EMR active season, speed limits at facilities and access roads (i.e., 2-track and gravel) in occupied habitat should be <15 MPH.
    c. In Tier 1 and Tier 2 habitat areas, drivers should be aware of the potential danger to the driver of swerving to intentionally drive over snakes as well as legal and conservation implications.

3. Heavy Equipment (both Tiers)
    a. Spill Prevention for oils/fluids
        i. Site staging areas for equipment, fuel, materials, and personnel at least 100 feet from the waterway, if available, to reduce the potential for sediment and hazardous spills entering the waterway. If sufficient space is not available, a shorter distance can be used with additional control measures (e.g., redundant spill containment structures, on-site staging of spill containment/clean-up equipment and materials). If a reportable spill has impacted occupied habitat:
            1. Follow spill response plan;
            2. Call MDEQ and the National Response Center (800-424-8802), and the Service's Michigan Ecological Services Field Office (517-351-2555) to report the release.
    b. Do not use large equipment or perform earth-moving activities, water withdrawal and discharge for hydrostatic testing, or other activities that substantially affect the ground or water levels in potential EMR hibernacula areas. Avoidance measures may include, but are not limited to, re-routing of pipeline and appurtenance facilities, boring or drilling, and timing/weather-related restrictions. Measures will be determined on a site-specific basis, based on local habitat conditions, contact Service for more information.

4. Hydrology impacts (both Tiers)
        i. Water levels in known/presumed occupied habitats should not be artificially manipulated during the inactive season.

ii. Where applicable, water levels should be allowed to flow naturally and not be artificially stabilized. This allows for the restoration of early successional habitats.

Habitat Management and Restoration

5. Vegetation Management
   a. Mowing
      i. In Tier 1, mow during the inactive season.
      ii. For Tier 2, mowing is unrestricted during the inactive season. During the active season, follow daytime mowing restrictions and mow during times of day when snakes are less likely to be active (Figure 1). Increase mower deck height to >8 inches to reduce likelihood of injury to snakes. Higher deck height will reduce the risk of death or injury to snakes in the area.
      iii. In areas with turf grass or areas where trying to discourage EMR (e.g., in areas around buildings), mow regularly and keep grass relatively short (less than 4-6 inches) to reduce its suitability for EMR. If starting with longer grass (greater than 6 inches), mow during the inactive season initially, and then maintenance mowing can occur during the active season (as long as it is regularly maintained and kept shorter than 4-6 inches, so that EMR is unlikely to use those areas). Unmaintained/longer grass may be used by snakes and make them vulnerable to mortality during the next mowing event.

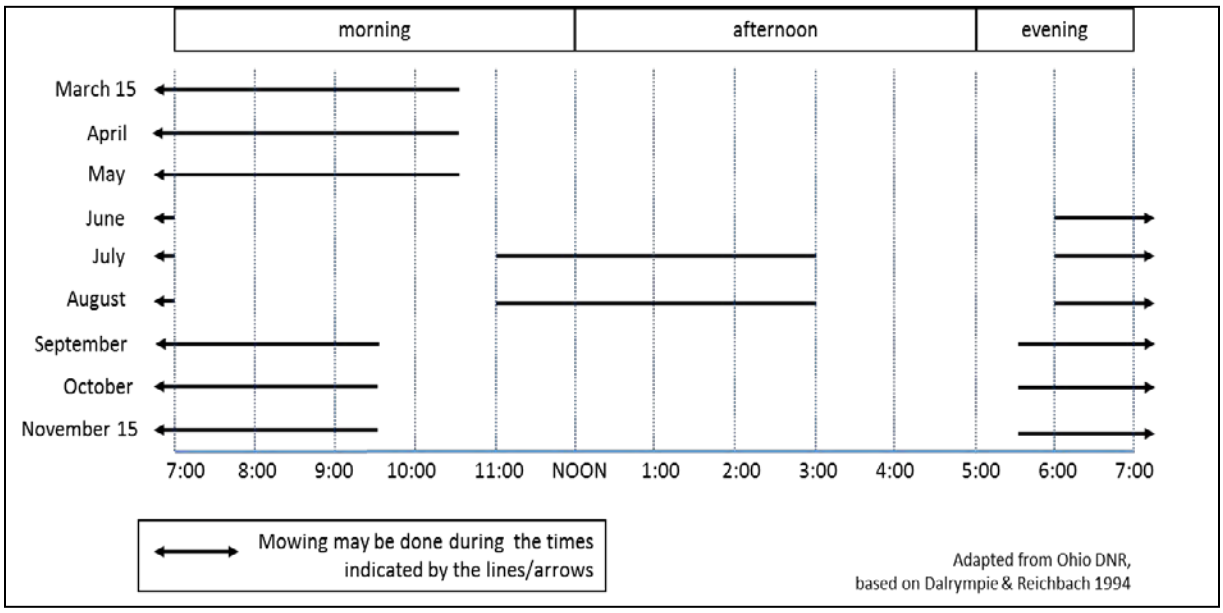

Figure 1. EMR Active season mowing schedule (NiSource Biological Opinion, page 273, USFWS 2015)

b. Cultivation (e.g., disking)
    i. In Tier 1 habitat, disking should be limited to the inactive season, and areas within 50 m of known or potential hibernacula should be avoided. In Tier 2, disking can occur in the active season if area is mowed during the inactive season and maintained shorter than 4-5 inches.
c. Brush/Tree Removal
    i. In Tier 1, conduct brush or tree removal in known/presumed EMR habitat during the inactive season, when the ground is frozen (such that soils can be left undisturbed).
    ii. Use low impact harvest methods in Tier 1 and Tier 2 wetlands to cut and remove individual trees. This includes using low-impact equipment such as light weight track mounted vehicles with low ground pressure. In Tier 1, if the ground isn't completely frozen (due to weather conditions during the inactive season or if working near seeps and springs that are less likely to freeze), or if working near potential hibernacula, use hand tools and access site on foot.
    iii. In Tier 1 and Tier 2, do not burn brush piles during the active season. Dispose of brush offsite or leave in place.
d. Herbicides
    i. Follow all appropriate label instructions regarding which herbicide formulation to use in potential EMR habitat. Avoid spray drift beyond the target species/area (observing label instructions regarding optimal wind speed and direction, boom height, droplet size calibration, precipitation forecast, etc.).
    ii. Avoid broadcast applications of herbicides in Tier 1. Spot spraying or wicking can be used to control invasive plants in occupied habitat. If using broadcast spray in Tier 2, limit the area of exposure to less than half of the available EMR habitat to allow for untreated areas to provide potential areas of refugia from exposure. Contact the Service if you need help in determining this.
e. Prescribed burning (Tier 1 and Tier 2)
    i. Conduct prescribed burns during the inactive season before snakes emerge from hibernation. Walk the burn unit following the burn and report any dead or injured EMR to the Service within 24 hours. Burn only a portion (e.g., one-third) of available EMR habitat in any year to leave suitable cover for EMR and its prey.
    ii. Establish fire breaks using existing fuel breaks (roads, rivers, trails, etc.) to the greatest extent possible. Cultivation (disking or roto-tilling) of burn breaks will be minimized to the extent that human health and safety are not jeopardized. Cultivation and mowing to establish fire breaks will occur during the inactive season.

6. Erosion control
    a. Use wildlife-safe erosion control blankets (without plastic mesh netting in the layers of material) as required in the general BMPs. Remove all silt fence used for erosion control once soils are stable to reduce barriers to EMR movement.
7. Revegetation
    a. Revegetate all disturbed Tier 1 and Tier 2 habitat with appropriate plant species (i.e., native species or other suitable non-invasive species present on site prior to disturbance). Monitor all restoration plantings for proper establishment and implement supplemental plantings as necessary to ensure restorations are of equal to or better habitat quality than previous conditions.
8. Invasive species
    a. In Tier 1 and Tier 2, avoid spread of invasive species into EMR habitat by following best practices. This includes inspecting and cleaning equipment and vehicles between work sites as needed to avoid the spread of invasive plant materials.
9. Wetland restoration
    a. Restoring natural hydrology in areas that have been drained by tiling and ditching may greatly benefit EMR habitat. Conduct tile breaking or excavation well within the active season to avoid potential hibernacula. Have a qualified individual walk in front of the equipment to clear the area. Work with the Service for Tier 1 habitat to ensure no indirect adverse effects are expected as a result of restoration efforts.
10. Water-level manipulation
    a. Water levels should not be artificially manipulated during the inactive season to avoid impacts to hibernating snakes. Contact the Service in Tier 1 habitat when water levels will be manipulated during the inactive season or will result in significant alterations to EMR habitat during the active season.

Construction Environmental Checklist

Pre-Work Migratory Bird Field Assessment
Velsicol Chemical Corporation Superfund Site, Former Plant Site

Date of Assessment:	
Site:	

It is illegal to violate the Migratory Bird Treaty Act, which is fully prosecutable with civil and criminal penalties.

Name of Person Conducting Assessment:	Company Name:	Time of Assessment:
Section of Property Being Assessed:	Area Marked on Figure? YES No	Planned Construction Activity:
Description of Vegetation Present:	Is vegetation to be removed? Yes or No	Is vegetation marked on construction documents? Y/N

The following checklist is to help the project protect migratory birds by surveying the area prior to beginning any construction, land clearing or vegetation removal work between March 15 and August 15 of each year for most species and varies by location (note bald eagles may nest year-round). Walk all areas prior to land disturbing activities, to identify whether any birds flush from the ground or trees when approached. If a bird flushes, look for a nest in that vicinity.

Live Species Observed?		# of Individuals Observed	Is it breeding here?		Behavior Observed	Habitat and Notes
Yes	No		Yes	No		

If a nest is present and not active (i.e., no eggs, no chicks, no adult birds, etc.), the nest may be removed as long as it will not result in the accidental death or injuring of a migratory bird or eggs. Nest removal helps to prevent migratory birds from nesting or returning to the area.

Nests Present?		Nest Location					Is Nest Active?		If No, has Nest been Removed?	
Yes	No	Tree	Shrub	Ground	Utility Pole	Other (specify)	Yes	No	Yes	No

If an active nest is present, the nest must be protected until the chicks fledge the nest (duration is dependent upon the species) *If found on-site, do not approach or harass the bird. Immediately call the Owner's Representative and establish a no-entry zone around the bird nest.*

Circle all the Protection Measures Implemented		
Work Activity Delayed	Area Marked and Roped Off	Fencing/Barrier installed
Vegetative Buffer Maintained	Field Disturbance in Area Minimized	Buffer Zone Established

Additional measures or actions taken: _____

Comments/Findings: _____

_____

If active bird nests are in or near the construction site, the following specific situations are those most likely to be encountered during construction

- Blown-down nest (after storm events): if the nest is relatively undamaged and the young birds or eggs are unharmed, replace the nest into the tree/shrub from which it fell or in a nearby tree/shrub. The parents should continue to attend to the nest. A badly damaged nest may be replaced into a strawberry basket or other appropriately sized basket before placement in a tree/shrub. Note: it is a common fallacy that birds reject their young if they have acquired a human scent. However, excessive handling should be avoided none-the-less.
- Grounded Baby Birds: Frequently, birds seen hopping on the ground begging for food do not require your assistance. It is common for birds to fledge from the nest before they are fully feathered or flight-ready. They will be fed on the ground for a day or two until they are able to fly, and then may fly with a parent until able to forage on their own. Usually, if the grounded bird is a healthy fledgling, you will see the parent attending it or foraging nearby. Careful observation should help you make a correct determination. If the bird is in the road, place it under a nearby bush. Never unnecessarily handle or move the fledgling from the area where it was found. Baby blue jays are slow to mature, so the fledgling stage will generally take longer for them.

  If the bird is tiny and not feathered, it is likely a 'nestling' that has fallen from its nest. If you can find the nest, put the nestling in the nest and avoid the area. If you cannot find the nest, line a small box with tissue and suspend from a branch or put it on the ground near where its nest is believed to be located and avoid the area.

If injured wildlife or bird is found, call the Owner's Representative. Also call District 6 of the Michigan Department of Natural Resources: Lt. Jeremy Payne, Phone: 989-684-9141, Bay City Operations Service Center, 3580 State Park Drive. Bay City, MI 48706. Email Lt. Payne in District 6 (paynej5@michigan.gov)
For all bird injuries or deaths during construction, contact the U.S. Fish and Wildlife Service, Michigan Ecological Services Field Office, (517) 351-2555, address 2651 Coolidge Road, Suite 101, East Lansing, MI 48823-6360

Draw a figure to identify area assessed and location of Any Active Nests

Velsicol Chemical Corporation Superfund Site, Former Plant Site Nest Clearing Protocol

The specifications will require that the construction manager retain a biologist with competency in migratory bird identification if trees or shrubs are being removed from March 15 to August 15. The following protocol and checklist will be in the project specifications:

Shrubs/Small Trees to be Removed by Excavator:

1. Approach and note if any birds leave the shrub/tree.
2. Examine the shrub/tree to determine if there are any nests present on branches or ground.
3. If a nest is present and has eggs or live young birds in it, take a photo without disturbing the nest, and call the Owner, who will consult with a biologist. Do not remove the nest or birds until directed by appropriate Owner's supervision.
4. If no nest is present or one is present and no eggs or live birds are in it then proceed to remove the shrub/tree.

Large Tree to be Removed by Cutting:

1. Approach and note if any birds leave the tree.
2. Move into first position for cutting and determine if there are any nests or cavities present .
3. If a nest or cavity is present, listen to determine if any live birds can be detected.
4. Take a picture of the nest and send it with any related field notes to the Project construction manager. Then attempt to visually determine if live mature or young birds or eggs are present. Use the nest guide to determine the type of bird.
5. Call the Owner. Do not remove the nest, eggs, or birds until directed by Owner or appropriate Owner Representative's supervision.
6. If no nest or cavity is present or if no live birds are present then proceed to trim in that area as prescribed.

Move to the next cutting position and repeat the steps.

If ANY nests with live unfledged birds are identified during cutting or vegetation removal, stop work at that area and call the Owner. Work may proceed in other areas that have no eggs or live unfledged birds present.

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Occupational Safety and Health Administration:
   a. Title 29, Labor, Chapter XVII Occupational Safety and Health Administration (OSHA), Part 1910, Occupational Safety and Health Standards: Part 1910.120, Hazardous Waste Operations and Emergency Response.
2. U.S. Environmental Protection Agency:
   a. Resource Conservation and Recovery Act (RCRA).
      1) Title 40 of the Code of Federal Regulations, Part 261 (40 CFR 261), Subpart C Characteristics of Hazardous Waste.
      2) 40 CFR 263, Standards Applicable to Transporters of Hazardous Waste.
      3) 40 CFR 268, Land Disposal Restrictions.
   b. Toxic Substances Control Act (TSCA), 40 CFR 761
3. U.S. Department of Transportation:
   a. 49 CFR 171, General Information, Regulations, and Definitions.
   b. 49 CFR 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
   c. 49 CFR 173, Shippers - General Requirements for Shipments and Packaging.
   d. 49 CFR 178, Specifications for Packaging.
4. State of Michigan:
   a. Transportation Standards and Recordkeeping (Mich. Admin. Code R 299.9608-9609).
   b. Solid Waste Management (Mich. Admin. Code R 299.4101 - 299.4922).
5. U.S. Army Corps of Engineers Engineering Manual 385-1-1.

1.02 SUBMITTALS

A. Informational Submittals:

1. Proposed location(s) of stockpiled excavated material for road and staging area construction and proposed location(s) for staging drill cuttings.

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a. Qualifications:
   1) Documentation that RA Contractor's personnel and Subcontractor's personnel proposed for Work with contaminated materials have been 40-hour trained in accordance with 29 CFR 1910.120.
   2) Waste Transporter: Documentation of permitting, valid DOT number, and equipment capabilities.
   3) Offsite Disposal and Treatment Facilities: Documentation of permit, disposal requirements, and acceptance of waste.
      a) CERCLA OSR approval.

B. Codes and Regulations:

1. Comply with federal, state, and local regulations in handling, testing, transporting, and disposing materials and in performing the Work.
2. Prior to commencing excavation operations, obtain applicable local, state, and federal permits and licenses that directly impact RA Contractor's ability to perform the Work.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized over excavation or over-drilling.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering. If necessary, continue dewatering the excavated material or drill cuttings to meet requirements for transportation and disposal.

1.06 SITE CONDITIONS

A. The subsurface information and data furnished to the RA Contractor is not intended as a representation or warranty but is furnished for information only. The Owner is not responsible for any deduction, interpretation, or conclusion drawn by the RA Contractor.

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B. Existing Utilities and Underground Structures:

1. Known/assumed existing utilities and underground structures are shown on Drawings. The location of existing utilities and underground structures should be considered approximate.
2. Prior to commencing work, the RA Contractor shall locate and identify all existing utilities in the areas of Work. If utilities are to remain in place, provide adequate means of protection.
3. Should uncharted, or incorrectly charted, piping, or other utilities be encountered during excavation, consult the Owner immediately for directions. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation. The RA Contractor shall repair damaged utilities to the satisfaction of the Owner and utility company.
4. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, except when permitted in writing by the Owner and then only after acceptable temporary utility services have been provided.

C. Protection of Persons and Property:

1. Barricade and mark open excavations occurring as part of this Work in accordance with applicable standards.
2. Protect facilities, structures, utilities, pavements, sidewalks, fences, and other facilities designated to remain from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations and heavy truck/equipment traffic.
   a. Unless otherwise noted, existing monitoring wells are to remain. The RA Contractor shall take necessary precautions to protect existing wells and utilities during all phases of the Work.
   b. Any damage to facilities, structures, utilities, etc. designated to remain shall be repaired and/or replaced by the RA Contractor at no additional expense to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. A. Plastic Sheeting:

1. Nylon-reinforced polyethylene sheeting, opaque/frosted.
2. Thickness: Minimum 10 mils.

B. Tape and Glue: Capable of sealing joints of adjacent sheets of plastic and capable of adhering under wet conditions.

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C. Geomembrane: 30-mil thick Linear low-density polyethylene (LLDPE) containing no plasticizers, fillers, extenders, reclaimed polymers, or chemical additives, except following:

1. Approximately 2 percent by weight of carbon black to resin for ultraviolet resistance.
2. Antioxidants and heat stabilizers, not to exceed 1.5 percent total by weight, may be added as required for manufacturing.
3. Ballast: Sandbags or other ballast materials of sufficient weight and quantity to maintain polyethylene sheeting securely in place.

PART 3 EXECUTION

3.01 GENERAL

A. Excavate/drill soil from the designated areas to the lines, grades, and elevations as shown on Drawings.

1. Establish vertical controls/procedures to limit/maintain the excavation to the required widths and depths below the existing ground surface.
2. Document the lateral and vertical extent of the final excavation area by field surveying.
3. The Owner reserves the right to increase or decrease the excavation widths and depths or make such other changes in the excavation sections as may be deemed necessary.

B. Do not overexcavate without written authorization of Owner. RA Contractor shall repair unauthorized excavations with material and procedures satisfactory to the Owner at no additional cost to the Owner.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

D. If material is not direct-loaded into trucks for immediate offsite disposal, stockpiling of contaminated materials awaiting loading for offsite disposal will be stored in a geomembrane-lined, bermed area to contain runoff, and will securely covered with plastic sheeting at the end of the work day. The staging areas will be constructed and maintained by the RA Contractor.

E. If free product is encountered, the RA Contractor will segregate free product form the wastewater for separate waste characterization. The RA Contractor is responsible for offsite disposal of free product, if encountered.

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F. The RA Contractor will segregate free product-stained soil from other excavated or drilled material for separate waste characterization. The RA Contractor is responsible for offsite disposal of free product-stained soil, if encountered.

G. Install and maintain erosion and sediment control measures before and during earth disturbing and stockpiling activities in accordance with approved SESC Plan.

H. If objectionable odors are detected during construction, the RA Contractor shall provide and apply an odor-suppression foam, if directed by Owner.

I. Use of explosives shall not be allowed.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.04 STOCKPILING EXCAVATED MATERIAL

A. Existing clay cap material that is excavated for site roads and other support areas shall be stockpiled for reuse. Stockpiled material will be stored in a lined bermed area to contain runoff and covered when not actively placing material in it. The staging areas will be constructed and maintained by the RA Contractor.

B. Drill cuttings and any excavated material below the existing clay cap shall be containerized, characterized, and disposed offsite. Waste characterization sampling and analysis shall be performed as required by the disposal facility and in accordance with the RA Contractor’s approved Waste Management Plan.

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C. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

D. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

E. Do not stockpile excavated material or drill cuttings adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

F. Do not stockpile excavated materials or drill cuttings near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

G. If excavated or drilled material is saturated, or deemed too wet for offsite disposal based on the disposal facility's requirements, soil will be placed on 10 mil polyethylene or approved equivalent and stabilized prior to offsite disposal. A pozzolanic agent, approved by the Owner, may be used to facilitate drying and stabilizing of the load-out piles. The leachate from the wet/saturated soil will be collected, managed, and disposed offsite in accordance with the RA Contractor's Transportation and Disposal Plan.

3.05 LOADING OF EXCAVATED AND DRILLED MATERIAL

A. This task includes all moving, handling and loading of excavated material and drill cuttings for transportation. Sequencing of moving, handling and loading of trucks is to be done in accordance with the RA Contractor's Transportation and Disposal Plan.

B. Trucks will be fully loaded, within allowable hauling weight limits, prior to transporting the excavated materials and drill cuttings to the approved licensed disposal facility.

C. A temporary ground covering, 10 mil polyethylene or equivalent, will extend a minimum of 2 feet under trucks to minimize the potential for soil to spill into roadways or other areas not requiring remediation. In lieu of a temporary ground covering, the RA Contractor may submit an alternative plan to prevent spills in roadways and other areas not requiring remediation to the Owner for approval.

3.06 TRANSPORTATION AND DISPOSAL

A. Dispose of excavated materials and drill cuttings, which are unsuitable or exceed quantity needed for backfill, offsite at Owner-approved facility.

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B. The exterior of each transportation vehicle and load of waste will be visually inspected and all loose soil/material removed and collected before leaving the site.

C. Each truck and/or container will be lined prior to loading with excavated material or drill cuttings.

D. Each truckload will be covered with a fully functioning tarp system that satisfies local, county, state and federal regulations prior to transporting the excavated materials and drill cuttings to the approved licensed disposal facility.

E. The RA Contractor will coordinate waste pickup with the selected waste transporter once all analytical, profiles and manifests are in order.

F. Transportation of nonhazardous wastes will be completed by a transporter licensed for commercial transportation in the State of Michigan. The transporter will adhere by and be in compliance with all regulatory requirements under 49 Code of Federal Regulations (CFR).

G. RA Contractor will provide documentation indicating that the selected transporter and any lower tier subs has appropriate licenses, permits as a commercial transporter of nonhazardous and hazardous wastes including a valid U.S. DOT number. Transporters of hazardous waste must also maintain hazardous certification and a valid EPA ID number. Transporter must be in good standing with the State and U.S. DOT as well as the USEPA.

H. Transporters will be required to abide by all health and safety requirements of Owner and the installation when driver is out of the truck. At a minimum, each driver will be required to wear a hard hat (at all times while on premises of the facility while the driver is out of the truck), long pants, appropriate work shirts, high-visibility safety vest, steel-toe safety shoes and safety glasses. Gloves are required when detaching or attaching trailers. Owner reserves the right to turn away any driver who does not meet these minimum health and safety requirements. Owner will not be responsible for any demurrage or other costs as a result of turning away a driver who does not meet Owner's health and safety requirements.

I. Each driver will also be required to produce proof of insurance for his truck, and the driver's valid commercial driver's license. Hardcopies of these documents must be kept onsite during execution of the Work.

J. Each driver will follow the site traffic signs including stop and speed limit signs and transportation routes as described in the RA Contractor's Transportation and Disposal Plan. Talking on cell phones while driving is prohibited.

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K. Transporter will prevent contamination of soil, water, or atmosphere by the discharge of noxious substances resulting from their activities; prevent the tracking of soil and debris from the work areas to other facility locations as well as off-site; and perform emergency measures (if required) to contain and address any releases resulting from RA Contractor operations. The RA Contractor will report any releases to the Owner. Should the RA Contractor cause a release, the RA Contractor will be held financially responsible for cleanup and removal of impacted material, sampling and analysis of waste for disposal purposes, and disposal costs associated with the release.

L. Heavy equipment fueling, lubrication, and maintenance will be performed on site in designated areas approved by the Owner. Secondary containment systems must be used during fueling activities, and spill kits must be available nearby. This excludes transport trucks, which should be fueled and maintained at the truck base facility.

M. Soil waste and wastewater removed from the site will be transported and disposed of at a licensed facility approved by USEPA. Disposal facilities will be required to provide proof of USEPA approval under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Offsite Rule, set forth in the National Contingency Plan, at 40 Code of Federal Regulations 300.440.

N. Non-hazardous waste manifests will be prepared by the RA Contractor and signed by the Owner. A completed draft manifest will be provided to Owner prior to beginning excavation work. A manifest will accompany each load.

O. If required by the disposal facility, waste characterization samples will be collected by the RA Contractor. RA Contractor will provide the results of analysis to the Owner.

P. The quantities of waste will be recorded by documented weighing at the approved disposal facility. For each load of material, weight measurements will be obtained for each full and empty container or dump truck. Disposal quantities will be based on the difference of weight measurements between the full and empty container or dump truck. Copies of haul tickets will be signed and provided to Owner on a daily basis.

Q. The following procedures also will be observed when transporting wastes offsite:

1. The RA Contractor will coordinate waste pickup with the waste transporter once all analytical, profiles and manifests are in order.
2. Waste material transportation will comply with federal, state and local regulations.

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3. Impacts to general public traffic will be minimized.
4. All truck traffic will enter and exit the site through the newly site entrance located off of M-46/Washington Avenue, unless directed otherwise by Owner.
5. If road damage is caused by construction and/or hauling traffic, the damage will be repaired at no additional cost to the Owner.
6. Material spilled in transit will be cleaned up.
7. Safety and spill response procedures will be followed.
8. Sealed trucks will be used to transport liquids or wet materials.
9. No materials from other projects will be combined with materials from this site.
10. The approved Waste Management Plan and Transportation and Disposal Plan will be followed.

END OF SECTION

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SECTION 31 23 19.01
WATER CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section details the handling of water produced during backfilling operations and other earthwork activities. Dewatering of cylindrical pilings for the walls are prohibited as per Section 31 63 29, Drilled Concrete Piers.

1.02 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Discharge permit-equivalency (substantive requirements document).

1.03 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to: equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

B. Water Control Plan shall be sealed by a professional engineer licensed in the State of Michigan.

C. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. Remove and control water during periods when necessary to properly accomplish Work.

C. Install pumps with controls to quickly discharge water from the work area.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. RA Contractor shall accommodate expected variations in levels of the Pine River similar to, and potentially greater than historical data.

C. Open inactive excavations may be allowed to temporarily collect water if the excavation sidewalls and base remain stable.

D. Construct diversion ditches, benches, and berms to retard and divert runon away from the area of work and runoff to protected drainage courses. Stormwater from the site shall be diverted, to the extent practicable, to minimize infiltration into open excavations and to avoid contact with contaminated materials.

E. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.

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3. To relieve artesian pressures and resultant uplift of excavation bottom and provide a stable working platform for subsequent fill placement and compaction.

F. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

G. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

H. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

I. Excavations shall be dewatered as backfill is placed, to prevent overtopping and discharge to adjacent lands and the Pine River.

3.04 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Owner.

3.05 DISPOSAL OF WATER

A. Obtain discharge permit-equivalency (substantive requirements document) for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

E. In the event that free product is encountered during excavation activities, it will be segregated, stored, and analyzed for disposal.

END OF SECTION

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SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   e. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. EPA SW-846 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods Compendium.
3. Michigan Part 201 Residential Soil criteria.

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Owner.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

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C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Geosynthetics: Geotextiles, geogrids, or geomembranes.

G. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

J. Selected Backfill Material: Materials available onsite that Owner determines to be suitable for specific use.

K. Imported Material: Materials obtained from sources offsite, suitable for specified use.

L. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

N. Earth Fill: Existing onsite material that will be excavated and reused for backfill.

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O. Standard Specifications: When referenced in this section, shall mean Michigan Department of Transportation Standard Specifications for Construction.

1.03 SUBMITTALS

A. Action Submittals:

1. Samples: Imported material taken at source.
2. Certified test results from independent testing agency, and compliance to specifications.

B. Informational Submittals: Manufacturer's data sheets for compaction equipment.

1.04 QUALITY ASSURANCE

A. Notify Owner when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing and Section 31 23 16, Excavation prior to placing fill or backfill.

B. Backfill against the wall only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Owner's acceptance of concrete work and attained strength prior to placing backfill.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, test as follows:
   a. One test per 2,000 tons, with minimum of one test per material per source.

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B. Final approval of imported source materials will be based on test results. The borrow source material (except for Stone Fill and Aggregate Fill) will meet the Michigan Part 201 Residential Soil criteria to be determined to be "clean." Should the borrow source fail to meet Michigan Part 201 Residential Soil criteria only for chemicals commonly found at elevated background levels such as arsenic, the borrow source might still be approved for use by the appropriate regulatory agencies.

C. Chemical Analysis. Chemical analyses shall be performed on imported material (except for Stone Fill and Aggregate Fill) delivered to the site:

1. As necessary to locate acceptable sources of imported material.
2. Collect one sample per 3,000 cubic yards of imported source material to be analyzed for the following parameters:
3. Target compound list (TCL) volatile organic compounds (Method SW846 8260C).
   a. Includes 1, 2-dibromo-3-chloropropane (DBCP).
4. Target compound list (TCL) semivolatile organic compounds (Method SW846 8270D).
   a. Includes Tris (2,3-dibromopropyl) phosphate (TRIS).
5. Target compound list (TCL) Pesticides/PCBs (Method SW846 8081A/8082).
   a. Includes Polybrominated biphenyls (PBB), Hexabromobiphenyls (HBB), and Dichlorodiphenyl trichloroethane (DDT).
6. Target analyte list (TAL) metals (23), ICP and CVAA (Method SW846 6010/7470 or 7471.
7. Total Cyanide (Method EPA 335.4/SW 846 9014.
8. Target compound list (TCL) Acid Fraction Compounds (Method SW846 8270D).
9. Target compound list (TCL) Base Neutral Compounds (Method SW846 8270D).
10. During production of imported material, test as follows:
    a. One test per 2,000 tons.

2.02 STONE FILL

A. Off-site borrow source consisting of sound crushed rock processed to conform to the following particle size distribution:

Sieve Size	Percent Passing by Weight
2.5-inch	100
2-inch	90 – 100
1.5-inch	35 – 70
1-inch	0 – 15
1/2-inch	0 – 5

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B. Free from dirt, clay balls, and organic matter or other deleterious material.

2.03 AGGREGATE FILL

A. Off-site borrow source consisting of aggregate processed to conform to the following particle size distribution:

Sieve Size	Percent Passing by Weight
1.5-inch	100
1-inch	95 – 100
1/2-inch	25 – 60
No. 4	0 – 10
No. 8	0 – 5

B. Free from dirt, clay balls, organic matter or other deleterious material.

2.04 GRANULAR FILL

A. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 – 8

B. Free from clay, organic matter, or other deleterious material.

C. Chemical analyses as per Section 2.01.B.

2.05 EARTH FILL

A. Excavated material from required excavations or imported material free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Earth fill placed over geotextiles shall have a maximum particle size of 1 inch and must be free of sharp angular pieces that may damage the geotextile.

2.06 MEGABASE

A. Off-site borrow source consisting of 0 by 3 inches crushed rock.

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B. Free from trash, debris, and other deleterious materials.

PART 3 EXECUTION

3.01 GENERAL

A. Place and spread materials in horizontal lifts of uniform thickness. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

B. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

C. Groundwater and Surface Water Runoff Control:

1. In accordance with Section 31 23 19.01, Dewatering.
2. Provide adequate pumping and drainage facilities to maintain a water level no higher than the level of the adjacent river. Exception to this statement is the elevation of water in the cylindrical piles may be temporarily higher to provide for positive hydraulic head during drilled shaft excavation operations. Manage the drainage of all water resulting from pumping so as not to cause physical or environmental damage to adjacent areas.
3. Perform pumping and dewatering operations in such a manner as to prevent damage to the Work and so that no loss of ground results from these operations. Take precautions to protect new work from flooding during storm events or from other causes. Perform continuous pumping, as required, to protect the Work and/or to maintain satisfactory progress in the Work.
4. Control the grading in surrounding areas so that the ground surface is properly sloped to prevent water from running into the project area.
5. Control erosion/sediment to minimize impact of the Work to off-site surface water bodies or drainage systems.

D. Impact to DGVBW: The size and type of placement and compaction equipment used proximate to the DGVBW shall be selected to not impact the alignment or verticality of the DGVBW. Any deformation or damage to the DGVBW shall be remediated by the RA Contractor with no additional compensation from the Owner.

E. Stone Fill and Aggregate Fill:

1. Stone Fill and Aggregate Fill may be placed in the water provided a method is pursued that results in a surface grade that is stable. The stability of the surface grade of each of these materials shall be based on

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visual inspection for evidence of pumping or rutting once the fill has been placed to an elevation above the standing water and trafficked with a fully loaded tandem-axle dump truck. Any pumping / rutting shall be referred to the Owner along with proposed remediation method. The method of placement and compaction shall be approved by Owner prior to start of filling activities and a test section shall be completed to confirm the appropriateness of the proposed fill placement and surface inspection methods.

F. Granular Fill and Earth Fill: Granular Fill and Earth Fill shall be placed in lifts with thicknesses not greater than 8 inches and shall be compacted to a minimum dry density equal to 95 percent of that obtained as per ASTM D698. Granular Fill and Earth Fill shall not be placed or compacted in water or placed on saturated subgrades.

G. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

H. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 SITE TESTING

A. Gradation:

1. One sample from each 2,000 tons of finished product or more often as determined by Owner, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: Where densification requirements are required in adherence to ASTM D698, in place density shall be performed in accordance with ASTM D6938. During placement of materials test every 500 cubic yards, but no less than two tests per day for each day material is being placed, and no less than two tests per lift.

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C. The surface of Stone Fill and Aggregate Fill shall be proof-rolled to confirm adequate compaction. Areas not successfully proof-rolled shall be delineated and referred to Owner for additional remediation measures.

3.03 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Owner as follows:

1. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
2. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
3. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Owner's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.04 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base and Subbase Courses.

END OF SECTION

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SECTION 31 32 19.16
GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   b. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   c. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   d. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   e. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   f. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
   g. D6193, Standard Practice for Stitches and Seams.
   h. D6241, Standard Test Method for Measuring Static Puncture Strength of Geotextiles and Geosynthetic-Related Products Using a 50-mm Probe.

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

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F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
2. Samples:
   a. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.
   b. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
   c. Securing Pin and Washer: One each.

B. Informational Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

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1.05 SCHEDULING AND SEQUENCING

A. Notify Owner whenever geotextiles are to be placed. Do not place geotextile without Owner's approval of underlying materials.

PART 2 PRODUCTS

2.01 NONWOVEN GEOTEXTILE

A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Physical Properties: Conform to requirements in Table No. 1.

Table No. 1
Physical Property Requirements for Nonwoven Geotextile

Property	Requirement	Test Method
Water Permittivity	0.5 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	0.425 mm	ASTM D4751
Grab Tensile Strength, Machine Direction	200 lb, MinARV	ASTM D4632
Puncture Strength	440 lb, MinARV	ASTM D6241
Trapezoid Tear Strength	75 lb, MinARV	ASTM D4533

2.02 SILT FENCE

A. Properties of, and procedures for installation of silt fence are contained in Specification 01 57 13, Temporary Erosion and Sediment Control.

2.03 SECURING PINS

A. Steel Rods or Bars:

1. 3/16-inch diameter.

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2. Pointed at one end.
3. With head on other end sufficiently large to retain washer.
4. Minimum Length: 12 inches.

B. Steel Washers for Securing Pins:

1. Outside Diameter: Not less than 1.5 inches.
2. Inside Diameter: 1/4 inch.
3. Thickness: 1/8 inch.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

B. Install in accordance with Manufacturer recommendations

C. Do not install in water, on soil softened by precipitation or surface water, or soil cracked due to desiccation.

D. Install on flat subgrade free of sharp rocks or other objects which may compromise the integrity of the geotextile.

E. Repair any damage to the soil surface caused by installation activities at the RA Contractor's expense.

F. Do not leave geotextiles exposed for a period greater than 10 days unless a longer exposure period is approved by the Owner.

G. In the presence of wind, weigh down the geotextiles with sandbags or equivalent. Sandbags (or equivalent) to remain until replaced with overlying layers of material.

H. Examine the geotextile surface after installation to ensure that no potentially harmful foreign objects are present. Remove foreign objects and replaced damaged geotextile at no additional cost to Owner.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

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3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   a. Foundation/Subgrade Stabilization: Minimum 18 inches.
   b. Material Separation: Minimum 18 inches.
   c. Riprap: Minimum 18 inches.
   d. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
   e. Other Applications: Minimum 12 inches.
3. Overlap geotextile such that the downgradient geotextile sheet is placed under the upgradient geotextile sheet creating the overlap.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Owner.

B. Secure Geotextile with Securing Pins:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
   a. Midway between edges of overlaps.
   b. 6 inches from free edges.
3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Owner. Do not cover installed geotextile until after Owner provides authorization to proceed.

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B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Owner.

3.08 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Owner's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

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SECTION 31 32 19.17
GEOGRID

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
   b. D6637, Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
   c. D7748, Standard Test Method for Flexural Rigidity of Geogrids, Geotextiles and Related Products.

1.02 DEFINITIONS

A. Geogrid: Single layer of a uniform square or rectangular grid of bonded, formed, or fused polymer tensile strands consisting of polyester, polypropylene, polyamide or polyethylene.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geogrid furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geogrid furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer material specifications and product literature.

B. Informational Submittals: Certifications from each geogrid manufacturer that furnished products have specified property values. Certified property values will be either minimum or maximum average roll values, as appropriate, for geogrid furnished.

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1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geogrid with suitable wrapping for protection against moisture and ultraviolet exposure. Store geogrid in way that protects it from elements. If stored outdoors, elevate and protect geogrid with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Notify Owner whenever geogrids are to be placed. Do not place geogrid without Owner's approval of underlying materials.

PART 2 PRODUCTS

2.01 GEOGRID

A. Biaxial geogrid composed on a single layer of a uniform square or rectangular grid of bonded, formed, or fused polymer tensile strands. Furnish polyester, polypropylene, polyamide, or polyethylene material that maintains dimensional stability during handling, placing, and installation. Use geogrid that is at least 6 feet wide.

B. Physical Properties: Conform to requirements in Table No. 1.

Table No. 1
Physical Property Requirements for Geogrid

Property	Requirement [1]	Test Method
Tensile Strength at 5% Strain (both principal directions in lb/ft)	700	D6637 Method A
Flexural Rigidity (both principal directions in mg/cm)	300,000	ASTM D7748
Aperture Area (square inches)	5.0 max	Inside measurement
Aperture Dimension (inches)	0.5 min	Inside Measurement

[1] All numerical values represent minimum/maximum average roll values in accordance with ASTM D4759. Average test results from all rolls in a lot must conform to the values in Table 1.

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PART 3 EXECUTION

3.01 LAYING GEOGRID

A. Lay and maintain geogrid smooth and free of tension, folds, wrinkles, or creases.

B. Overlap geogrid at each joint with upstream sheet of geogrid overlapping downstream sheet.

3.02 JOINTS

A. Unseamed Joints Overlapped: Minimum 12 inches.

3.03 SECURING GEOGRID

A. Secure geogrid during installation with pins, or other devices to prevent movement or displacement. Secure lapped sections together using Owner-approved ties, straps, clops or other devices.

3.04 PLACING PRODUCTS OVER GEOGRID

A. Do not operate vehicles or construction equipment directly on geogrid.

B. Before placing material over geogrid, notify Owner. Do not cover installed geogrid until after Owner provides authorization to proceed.

C. If tears, punctures, or other geogrid damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geogrid. Overlap the damaged area by at least 3 feet in all directions. Remove and replace geogrid sections with large rips, tears, defects, or other damage as the Owner directs before backfilling.

3.05 REPLACING CONTAMINATED GEOGRID

A. Protect geogrid from contamination that would interfere, in Owner's opinion, with its intended function. Remove and replace contaminated geogrid with clean geogrid.

END OF SECTION

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SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. C150, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.02 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23, Fill and Backfill.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Description and location of proposed sources of riprap.

B. Informational Submittals:

1. Quarry Certificate of Conformance and supporting documentation showing proposed riprap meet Standard Specification gradation and materials requirements for the Class or Type specified.
2. Certified Test Results:
   a. Riprap:
      1) Gradation.
      2) Abrasion resistance.
      3) Bulk density.
3. Trip tickets showing source, type, and weight of each load of material delivered to Site.

1.04 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

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B. Site Visit: Make arrangements for Owner to visit quarry site to observe materials proposed for riprap and riprap bedding.

1.05 SCHEDULING AND SEQUENCING

A. Complete geotextile installation as specified in Section 31 32 19.16, Geotextile, prior to placing riprap.

PART 2 PRODUCTS

2.01 RIPRAP FOR STORMWATER OUTLETS

A. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.

C. Median D_{50} size: 6-inch diameter.

D. Maximum D_{100} size: 12 inches, or as approved by the Owner.

2.02 RIPRAP FOR TOE STONE

A. Rip rap shall meet the requirements of most current edition of Michigan Department of Transportation Standard Specifications for Construction Section 916.01.C.1, Erosion and Sedimentation Control Material, Plain Rip Rap.

B. Natural stone shall be used.

PART 3 EXECUTION

3.01 PLACING RIPRAP FOR STORMWATER OUTLETS

A. Place riprap to thickness as shown on Drawings.

B. No mechanical compaction of riprap is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap free from irregularities and to tolerances of 0.2 feet from established grade.

D. Place and grade riprap in a manner that avoids subgrade disturbance.

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3.02 PLACING RIP RAP FOR TOE STONE

A. Place rip rap in accordance with most current edition of Michigan Department of Transportation Standard Specifications for Construction Section 813.03.E.1, Slope Protection.

B. Place rip rap on geotextile without displacing, puncturing or damaging geotextile. If accidentally damaged, repair geotextile prior to proceeding.

END OF SECTION

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SECTION 31 41 16
SHEET PILING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A328, Standard Specification for Steel Sheet Piling.
   c. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   d. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

1.02 DEFINITIONS

A. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

B. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering a subsurface or physical condition.

C. Rated Hammer Energy: Rated energy from manufacturer's literature.

D. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

1.03 SUBMITTALS

A. Action Submittals:

1. Sheet Pile Installation and Sealing Plan. The plan shall include at a minimum the following items:
   a. Methods and procedures for fabrication welding (field and/or shop)
   b. Methods of sheet pile installation.
   c. Equipment: A list of major equipment by type and capacity.

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d. A description of the following:
   1) Quality control testing, including visual inspection procedures and frequency and method for non-destructive testing of welds in accordance with AWS D1.1/D1.1M or approved equal.
   2) Minimum standards with which to gage the quality of the work during fabrication.
   3) Who is responsible for performing and for verifying the work.
   4) Sample Quality Control Inspection report.
   5) Quality control testing and sampling methods.
   6) Minimum standards with which to gage the quality of the work during installation/construction.
e. Physical properties and manufacturer's stated properties for all supplemental sheet piles that may be procured by the RA Contractor, including manufacturer's certifications of quality, and mill certificates.
f. Criteria used to indicate the piles have extended to the till material.
g. Procedures which will be employed in the case of substandard results.
h. Methods for sealing, including the following:
   1) Manufacturer of sealant and literature indicating appropriateness of use for this project.
   2) Sealing sheet pile interlocks/joints.
i. Field observation protocol and documentation forms for all testing, including visual assessment of leaks on the interior of the bulkhead while they are exposed and available for observation.
j. Adjustments as necessary to accommodate the requirements of underground utility owners.

B. Sheet Pile Shop Drawings: RA Contractor shall provide sheet pile field fabrication shop drawing details to the Owner for approval at least 2 weeks prior to the commencing installation of sheet piles.

C. Informational Submittals:

1. Pile driving schedule.
2. Product Data and Material Certificates: For each shipment of supplemental sheet pile procured by the RA Contractor, submit certificates identified with specific lots prior to installing sheet piling. Include in the identification data piling type, dimensions, chemical composition, section properties, heat number, and mill identification mark.

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3. Hammers: Manufacturer's specifications and catalog information.
4. Installation Records: Submit copies of the driving records of each sheet pile to the Owner not later than 2 days after installation. Include the project name and number, name of RA Contractor, pile location and number, type and size of hammer used, type of pile driving cap used, rate of operation of sheet pile driving equipment, sheet pile dimensions, elevation of point, elevation of but before and after cutoff, ground elevation, continuous record of number of blows, or rate of penetration, for each foot of penetration if appropriate, verticality measurements or pile deviation, adjacent sheet pile uplift and reaction, and any unusual occurrences during sheet pile driving.
5. Visual inspection reports and non-destructive weld test results.
6. Post-construction report.

1.04 QUALIFICATIONS

A. The installation of sheet piles shall be conducted by a qualified RA Contractor, or subcontractor retained by RA Contractor, experienced in sheet pile wall installation. A qualified RA Contractor or subcontractor is defined as having at least 15 years direct experience. A qualified RA Contractor or subcontractor shall have self-performed not less than five projects of similar scope. The RA Contractor or subcontractor will be required to submit evidence that competent personnel are available to conduct the operations specified, that such personnel will be assigned to this project, and that such personnel will have previous experience with sheet pile installation. Documentation of work experience shall be provided by the RA Contractor with the bid.

B. Welding (Shop and Field): Qualification for welding procedures, welders, and operators shall comply with requirements of AWS D1.1 or approved equal. RA Contractor shall keep records of test results of welding procedures and submit copies of each qualified welding operator to Owner for approval before starting welding.

C. Superintendent: Qualifications and documented experience of at least five projects with similar scope and responsibilities, for Owner approval.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. An independent third-party Construction Quality Assurance (CQA) Inspector provided by the RA Contractor, and approved by the Owner, having experience with sheet pile construction shall be used to supervise construction and quality control. The specialist shall be at the site of operation at all times that the installation is in process. The knowledge and experience of the

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specialist should include, but not necessarily be limited to: construction equipment, materials testing, and quality control as required for driven pile construction.

PART 2 PRODUCTS

2.01 SHEET PILES

A. Minimum size and wall thickness shown manufactured to ASTM A572.

B. Sections: As indicated on Drawing.

C. Stamp mill heat number on each pile.

D. Pulling (Handling) Holes: Manufacturer's standard, additional will not be allowed.

2.02 ACCESSORIES

A. Steel Shapes, Plates, Bars, Washers, etc.: As noted on Drawings.

B. Interlock Sealant:

1. A sealant shall be utilized in all bulkhead interlocks extending from the top of the bulkhead to the bottom of the sheet.
2. Sealant shall have a maximum hydraulic conductivity of $1x10^{-6}$ cm/sec when permeated with surface water from the project site.
3. Sealant shall have a design life of at least 50 years and the installer shall have documented experience of its use, as approved by the Owner.
4. Sealants shall not permit inward seepage of river water during excavations adjacent to the bulkhead, as approved by the Owner.
5. Sealant shall have documented lack of degradation when exposed to chemicals of concern found at the Site (i.e., chemical capability) as demonstrated through testing with Site soils between the existing slurry wall and DGVBW alignment, as approved by the Owner.
6. Sealants shall be applied in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 PREPARATION

A. The RA Contractor is responsible for removing identified obstructions to complete installation of the bulkhead in accordance with the Drawings and Specifications.

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B. Store materials to permit easy access for inspection, identification, and sealing as appropriate. Keep steel members off the ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

C. Lift piles using a cradle or multiple point pick-up to ensure that the maximum permissible camber or sweep is not exceeded due to insufficient support, except that a one-point pick-up may be used for lifting piles that are not extremely long into the driving leads or template. Point pick-up devices must be of the type that clamp to both pile flanges at each pick-up point. Do not drag piles across the ground.

D. Do not store materials in a manner that might cause distortion, damage, or overload to members or supporting structure. Repair or replace damaged materials or structures as directed. Piling stored on-site shall not exceed stack height and weight as shipped from the mill. Blocking shall be used to maintain piling in a level position. Blocking between bundles shall be directly over any block placed immediately below. Blocking shall not be spaced more than 10 feet apart and not more than 2 feet from the ends.

E. Inspect piles for excessive camber and sweep and for damage before transporting them from the storage area to the driving area and immediately prior to placement in the driving leads or template. Camber, curvature in the pile in the direction normal to the pile interlocks, must be measured with the pile flange base laying on a flat surface and is the distance between the flange base at the mid-length of the pile and the flat surface. Sweep, curvature in the pile in the direction parallel to the interlocks, must be measured with the pile flange tips laying on a flat surface and is the distance between the flange tips at the mid-length of the pile and the flat surface. The maximum permissible camber or sweep is 2 inches over the length of the pile, and they must be installable without interlock or sealant failure. Piles having excessive camber or sweep will be rejected.

F. Mark each pile's length by painting a horizontal line at 1-foot intervals, and the number of feet from the pile point at 5-foot intervals.

G. Perform all manual arc-welding using the shielded metal arc or the submerged arc method, complying with AWS Standards and the RA Contractor's approved Health and Safety Plan.

H. Clean surface to be welded of all rust, scale, oil, paint, and foreign material. Use only pile members with identical cross-sections for splicing. Splicing shall only be permitted if authorized by the Owner. Make splices before starting driving operations wherever possible. If a welded splice is required

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during driving, make the splice when the top of the pile is at least 3 feet above the ground to permit inspection of the welded connection during welding and during subsequent driving. Splices shall be 100 percent butt welded, producing a straight pile alignment through the splices, developing full strength of the pile in both bearing and bending.

3.02 DRIVING EQUIPMENT

A. Provide driving equipment that is adequate to extend the steel sheeting to the glacial till. Operate equipment in accordance with the manufacturer's recommendation.

3.03 PILE LENGTHS

A. Lengths shown are those required below cutoff. Furnish sheet piling with sufficient extra length to provide for fresh heading and to reach from the cutoff elevation up to position of driving equipment.

3.04 DRIVING GUIDES

A. Position sheet piles using temporary guide wales support and anchor guide wales to form rigid structures during the sheet pile setting and driving operation.

B. Guide Wales: Stationary (not moveable) with fluctuating water stage.

3.05 SETTING

A. Clean pile; inspect for defects and proper interlock dimensions.

B. Allow pile sufficient clearance in the interlocks to slide, under its own weight, in the interlock of the sheet pile previously placed until the top of existing ground is reached by the tip of the sliding pile. Do not use vibratory or drive hammer to force the interlocking of piles.

3.06 DRIVING

A. Do not drive piles within 200 feet of structural concrete less than 7 days old.

B. Before driving is started, check sheet piles for position and alignment. Locate pile top within 2 inches of location shown.

C. Drive sheet piles in rotating stages such that the tip of any sheet pile is not more than 5 feet below the tip of any adjacent sheet pile nor more than 8 feet below the tip of any other sheet pile in the bulkhead, except as required by the final tip elevations shown.

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D. Remove and replace sheet pile driven out of interlock.

E. Driving Tolerances:

1. Not more than 1/8 inch per foot from the vertical in all directions. Furnish plumb line or other device for checking vertical alignment. Centroid of pile at cutoff elevation shall not vary from design position shown by more than 3 inches after driving.

2. Not more than 1 percent from vertical.

F. If an unidentified obstruction preventing the proper installation without damage is encountered, the pile shall be withdrawn, and the obstruction shall be removed to the extent required to complete installation of the DGVBW.

G. Withdraw selected driven piles when directed by the Owner to determine the condition of piles after driving. Redrive piles withdrawn for inspection, unless damaged or found not meeting specification requirements. Replace rejected piles with new piles as specified.

3.07 FIELD APPLICATION OF SEALANT

A. The sealant shall be applied between the top of bulkhead to the bottom of sheets for all bulkhead interlocks.

B. The interlock shall be sealed in accordance with sealant manufacturer's specifications and/or recommendations.

C. Interlocks with sealant shall be oil-tight and watertight. RA Contractor shall demonstrate watertightness of all interlocks as described in the approved sheet pile installation and sealing plan.

3.08 PILE CUTOFF

A. Cut square at required elevation, as per plans, with tools that will not damage area below cut surface.

B. Tolerance: Plus or minus 1/2 inch.

C. Cut-off sections may be used for splicing at the discretion of the Owner.

3.09 CUTTING AND SPLICING PILES

A. Extend to required grade by welding on additional full-length piles driven below grade, and piles with damaged heads which have been cut off to permit further driving.

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B. A maximum of one weld is permitted per pile.

C. Pile Splicing: Butt weld, making full penetration of the web. Piles adjoining spliced piles shall be full length piles.

3.10 FIELD QUALITY CONTROL

A. Daily Log and Record: Document for each sheet pile driven, showing as a minimum:

1. Pile identification/location.
2. Weather/groundwater conditions.
3. Date and time start and complete driving.
4. Respective depths of penetration.
5. Cutoff elevations.
6. Driving resistance for each foot of driving over entire pile length.
7. Equipment used.
8. Installation method.
9. Final pile head position (x, y, z coordinates) after cut off indicating if pile is installed within the specified tolerances.
10. Nature and location of obstructions encountered.
11. Other pertinent pile driving behavior.

END OF SECTION

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SECTION 31 62 16
STEEL PILES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 318/318R, Building Code Requirements for Structural Concrete and Commentary.
2. American Welding Society (AWS): D1.1, Structural Welding Code—Steel.
3. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
   d. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

1.02 DEFINITIONS

A. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

B. Elevations: Referenced to project datum.

C. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering a subsurface or physical condition.

D. Set: Pile penetration in inches per blow.

E. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

1.03 SUBMITTALS

A. Action Submittals:

1. Splice Design Details and Calculations:
   a. AWS D1.1 Appendix E; include documentation establishing each welder is currently qualified in the proposed welding procedure.

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b. Premanufactured Splices: Manufacturer's recommendations for installation.

B. Informational Submittals:

1. Production pile driving schedule and sequence.
2. Piling Installer Qualifications.
3. Welder Qualifications and Certifications: Source and Site welding.
4. Manufacturer's Certification of Compliance: Manufactured Products.
5. Certification of Calibration:
   a. Pressure gauge for measuring air pressure (for air hammers) or chamber pressure (for closed-end diesel hammers). Include correction data for hose losses if air pressure gauge is located away from hammer. Include a chart for closed end diesel hammers that equates bounce chamber pressure to either equivalent stroke or energy.
   b. Flowmeter and pressure gauge used for measuring flow rates and water pressures at jetting pump.
6. Proposed method(s) to align and maintain pile alignment, including type of leads to be used with details on methods and equipment to be used to measure alignment.
7. Manufacturer's Specifications of Products, and Maintenance Manuals, for pile hammer and auxiliary equipment.
8. Complete Pile Hammer Data Sheet, attached as Supplement to this Specification. Refer to Part 3, Article Supplements.
9. Criteria used to indicate the piles have extended to the till material.
10. Daily Log and Record: At end of each working day, submit two copies of each record for every pile constructed that day.

1.04 QUALIFICATIONS

A. Piling Installer: Minimum of 5 years of past successful experience on ten projects of steel pile installation.

B. Source and Site Welders: Current qualification in proposed welding procedure(s) in accordance with AWS D1.1.

1.05 STORAGE AND HANDLING

A. Do not subject piles to damage by impact bending stresses in transporting to and storing piles onsite.

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1.06 SEQUENCING AND SCHEDULING

A. Conduct installation of steel piles in conjunction with sheet piling in a manner conducive to maintaining project alignment and integrity of the interlocks and sealants.

PART 2 PRODUCTS

2.01 PILES

A. Minimum size and wall thickness shown on Drawings manufactured to ASTM A252 GR3, with minimum specified yield of 50,000 psi, and with chemical conformance to ASTM A572 GR50. All piles shall be open-ended.

2.02 PILE SPLICES

A. Meet requirements of AWS D1.1, and provide equal stress strain behavior in bending, tension, compression, and torsion as unspliced segments of pile.

B. Premanufactured: Owner's prior approval required.

C. A maximum of one splice per pile allowed.

2.03 CONCRETE

A. As specified in Section 31 63 29, Drilled Concrete Piers.

PART 3 EXECUTION

3.01 PILE DRIVING EQUIPMENT

A. Provide driving equipment that is adequate to extend the piling to the glacial till. Operate equipment in accordance with the manufacturer's recommendation.

3.02 INTERLOCKS

A. Interlocks compatible with the adjacent steel sheeting shall be installed on each cylindrical pile in an orientation compatible with the wall alignment. Interlocks shall be shop welded to the pile.

B. Sealant shall be applied to interlocks as specified in Section 31 41 16 Sheet Piling.

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3.03 PREPARATION

A. Use templates or other suitable methods to ensure required degree of accuracy.

B. Do not drive piles within 200 feet of structural concrete less than 7 days old.

3.04 INSTALLATION

A. Notify Owner 7 days in advance of and perform driving in presence of Owner.

B. Welding: Meet requirements of AWS D1.1.

C. End Plates: Drive each pile open-ended.

D. Splicing:

1. Do not splice without Owner present.
2. Number: Maximum of one splice per pile.
3. Preparation: Square ends of both pile sections to be joined.
   a. Tolerance: Pile ends shall not be out of square by more than 1/16 inch.
4. Pre-Manufactured Splices or Couplers: If used, install in accordance with manufacturer's recommendations.
5. Spliced Pile: Straight, deviation in pile alignment shall be less than 1 inch in 50 feet.

E. Pile Marking: At 1-foot intervals for purpose of recording driving resistance and depth of penetration of pile.

F. Pile Driving:

1. Perform in presence of Owner.
2. Maintain hammer concentric with driving train in axial alignment on pile. Do not use hammer to limit deviation of pile during driving by exerting lateral forces or striking at angle. Where pile orientation is essential, take special care to maintain orientation during driving.
3. Drive piles continuously, and without voluntary interruption, to glacial.

G. Driving Tolerances: Not more than 1 percent from vertical or 2 percent from batter shown.

3.05 PILE CUTOFF

A. Cut square at required elevation with tools that will not damage area below cut surface.

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3.06 PLACING CONCRETE IN PIPE PILES

A. Drill within open-ended pipe piles after installation in accordance with Section 31 63 29, Drilled Concrete Piers. Clean and fill piles in accordance with Section 31 63 29, Drilled Concrete Piers and 03 30 00, Cast-in-Place Concrete.

3.07 FIELD QUALITY CONTROL

A. Daily Log and Record: Document for each pile showing as a minimum:

1. Pile identification/location.
2. Weather/groundwater conditions.
3. Date and time start and complete driving.
4. Respective depths of penetration.
5. Pile toe and cutoff elevations.
6. Driving resistance for each foot of driving over entire pile length.
7. Equipment used.
8. Installation method.
9. Final pile head position (x, y, z coordinates) after cutoff indicating if pile is installed within the specified tolerances.
10. Nature and location of obstructions encountered.
11. Other pertinent pile driving behavior.

END OF SECTION

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SECTION 31 63 29
DRILLED CONCRETE PIERS

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. This Section covers work required to drill inside and beyond the bottom of each cylindrical "king" pile, cleanout of the excavation, placement of reinforcing bar and filling of excavation and cylindrical pile with concrete.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 306.1, Standard Specification for Cold Weather Concreting.
2. ASTM International (ASTM):
   a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   c. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.03 DEFINITIONS

A. Bearing Stratum: Formations or layers of soil or rock that support pier and loads imposed on it.

B. Casing: Protective steel casing usually of cylindrical shape, lowered into excavated pier to prevent collapse or cave-in of sidewalls and for purpose of excluding soil and water from excavation.

C. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

D. Deviation: Difference between actual as-constructed horizontal location of center of pier from required location.

E. Drilling Slurry: A mixture of water and mineral in suspension used with or without casing to stabilize excavated pier until casing has been installed or concrete has been placed.

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F. Plumbness: Difference in horizontal location of center of pier measured at top and at bottom.

1.04 SUBMITTALS

A. Action Submittals:

1. Product Data: Commercial materials including cement, admixtures, and fluidifiers.
2. Steel Reinforcement:
   a. Include design calculations.
   b. Show that steel layout and details conform with those shown.

B. Informational Submittals:

1. Installer qualifications.
2. Manufacturer's Certification of Compliance: Commercial products.
3. Certified Test Results: Concrete mix design, including certification of minimum 28-day compressive strength, and aggregates.
4. Mill Certificates: Reinforcement steel, spirals, pile anchorage steel, void form material, and other embedded items.
5. Details on Contractor's equipment, methods, sequence, and procedures to include:
   a. Pier drilling and casing installation and removal, if any.
   b. Slurry design, method to mix, circulate, and desand.
   c. Method of checking and proving the cleanliness of the pier bottom and soundness of foundation material prior to concreting.
   d. Concreting system, and materials for casting and curing, including methods during cold weather.
   e. Dewatering and water/mud disposal plan.
6. Qualifications of Thermal Integrity Profiler (TIP) Consultant.
7. Daily Log and Record: At end of each working day, submit two copies of each record for every pier constructed that day.
8. TIP Testing Results: As detailed in Section 3.09.G of this specification.

1.05 QUALIFICATIONS

A. Installer: Minimum of 5 years of past successful experience on 10 projects of drilled concrete pier installation.

B. TIP Consultant: Licensed Professional Engineer in Michigan with documented and approved experience in TIP Testing.

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1.06 SEQUENCING AND SCHEDULING

A. Complete earthwork in vicinity of pier to top elevation of drilled pier prior to commencing pier drilling.

B. Drill pier, clean out, inspect, install reinforcing steel, and place concrete, all in same day. If acceptable in advance by Owner, pier may be left open overnight but must be temporarily cased and have a cover placed over top of casing.

PART 2 PRODUCTS

2.01 CONCRETE

A. Meet requirements specified in Section 03 30 00, Cast-in-Place Concrete, except slump shall be 4 to 6 inches.

2.02 BENTONITE SLURRY

A. Mix design by RA Contractor with the following minimum requirements:

1. Viscosity (Measured by March Funnel, Seconds): 30 to 60.
2. Sand Content by Volume (Percent): 6, maximum.
3. pH: 8 to 12.
4. Density: Not less than that required to maintain positive head within excavation and prevent sidewall sloughing and such to allow proper displacement during concreting.

2.03 REINFORCING STEEL

A. Meet requirements specified in Section 03 21 00, Reinforcing Steel.

2.04 THERMAL WIRE CABLE

A. Thermal wire cables with calibrated sensors at nominal one-foot intervals designed to be compatible with a TIP Data Acquisition System.

2.05 TIP DATA ACQUISITION SYSTEM

A. Thermal Integrity Profiler (TIP) as manufactured by Pile Dynamics, Inc (30725 Aurora Road, Cleveland OH 44139, (216) 831-6131) or approved equivalent with the following capabilities:

1. A computer-based TIP Data Acquisition System to monitor and download temperature versus time after casting.
2. Ability to automatically collect data at user-defined time intervals (typically 15 minutes).

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PART 3 EXECUTION

3.01 DRILLING EQUIPMENT

A. Suitable type and size to produce a drilled pier of required size and length.

B. Capable of producing a pier without disturbance to material along pier or at pier base.

C. Do not use equipment with bent kelley bars or that wobbles during rotation while drilling.

3.02 DEWATERING AND WATER CONTROL

A. Dewatering is prohibited without advance approval of Owner.

B. Water level within cylindrical piles should be kept higher than the level of the Pine River to provide positive hydraulic head and ensure stability of the excavation.

3.03 EXCAVATION

A. Unclassified: Complete excavation regardless of type of materials encountered.

3.04 DRILLING

A. Provide Owner 7 days' notice of and perform only in presence of Owner.

B. Use drilling slurry to prevent caving and/or water inflow.

C. Perform in continuous operation without interruptions until pier is complete and in a manner so as not to disturb material adjacent to pier.

D. Avoid over-drilling of diameter and depth.

E. Drilling Depth: Actual depth determined by Owner during excavation (plus or minus 6 inches) to achieve depth within glacial till specified in Plans.

F. Defective Piers: Correct piers drilled in excess of specified tolerances by reaming to a larger diameter as determined by Owner.

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3.05 CLEANOUT

A. Remove any soil remaining on the sides of the cylindrical piles using a wire-brush or similar tool designed for such purpose. Do not use augers for cleaning soil off the inside surface of the pile.

B. Flush and desand slurry to the satisfaction of the Owner.

3.06 REINFORCING STEEL

A. As specified in Section 03 21 00, Reinforcing Steel.

B. Spacers: Locate to ensure specified coverage tolerances.

C. Reinforcing Cages:

1. Fasten bars together to form single, rigid, straight unit.
2. Position and securely fasten bars to ensure clearance between reinforcing bars and sides of drilled pier.

D. Ensure reinforcement will remain in place throughout concrete placement and that specified concrete cover is attained and maintained.

E. Hang cage from top cylindrical pile throughout the concreting process. Cages shall not rest on base of drilled pier excavation.

3.07 CONCRETE PLACEMENT

A. Place concrete continuously in one pour to top elevation using a hopper with a spout that directs concrete down middle of pier. Extend rigid pipe spout from hopper to beyond bottom of reinforcement steel cage to direct concrete down pier center to prevent concrete from hitting sides of excavation.

B. Adjust rigid pipe spout length as pier is being filled such that maximum drop from bottom of rigid pipe to fresh concrete surface is no greater than 10 feet.

C. Vibrate concrete within top 10 feet of drilled piers with mechanical tools as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Excess Concrete: Remove accumulation at top of pier so pier has a uniform diameter throughout.

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E. Tremie Methods: Placement of concrete beneath surface of water or bentonite slurry:

1. Keep tremie pipe as near as possible to the bottom of excavation, equip with weight as necessary.
2. Prevent water intrusion into tremie pipe.
3. Equip tremie pipe with a bottom plate or floating plug. Vent as necessary to prevent formation of air pockets.
4. Keep discharge end entirely immersed in concrete at all times.
5. Support tremie pipe so that it can be raised to increase discharge rate or lowered to decrease discharge rate. Bottom of tremie pipe to be no shallower than 5 feet below the current top of concrete.
6. Provide continuous flow of concrete in order for concrete in tremie pipe to maintain a positive pressure differential at all times to prevent slurry intrusion into the pier concrete.

F. After concrete has attained an initial set as evidenced by absence of bleed water, place a suitable cover that prevents drying of top or contamination with foreign material. A curing compound may be used.

3.08 WASTE DISPOSAL

A. Remove spoil and bentonite slurry from Site and dispose of as specified in Section 31 23 16, Excavation.

3.09 THERMAL INTEGRITY PROFILER (TIP) TESTING

A. One out of every three cylindrical “king” piles shall be equipped with Thermal Wires and connected with a functional Thermal Access Port (TAP) immediately after completion of concrete placement, in accordance with the manufacturer’s instructions and/or the direction of the TIP Consultant.

B. TIP Testing shall conform with ASTM D7949, “Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations”, Method B.

C. Each shaft subjected to testing shall contain four (4) thermal wires installed, each wire extending vertically from the top to the bottom of the cage.

D. Thermal wires shall be attached to the reinforcing cages, with each rebar having a thermal wire extended to the top of the shaft to ensure coverage along the entire length of the shaft.

E. The TIP Consultant shall be responsible for guidance and training on the proper installation and hookup of the thermal wires. All thermal wires shall be attached to the steel reinforcing cage prior to insertion into the excavation, with serial numbers noted for each wire and position noted. Thermal wires shall be installed in accordance with the manufacturer’s recommendations and electronically tested prior to insertion into the excavation.

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F. Thermal wires shall be connected to a Thermal Access Port (TAP) collection system immediately following casting. Data shall be collected by the TAP at intervals of time of not less than 15 minutes for a duration of time specified by the TIP Consultant (not less than 24 hours). In the event peak temperature is not achieved within the specified time period, the TAP units shall remain connected to the Thermal Wire Cables for a longer duration as directed by the TIP Consultant. After completion of the data collection period, the TAP shall be connected to the main TIP data acquisition unit and the data files shall be downloaded for inspection of temperatures versus depth. Potential local anomalies indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths, shall be immediately reported to the Owner.

G. Results of TIP testing shall be presented in a written report within 5 working days of completion of the testing. The report shall present results of TIP tests by including:

1. The final analysis must include top-of-shaft and bottom-of-shaft adjustments per the manufacturer's recommendations, so that the temperature plots are adjusted for end effects.
2. Graphical displays of all temperature measurements in each thermal wire versus depth at peak temperature.
3. Indication of unusual temperatures particularly significantly cooler local deviations of the average at any depth from the overall average over the entire length.
4. The overall average temperature at peak temperature. This temperature is proportional to the average radius computed from the actual total concrete volume installed. Radius at any point can then be determined from the temperature at that point compared to the overall average temperature.
5. A depiction of the shaft radius versus depth including the concrete cover at peak temperature. Variations in temperature between wires (at each depth) which in turn correspond to variations in cage alignment should be noted. The cage alignment (or offset) from center should be noted.
6. Conclusions or recommendations concerning the acceptability of the drilled shaft based on the interpretation of the TIP testing results obtained.

3.10 FIELD QUALITY CONTROL

A. Do not start reinforcing steel or concrete placement until pier excavation has been successfully inspected and accepted by Owner.

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B. Daily Log and Record: Document for each drilled concrete pier showing as a minimum:

1. Pier number and location.
2. Model and type of drilling equipment.
3. Pier diameter.
4. Pier length, deviation, and plumbness.
5. Depth drilled.
6. Elevation of ground surface at start of drilling.
7. Top and bottom elevations of concrete.
8. Description of bearing stratum.
9. Water conditions encountered during drilling including estimated inflow, source, and elevation(s).
10. Bottom elevation, type, length, and diameter of casing used, if any.
11. Nature and location of obstructions encountered.
12. Any unusual occurrences during drilling.
13. Theoretical and actual volume of concrete placed.
14. Date and time at start of drilling, completion of drilling, inspection, start of concrete placement, and completion of concrete placement.

END OF SECTION

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SECTION 31 80 00
GEOTECHNICAL INSTRUMENTATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. The purpose of geotechnical instrumentation is to permit the Owner to monitor the RA Contractor's general compliance with the requirements of the RA Contract regarding ground movement in the vicinity of DGVBW installation and protection of adjacent property. The instrumentation program specified herein is not intended to be used to ensure the safety of the Work.

B. The RA Contractor shall be responsible for monitoring ground conditions as necessary to conform to the requirements of the RA Contract. The instrumentation program required by this section does not relieve the RA Contractor of responsibility for providing additional instrumentation and monitoring if, in the RA Contractor's opinion, such additional instrumentation and monitoring are necessary to accomplish the Work.

C. The Work specified in this section includes, but is not limited to, requirements for furnishing, installing, and maintaining geotechnical instrumentation to monitor ground and structure movements. This section also includes the vibration and inclinometer monitoring the RA Contractor is required to perform.

D. At a minimum, the RA Contractor shall install the instrumentation detailed in this section and at locations specified by the Owner prior to construction. Additionally, the RA Contractor shall install instrumentation as necessary to control operations, monitor ground conditions, and ground response to achieve specified project requirements and to prevent damage to existing structures and facilities.

E. The RA Contractor shall hire an independent instrumentation specialist to install instrumentation as specified. The specialist shall have documented experience as set forth in Article 1.04, Quality Assurance, of this Specification section.

F. The RA Contractor’s Instrumentation Specialist shall install the instruments as specified at the locations established by the Owner. The RA Contractor will survey and monitor all settlement markers and furnish the Owner with results. The RA Contractor shall provide access to the instrumentation to allow the Owner to independently monitor the instrumentation at any time and for any reason.

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G. The RA Contractor shall complete an as-installed position survey to determine the horizontal and vertical positions of settlement markers and inclinometer casings in accordance with the requirements herein and furnish the Owner with a copy of the results within 24 hours of field data acquisition.

H. RA Contractor shall coordinate with Owner regarding instrumentation to be abandoned and instrumentation to be left in place upon completion of the Work.

1.02 SUBMITTALS

A. Action Submittals: Instrumentation shop drawings detailing locations; type, details, and other pertinent information showing the installation details for each type of instrumentation required.

B. Informational Submittals:

1. Qualifications of instrumentation specialists and personnel.
2. Drawing that indicates the locations of control points and benchmarks associated with surveys for monitoring geotechnical instrumentation.
3. Description of methods for installing and protecting all instruments.
4. Materials and mix portions for cement-bentonite or cement-lime grout for installing inclinometers.
5. Schedule of instrument installation related to significant activities or milestones in the overall Project.
6. Following installation of the instruments and prior to the start of excavation, submit as-built shop drawings showing the exact installed location, the instrument identification number, the instrument type, the installation date and time, and the anchor or tip elevation and instrument length, where applicable, and installed locations of control points and benchmarks associated with surveys for monitoring geotechnical instrumentation. Include details of installed instruments, accessories, and protective measures including all dimensions and materials used.
7. Product Data: Manufacturer's literature describing installation, operation, and maintenance procedures for all instruments, materials, readout units, and accessories.
8. Reports and Records:
   a. Submit three copies of initial/baseline readings specified herein to the Owner, on forms approved by the Owner, at least 15 days prior to the start of any excavation activity.
   b. Submit three copies of the instrumentation data to the Owner, on forms approved by the Owner, within 24 hours after the observation has been made.

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c. As applicable, submit reduced data and updated data plots in ground movements within 2 working days after observations have been made.
d. Inform Owner immediately when Action Limits or Displacement Limit is reached for any instrument.
e. Drilling and installation logs for instrumentation installations prepared by the instrumentation specialist.
f. Copies of abandonment forms for inclinometer casings.

9. Certificates: For each instrument to be installed, as applicable, a certificate issued by the instrument's manufacturer stating that the manufacturer has inspected and tested each instrument before it leaves the factory to see that the instrument is working correctly and has no defects or missing parts.
10. Permits and Consents: For drilling holes from ground surface and conducting monitoring activities and if necessary, for potholing to avoid utility interference.

C. Monitoring Plan:

1. Submit a single monitoring plan that includes the required frequency of monitoring (minimum frequency in Article 3.09, Movement/Settlement Monitoring, of this section). Monitoring shall include:
   a. On-site observation of the DGVBW performance, to be performed by the RA Contractor.
   b. Position (survey) measurement of geotechnical instrumentation, to be performed by the RA Contractor, and additional monitoring performed by the RA Contractor (see paragraph 3 below).
   c. Review of position measurements to assess ground movement adjacent to the DGVBW, to be performed by the RA Contractor.
2. The RA Contractor shall provide a Michigan-licensed surveyor to take position measurements of the instrumentation described in this Specification section at the frequency indicated in Article 3.09, Movement/Settlement Monitoring of this section. Additional monitoring as required by the ground support engineer's plan shall be performed by a Michigan-licensed surveyor retained by the RA Contractor. The RA Contractor's engineer shall review all measured data as required by this Specification section.
3. The RA Contractor shall provide monthly reports from RA Contractor's ground support design engineer on performance of DGVBW elements and associated adjacent ground movements and protection of adjacent property. This shall include, but not be limited to the adjacent residential parcel east of the north/east terminus of the wall and STH 46 on the south terminus.

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1.03 DEFINITIONS

A. Facility Settlement Marker (FM): A readily-identifiable existing feature or new paint marking on an existing building or above-grade facilities; or an inscribed marking, approved surveyor's nail, or brass or stainless steel rod (pin) installed onto a manhole, vault, or other similar structure at predetermined locations to measure vertical elevation changes of a facility or structural element.

B. Inclinometer (INC): Vertical inclinometers are instruments for measuring relative horizontal displacements affecting the shape of a guide casing embedded in the ground or structure. Inclinometer probes usually measure displacement in two perpendicular planes; therefore, displacement magnitudes and directions (vectors) can be calculated. The bottom end of the guide casing serves as a stable reference (datum) and must be embedded beyond the displacement zone. Relative displacement over time is determined by repeating measurements at the same depths and comparing data sets.

C. Vibration Monitoring (VM): Vibration monitoring involves installing electronic equipment that continuously measures the particle velocity in the earth resulting from specific construction activities.

1.04 QUALITY ASSURANCE

A. Personnel Qualifications:

1. Qualified technicians with a minimum of 2 years' experience in the installation of geotechnical instrumentation similar to those specified herein.
2. Instrumentation Specialist: A professional Civil or Geotechnical Engineer or Engineering Geologist, with a minimum of 5 years' experience in the installation of instrumentation specified herein, shall prepare instrumentation shop drawings and supervise and direct technicians and be responsible for instrument installation required. The instrumentation specialist shall be physically present at the installation sites to supervise the installations.

B. The RA Contractor shall notify the Owner at least 24 hours prior to all instrumentation installation operations so that the Owner may monitor the installation work.

C. Each instrument specified herein shall be the product of an acceptable manufacturer currently engaged in manufacturing geotechnical instrumentation hardware of the specified types.

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D. Surveys (performed by the RA Contractor) for monitoring geotechnical instrumentation shall be referenced to the same control points and benchmarks established for setting out the work. Control points shall be tied to benchmarks and other monuments outside of the zone of ground movements that might result from underground work.

1.05 TOLERANCES

A. FMs, VMs, and INCs shall be installed within 12 inches of the horizontal locations as agreed by the Owner or approved shop drawings.

B. Should actual field conditions prohibit installation at the locations and elevations established by the Owner, the Owner shall be consulted, and new instrument locations and elevations established.

1.06 PROJECT CONDITIONS

A. Obtain necessary permits for the installation of monitoring systems.

B. Provide the Owner access to the instruments at all times.

C. All INCs and VMs shall be protected from vandalism or other accidental damage using steel locking covers or traffic-rated flush bolt-down covers.

PART 2 PRODUCTS

2.01 SETTLEMENT MARKERS

A. Facility settlement markers (FM) on the DGVBW shall consist of reflective prisms, punch marks, survey nails, or other suitable devices capable of being monitored for providing vertical and horizontal displacement.

2.02 INCLINOMETERS (INC)

A. Inclinometer casing shall be grooved plastic 2.75-inch-O.D. casing that is compatible with the inclinometer being provided. The casing shall be complete with necessary rigid self-aligning couplings and end plugs. All inclinometer casings shall extend a minimum of 20 feet beyond the bottom of the drilled shaft components of the adjacent DGVBW.

B. The inclinometer monitoring system shall be provided by RA Contractor and include probe, 100 feet of cable, cable relief, pulley assembly, cable hole, and readout box. The inclinometer readout shall measure inclinations at any depth selected by the operator and shall digitally store, process and report the data (by display and downloadable digital files) as lateral movements from a stored

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baseline reading. The cable connecting the sensor and indicator shall have a stranded steel core to take the stress of pulling so as not to break any connectors or wires. The cable shall be jacketed with a waterproof material and marked externally at 1-foot intervals for accurate depth determination. The cable guide pulley shall mount to the top of the inclinometer casing.

2.03 VIBRATION MONITOR (VM)

A. Vibrations shall be monitored with triaxial geophones (TG). Provide Instantel Series III Minimate Plus and triaxial geophone or approved equal. Provide two triaxial packages and appropriate vibration monitor(s) when vibration monitoring is required.

B. All vibration instruments shall be supplied with current calibration documents and shall be recalibrated on approximately six-month use interval. At a minimum, instrument specific calibration curves of peak particle velocity input to peak particle velocity output shall be provided over the specified frequency ranges at both 0.05 and 5.0 inches per second (ips) for each instrument.

2.04 INSTRUMENT PROTECTION AND COVERS

A. Stick-up Covers: Covers for INCs where a stick-up casing is feasible shall be lockable steel covers compatible with the casing diameter.

B. Padlocks shall be furnished for each lockable protective housing. All padlocks shall be all brass construction and keyed the same.

C. Five keys for padlocks shall be provided to the Owner.

PART 3 EXECUTION

3.01 GENERAL

A. Instrumentation shall be installed at the locations established by the Owner prior to commencement of construction activities. The number of each type of instrument for each contract is contained below:

Instrument Type	Number
Inclinometers (INC)	5
Facility Settlement Marker (FM)	14
Vibration Monitors (VM)	3

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B. All instrumentation shall be installed under the direct supervision of the RA Contractor's instrumentation specialist.

C. Inclinometers shall be located within 5 feet of the DGVBW, at approximate equal intervals; exact locations to be proposed by RA Contractor and approved by Owner.

D. Locate conduits and underground utilities in all areas where borings are to be drilled and instruments installed. Instrument locations shall be modified, as approved by the Owner, to avoid interference with the existing conduits and utilities. Repair damage to existing utilities resulting from instrument installations at no additional cost to the Owner.

E. Owner shall have access to instrument locations and RA Contractor's cooperation is required in obtaining monitoring data, including the provision of assistance, as required.

F. All instruments shall be clearly marked, permanently labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public. Protective housing and box or vault covers shall be marked.

G. Geotechnical instrumentation shall be installed and baseline surveys or initial readings completed before commencing any excavation work.

H. Location Surveying: Promptly following installation, the RA Contractor shall survey and provide horizontal coordinates and vertical elevations of the ground surface and top of all instruments.

I. Drilling from the Ground Surface: RA Contractor shall obtain any permits required for boreholes drilled from the ground surface. Obtain necessary permits for each such instrument and conform to the permit requirements during drilling and installation.

J. Initial Reading: Following instrument installation the RA Contractor's surveyor, shall take a minimum of two sets of initial readings to provide baseline readings and to demonstrate the adequacy of the completed installation.

1. Installation of the instrumentation by the RA Contractor does not preclude the Owner, through an independent contractor, from installing instrumentation in, on, near, or adjacent to the construction work.
2. Elevations shall be recorded to a precision of 0.001 foot. Horizontal survey accuracy shall be 0.01 foot or less.

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3. The RA Contractor shall take additional survey(s) as requested by the Owner if in the opinion of the Owner the two sets of initial readings do not adequately establish the baseline level. After initial readings are approved by the Owner, the average of the two sets of initial readings shall be used to establish the baseline level of the instrument, unless otherwise directed by the Owner.

3.02 FACILITY AND GROUND SURFACE SETTLEMENT MARKERS

A. FMs shall be installed on the DGVBM where directed by the Owner, and approved submittals. Markers shall be installed firmly to prevent loosening and in a manner and location that allows survey rods to be consistently placed on the high point of the marker head or point being measured.

3.03 SOIL DRILLING AND SAMPLING

A. Hollow stem auger methods may be used to provide a casing for temporary soil support for installation of inclinometer casing. Boreholes shall be oversized at the ground surface as necessary to accommodate installation of protective covers.

B. Arrange ports in the drilling bit so that there is no jetting action of the drilling fluid ahead of the bit. Use the minimum amount of fluid necessary to carry away the cuttings.

C. Complete soil sampling at intervals of 2.5 feet or less using standard penetration tests that are conducted in accordance with ASTM D1586.

D. Store representative samples portions not retained for analytical laboratory testing in glass jars approximately 5 inches high and 1-3/4 inches in inside diameter at the mouth. Provide jars with metal screw caps containing a rubber or waxed paper gasket that forms an airtight seal when closed. Provide jars with labels large enough to identify the jar with the project number and name, boring number, sample number, depths at top and bottom of sample, blow count and recovery. Perform the laboratory testing on retained samples as deemed necessary.

E. Observe all soil drilling and sampling and prepare a log of the boring.

F. Upon completion of drilling, flush the boring with clear water prior to instrument installation.

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3.04 VIBRATION MONITORING

A. Vibration monitoring is required at sites where pile driving, demolition, or vibration-causing construction is being carried out within 200 feet of the eastern terminus of the DGVBW. The RA Contractor shall locate surface vibration sensors as listed in the vibration criteria table below. Remove the surface vibration sensors when surface vibration monitoring is not being performed. Install surface vibration sensors in accordance with the manufacturer's recommendations.

B. The RA Contractor shall be responsible for monitoring all instrumentation. The Owner, at their discretion, will make additional independent monitoring using the same readout instruments used by the RA Contractor. Provide monitoring equipment and access to instrumentation locations at any time for the Owner's independent monitoring.

C. The RA Contractor shall conduct background vibration monitoring at the monitoring points given in the vibration criteria table below at least 72 hours in advance of pile driving, demolition, or other vibration-causing work to establish a "normal operating vibration level". The RA Contractor shall notify the Owner of the start of monitoring to inspect the installation of the instrumentation.

D. Continuous vibration monitoring shall be performed during all pile driving including foundation piles and/or sheet piles for earth support or groundwater control for which pile driving is within 200 feet of the eastern terminus of the DGVBW. Trigger level for monitoring equipment shall be set at 50 percent of the maximum peak particle velocity (PPV). Vibration monitoring, during demolition or other construction activities, shall be made at least once a week for at least 2 hours when vibration producing demolition or construction is occurring. The Owner may adjust trigger levels and monitoring frequency based on collected data.

E. Vibration criteria established by the Owner are prescribed in the table below. The RA Contractor shall be responsible for determining the means and methods for preventing the criteria from being exceeded during demolition, pile driving, and other construction activities that may cause harmful vibration.

Recommended Sensor Location	**Maximum Vibration Level (peak particle velocity, in/sec)**
Adjacent to property line.	To be Determined by RA Contractor

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F. If the RA Contractor exceeds 80 percent of the ground vibration limit as given in the above table, for any construction activity, he shall cease that activity and submit a report. The report shall give the construction parameter data and include a proposal for corrective action necessary to ensure that the specified limit is not exceeded for future activities. This report shall be submitted to the Owner, and his permission shall be obtained prior to the continuation, or beginning of any future vibration-producing construction activities.

G. The RA Contractor shall record and report all vibration-producing activities at which ground vibrations were measured. The report shall include the maximum peak particle velocity and its associated frequency, type and location of the vibration producing event, location of the geophones and closest distance from the vibration-producing event to the geophone(s). A sample report shall be submitted to the Owner for approval at least 7 days prior to any recording activity.

H. All costs incurred by the Owner that are associated with the exceedance of the specified vibration criteria including, but not limited to, structure damage and plant downtime, shall be borne by the RA Contractor.

3.05 INCLINOMETER CASING

A. Install inclinometer casing at the locations established by the Owner prior to installation. Drill, sample, and log borings in soil drilled for the purpose of installing inclinometer casing as specified in this article.

B. Install the inclinometer casing complete with end plug as directed by the Owner. Install the inclinometer casing at least 10 feet below the elevation of the cylindrical pipe piles for the adjacent DGVBW. Carefully orient the casing grooves as instructed by the Owner. Grout the inclinometer casing in place. Place grout by tremie method. If steel drill casing has been used to support the borehole, remove the drill casing in increments, and top off the grout level with each increment.

C. The grout shall consist of a cement-to-water ratio ranging from 2.5 to 1 for hard soil and 6.6 to 1 for soft soil by weight. The specific ratio to be used will be determined by the Owner. The bentonite to cement ratio will be approximately 0.3 o 1, by weight, adjusted to produce grout with the consistency of heavy cream. Mix cement and water first. Add bentonite as necessary to achieve the specified consistency.

D. Provide the top of each inclinometer casing with a cap. The cap shall be easy to remove.

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E. Perform a groove tracking test after the installation has been completed to ensure that the inclinometer casing has been properly installed. Lower the inclinometer sensor to the bottom of the casing in all four possible orientations, verifying that on raising to the top of the casing the inclinometer orientation is unchanged.

3.06 INSTRUMENT PROTECTION, MAINTENANCE AND REPAIR

A. Flag and protect all locations. Exercise care during construction so as to avoid damage to instrumentation. Repair or replace instrumentation that is damaged as a result of the RA Contractor's operation at his expense. The Owner will determine whether repair or replacement is required. Complete the repair or replacement as soon as practical after notification by the Owner as to whether a repair or replacement is required.

B. Instruments shall be maintained by draining any accumulated water, removing any debris from under protective covers and keeping covers locked and sealed at all times.

3.07 GROUND / DGVBW MOVEMENT LIMITS

A. The RA Contractor shall use whatever means and methods are necessary to limit ground movements, settlements and damage of utilities, structures and other facilities during construction. These means and methods include, but are not limited to ground support systems, underpinning of vulnerable facilities, grouting and other forms of ground improvement.

B. The ground movement limits for all instruments are established as follows:

Facility	**Action Limit (inch)**	**Displacement Limit (inch)**
Inclinometer Lateral Movement	0.5	1.5
DGVBW	1.0	2.0

C. If settlement of a facility or settlement marker reaches an Action Limit during construction, the likely cause of the settlement shall be reported to the Owner and actions shall be promptly taken to limit further settlements and to prevent Settlement Limits from being exceeded. Actions to be taken in response to measured settlements shall be reported to the Owner before being taken, except in emergency situations. The cost of actions required to comply with settlement limits and to repair any damage to adjacent facilities shall be borne by the RA Contractor with no cost to the Owner.

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3.08 DISCLOSURE OF DATA

A. The RA Contractor shall not disclose any instrumentation data to third parties and shall not publish data without prior approval and written consent of the Owner.

3.09 ABANDONMENT OF INSTRUMENTS

A. At the completion of the job, coordinate with Owner to determine instrumentation to be abandoned or removed. Grout the full depth of instrument casings and pipes by tremie method or by pressure injection from the ground surface. Grout shall consist of cement and water, with the minimum amount of water necessary to allow pumping. Remove guard casings and valve boxes, and patch holes with materials and to a durability consistent with the surrounding surface. Salvaged material except readout instruments shall become the property of the RA Contractor. Readout instruments including any software used with the instruments for data collection will remain the property of the Owner.

B. Settlement Markers: All FMs shall be removed by the RA Contractor during the cleanup and restoration work, or sooner as allowed or required by the Owner. Abandonment shall be documented, and records submitted to the Owner and agencies requiring abandonment records. The resulting voids from casing removal shall be filled with soil and the ground surface restored.

END OF SECTION

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SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 GENERAL

A. Existing site perimeter fence that requires replacement due to construction activities shall meet the requirements of this specification.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   k. C150, Standard Specification for Portland Cement.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   o. F626, Standard Specification for Fence Fittings.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.

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q. F900, Standard Specification for Industrial and Commercial Swing Gates.
r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.03 DEFINITIONS

A. Terms as defined in ASTM F552.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
2. Samples:
   a. Chain Link Fabric: Approximately 6 inches square.
   b. Posts, Rails, Braces, Wire, and Ties: Approximately 6 inches long.
   c. Fittings: 1 each.
3. Test Reports: Field test result for compliance of installation of chain link fence and gates.

B. Informational Submittals:

1. Manufacturer's recommended installation instructions.
2. Evidence of Supplier and installer qualifications.

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1.05 QUALITY ASSURANCE

A. Qualifications: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for the Project.

B. Supply of equipment and components shall be product of individual company with record of installations meeting requirements specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.07 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.08 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot.

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B. Height: 96 inches, unless otherwise shown.

C. Core Wire Gauge: No. 9.

D. Pattern: 2-inch diamond-mesh.

E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.

F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

G. Wires of Twisted Selvages:

1. Twisted in a closed helix three full turns.
2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5. Protective Coatings:
   a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.375 inches.
   b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.875 inches.
   b. Weight: 5.79 pounds per foot.

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D. Posts for Swing Gates 8 Feet High and Under:

1. ASTM F900.
2. Round Steel Pipe:
   a. Outside Diameter: 4 inches.
   b. Weight: 9.11 pounds per foot.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece.
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

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2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.07 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
5. Gate Fabric Height: Same as for adjacent fence height.
6. Welded Steel Joints: Paint with zinc-based paint.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for single and double swing gate types.

1. Leaf Width: As shown.
2. Hinges: Offset type, malleable iron.
   a. Furnished with large bearing surfaces for clamping in position.
   b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.
6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released. Required for double swing gates only.

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2.08 CONCRETE

A. Materials: ASTM C387, packaged, dry, combined ingredients with Type I cement.

B. Mixing: In a clean metal container, mix package of dry materials by hand or machine. Following manufacturer's instructions, add clean water in sufficient quantity to produce a slump of 2 inches to 3 inches.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Owner. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.

1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.
2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

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B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

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3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.07 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

E. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

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3.08 GATES

A. Install gates according to manufacturer's written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.09 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.10 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

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SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.
   e. Michigan Department of Transportation Standard Specifications for Construction, 2020 or most current version.

1.02 SUBMITTALS

A. Action Submittals:

1. RA Contractor will identify borrow source(s) for sampling and approval by Owner. Borrow samples collected by the RA Contractor will be analyzed for the following:
   a. Chemical analyses of source materials (contamination, fertility and salinity).
      1) For chemical testing, test for the analyses listed in Section 31 23 23, Fill and Backfill, Article 2.01.C.
   b. Gradation analyses of source materials.

B. Informational Submittals:

1. Certified Topsoil Analysis Reports:
   a. Indicate quantities of materials necessary to bring imported topsoil into compliance with textural/gradation requirements.
   b. Indicate quantity of lime, quantity and analysis of fertilizer, and quantity and type of soil additive.

1.03 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 31 23 23, Fill and Backfill, prior to performing Work specified under this section.

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B. Perform Post-Backfill Survey in accordance with Section 01 31 13, Project Coordination, prior to performing Work specified under this section.

C. Complete work specified in this section after receiving authorization from Owner upon inspection of final backfill grade.

1.04 QUALITY ASSURANCE

A. Notify Owner when:

1. Subgrade is ready for backfilling or when backfilling operations are resumed after a period of inactivity.
2. Soft of loose subgrade materials are encountered.
3. Topsoil material appears to be deviating from Specifications.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: In accordance with Michigan Department of Transportation (MDOT) 2020 Standard Specifications for Construction Part 917.07, or most current version.

C. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

D. Testing of topsoil for grain-size, chemical analysis, pH, and organic content to be one sample per 1,000 CY of imported topsoil.

2.02 LIME

A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.

B. Gradation:

1. Minimum 50 percent passing No. 100 sieve.
2. Minimum 90 percent passing No. 20 sieve.
3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

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2.03 SOIL ADDITIVES

A. Sawdust or Ground Bark:

1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.

B. Peat:

1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
   a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.
   b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer: As specified in Section 32 92 00, Turf and Grasses.

D. Sand: Fine Aggregate: Clean, coarse, well-graded, ASTM C33/C33M.

2.04 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

B. The RA Contractor will submit all laboratory reports to Owner for approval within 1 day of receipt from the laboratory. RA Contractor must receive approval from Owner prior to placement of borrow source materials.

C. Source quality control samples shall be collected for the analyses listed in Section 31 23 23, Fill and Backfill, Article 2.01.C.

D. Perform tests necessary to locate acceptable imported source materials meeting specified physical and chemical requirements.

E. The RA Contractor will collect samples of topsoil for general fertility/salinity parameters using the Ag Source Harris ‘Diagnostic Test’. (http://documents.crinet.com/AgSource-Cooperative-Services/Locations/HarrisSoil-infosheet-v2-Interactive-2014.pdf) or equivalent. Collect one sample per 1,000 cubic yards of imported source material for general fertility/salinity parameters.

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PART 3 EXECUTION

3.01 GENERAL

A. This work includes transportation and installation of all material to the project site.

B. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

3.02 SUBGRADE PREPARATION

A. If pH is determined to be low, apply lime at the rate of 50 pounds per 1,000 square feet to subgrade before tilling.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.03 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

C. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth 6 inches where seeding and planting are scheduled.

D. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

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G. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.

H. Remove material placed in Work that does not meet Specification requirements.

END OF SECTION

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SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 12 weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass that has:

1. No bare spots larger than 3 square feet.
2. Viable establishment greater than 80 percent with no bare spots larger than 1 square foot.

1.02 SUBMITTALS

A. Action Submittals:

1. Product labels/data sheets.
2. Seed mixtures: Proportions of each kind of seed.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
2. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

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B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Prepare topsoil as specified in Section 32 91 13, Topsoil Preparation, before starting Work of this section.

B. Complete Work under this section within 3 days following completion of topsoil preparation.

C. Notify Owner at least 3 days in advance of:

1. Each material delivery.
2. Start of planting activity.

D. Growing Season: The period during which soil temperatures reach 50 degrees Fahrenheit or greater in the spring with a limited possibility of frost and greater than 45 degrees Fahrenheit in the fall, typically May 1 through October 16.

1.06 MAINTENANCE SERVICE

A. RA Contractor: Perform maintenance operations during maintenance period to include:

1. Water to support germination and sustain growth.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
5. Reseed/replant during next planting season if scheduled end of maintenance period falls outside of Growing Season, as defined in Article Sequencing and Scheduling.
6. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

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PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Application Rates: Determined by soil analysis results as described in Section 32 91 13, Soil Preparation.

2.02 SEED

A. The seed mix will contain a mixture of at least 10 native species of grasses and forbs with successive blooming periods such that the Site has viable cover throughout the span of the growing season.

B. The seed mix will contain species appropriate to the hydrologic regime anticipated for the planting site (i.e. dry land species for dry areas and wetland species for wet areas).

C. The seed mixture will be certified weed free and not contain any state-listed noxious, non-native, or non-native invasive species. The seed will be obtained from a supplier within 100 miles of the Project Site.

2.03 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.04 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

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2.05 NETTING

A. Jute:

1. Heavy-duty, twisted, weighing 1 pound per square yard.
2. Openings Between Strands: Approximately 1 inch square.

B. Matting:

1. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
2. Manufacturers and Products:
   a. Akzo Industries, Ashville, NC; Curlex mat.
   b. North American Green, Evansville, IN; S150 blanket.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseed all areas requiring restoration.

C. Hydroseeding:

1. Application Rate: Based on manufacturer's recommendation.

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2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

D. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre within 24 hours from the time seeding has been performed.

E. Netting: Immediately after mulching, place over mulched areas with slopes steeper than 3H:1V, in accordance with manufacturer's instructions. Locate strips parallel to slope and completely cover seeded areas.

F. Water: Apply with a fine spray after mulching to saturate the top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

A. Establishment will be measured a minimum of one time after the seeding is completed, prior to the end of the maintenance period.

B. The RA Contractor is responsible for maintaining the seeded areas and plantings in accordance with this specification.

C. If a satisfactory stand has not been established, Owner will make another determination after written notice from RA Contractor following the next growing season.

END OF SECTION

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Appendix C
Value Engineering Summary Technical Memorandum

Memorandum

CH2M HILL, Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

Subject:	**Value Engineering Screening Results Summary for Downgradient Vertical Barrier Wall Remedial Design**
Project Name:	Velsicol Chemical Corporation Superfund Site
Contract Info:	Contract Number 68HE0519D0007, Task Order Number 68HE0521F0106
Attention:	Tom Alcamo/U.S. Environmental Protection Agency (EPA)
From:	CH2M HILL, Inc. (CH2M)[1]
Date:	June 30, 2023
DCN:	GLAES-R5-21F0106-02016

CH2M has prepared this technical memorandum for EPA to summarize the findings from the value engineering (VE) screening for the downgradient vertical barrier wall (DGVBW) remedial design (RD) at the Velsicol Chemical Corporation Superfund Site (site). In accordance with the approved proposal (Jacobs, 2021), CH2M performed a VE screening review was performed from March 6 through 20, 2023, during the prefinal design phase to optimize costs for the DGVBW design without sacrificing the reliability or efficiency of the project. The VE screening was led by staff within CH2M, separate from the design team. This work was performed under Great Lakes Architect and Engineering Services (GLAES) II Contract 68HE0519D0007, Task Order Number 68HE0521F0106.

1. Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses approximately 100 acres in St. Louis, Michigan, and includes the Former Plant Site (FPS) and a residential area referenced as the adjacent or nearby properties (ANP). The lead agency for the remedial investigation (RI)/feasibility study was the Michigan Department of Environment, Great Lakes, and Energy. EPA is the lead agency for the ongoing RD and remedial action (RA).

A chemical manufacturing plant previously occupied the FPS from the mid-1930s until it was demolished in 1978. Industrial operations at the plant, which included manufacturing of pesticides and fire retardants, resulted in widespread contamination on the FPS. In 1982, the Velsicol Chemical Corporation entered into an administrative order on consent with the United States and the State of Michigan. Pursuant to the administrative order on consent, the Velsicol Chemical Corporation constructed a containment system for the FPS, which included the installation of a low-permeability cap and a 2-foot-thick, low-permeability slurry wall around the entire 52-acre FPS.

The FPS is fenced and is bordered on the south and east by the ANP, with Washington Avenue (M-46) along the southern edge. Watson Street and North Street mark the eastern edge, and Pine River and Mill

[1] CH2M HILL, Inc. is a wholly owned subsidiary of Jacobs Engineering Group Inc.

Pond form the western and northern boundaries. ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the FPS boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The site consists of four operable units (OUs):

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which a ROD was published in October 2022 (EPA 2022)
- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of Pine, Chippewa, and Tittabawassee Rivers, for which RI activities are ongoing

The DGVBW is a component of the OU1 remedy and will be installed within Pine River near the shoreline of the FPS to decrease the potential for contaminants present in the shallow unit of the FPS to directly discharge to Pine River.

2. Objective

The purpose of this technical memorandum is to summarize the results of the VE screening during the DGVBW RD.

3. Value Engineering Screening Findings and Design Changes

This section provides a brief summary of the major VE screening findings and subsequent design changes. Additional detail can be found in the review comment tracking form provided in Attachment 1.

- Multiple VE comments noted uncertainty with driving the sheet piles 10 feet into the till unit, regardless of the type of sheet pile used. Additionally, the VE team inquired if the tiebacks and deadman piles could be replaced with grouted anchors to lower the cost of construction. Based on these comments, DGVBW was redesigned using a combination wall approach. The combination wall will be cantilevered with drilled shaft support along the entire alignment, eliminating the need for anchorage and deadman support. Although construction of the combination wall is more expensive than the wall presented in the preliminary design, there is less construction risk. CH2M discussed the design change with EPA during the April 2023 design review meeting, and EPA directed CH2M to proceed with the combination wall design.
- VE reviewers commented that it was unclear how the DGVBW may or may not interfere with the dense nonaqueous phase liquid (DNAPL)/groundwater collection system (GWCS). Therefore, the DNAPL/GWCS was added to cross sections in the drawings (Appendix A of the Basis of Design Report) to better illustrate placement of the DGVBW relative to the DNAPL/GWCS.
- The VE team noted it was unclear how stormwater would be managed between construction of the DGVBW and engineered cap. An interim grading plan was added to the prefinal design to address stormwater between construction of the DGVBW and engineered cap.
- The VE team asked if clearing and grubbing material could be reused. As a cost-saving measure, clearing and grubbing material will be chipped and spread onsite.

4. References

Jacobs Engineering Group, Inc. (Jacobs). 2021. *Technical Proposal – Velsicol Chemical Superfund Site, St. Louis, Michigan, Remedial Design.* July.

U.S. Environmental Protection Agency (EPA). 2022. *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Operable Unit 3, St. Louis, Michigan.* October.

Attachment 1
Value Engineering Screening Comments

Review Comment Tracking Form

Client: EPA

Project: Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall Remedial Design

Project No.: D3542500

Submittal: Value Engineering - Review of Preliminary Basis of Design

Date: 3/27/2023

No.	Reference Page or Sheet No.	Review Comment	Response
1	NA	What is driving the use of the PZ-35 sheets? Corrosion/50 year design life, stability analysis or specifying a sheet stout enough to drive 10 feet into the till? If the later, consider reducing the stoutness of the sheeting to save on material costs (see later comments on embedment depth).	Wall redesigned for combination wall / drilled shaft support. Sheet piling thickness reduced as a result.
2	NA	The idea of needing to drive sheet piles, regardless of how oversized, 10 feet into the till may not be realistic given that the average till penetration in OU2 was only 4.3 feet. Specifying 10 feet of embedment could result in excessively long cut offs, and cause the bidders to increase their pricing to account for the extra effort and equipment wear and tear required to achieve the 10 feet of embedment.	Wall redesigned for combination wall / drilled shaft support. Will drive sheeting until refusal and drill below the circular piles. There will not be a minimum penetration depth or elevation specified.
3	NA	Consider the following risk reduction measures if the design maintains the 10 foot criteria: - In addition to drivability studies, verify that PZ-35 can be driven 10 feet into the till in several locations through an installation test program. - The as-built tech memo (January 2000) discussed stability analyses which were performed after the fact when the embedment was not achieved. Consider doing some of those stability analyses before hand to determine the contingency steps in the event the embedment is not achieved. - Probably need to develop a plan for various locations and penetration depths into the till such that work isn't halted during construction. Could predrilling work without reducing the barrier effectiveness? Could you default to grouted anchors inclined steeply enough to have the bond zone in the till?	Wall redesigned for combination wall/ drilled shaft support. There will not be a minimum penetration depth or elevation specified.

Review Comment Tracking Form

Client: EPA

Project: Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall Remedial Design

Project No.: D3542500

Submittal: Value Engineering - Review of Preliminary Basis of Design

Date: 3/27/2023

No.	Reference Page or Sheet No.	Review Comment	Response
4	NA	Presuming we need to stay with sheet piles, can we replace the tie-backs and deadman piles with a more steeply-inclined grouted anchor system that only has the bond zone in the till? It looks like the typical vertical distance between the tie-back elevation and the top of till is about 10 feet. Anchors inclined 20 degrees with a 15-foot bond zone would be less than 45 feet long. Can we cost out 45 or 50 foot grouted anchors compared to the deadman piles and ties? - In the BODR Appendix J, the cost of the tie-rods is $555K and the cost of the deadman piles is $499K. It's hard to imagine that a 25 foot tie rods 7.5 feet OC are more expensive than providing and installing a continuous 25-foot deep PZ-35 wall with corrosion protection. Check assumptions.	Wall redesigned as a combination wall which will act as a cantilevered element. There will be no anchorage.
5	Drawings Sheets 10-14	It would be helpful to show DNAPL collection system on the cross-sections in the Design Drawings, so we can see the potential interactions.	Added DNAPL collection system to cross sections.
6	Drawings	Could some portion of the perimeter drain system be constructed as part of the DGVBW work, so that it could assist with dewatering for fill placed between the DBVBW and the existing shoreline?	Unfortunately not. The perimeter drain system design is not included in our current task order from EPA.
7	NA	Why is the DGVBW being constructed before the UGVBW? It seems as if the downgradient wall without the other elements (cap and UGVBW) will tend to back up groundwater behind the new wall, making placement of the final cap more challenging. If constructing the UGVBW first is not an option, could there be a cost benefit to keeping the temporary dewatering system in place (at least the sumps/wells) for the capping contractor to use?	The design and construction sequencing is driven by predesign investigations completed to date and EPA funding. The upgradient portion of the site is still being investigated; therefore, the DGVBW is being designed and constructed first. An interim grading plan was added to the prefinal design to address stormwater between construction of the DGVBW and engineered cap. The entire site will be regraded as part of the engineered cap construction.

Review Comment Tracking Form

Client: EPA

Project: Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall Remedial Design

Project No.: D3542500

Submittal: Value Engineering - Review of Preliminary Basis of Design

Date: 3/27/2023

No.	Reference Page or Sheet No.	Review Comment	Response
8	Drawings Sheet 17	Sheet calls for Stage 2 dewatering to elevation 714.50, which is the top of the Stage 1 backfill. The dewatering elevation should be 2 feet below the grade (elevation 712.50) or a self-compacting material needs to be placed in the bottom 2 feet of Stage 2 fill to allow placement in wet conditions	Wall redesigned to eliminate the need for dewatering. All fill to consist of "self compacting" material which is further vibrated to achieve adequate compaction.
9	Drawings Sheet 17	Where does material that is temporarily excavated for deadman ties go? Can it be reused as fill? Can any other on-site material (i.e. access road material, any other material that might otherwise have to be disposed of offsite, etc.) be used as fill? If there area to be backfilled could be adequately and economically dewatered, could a general fill be used in lie of some of the 46G aggregate (which presumably would yield cost savings)?	The updated design removed the deadman; therefore, excavation is no longer required.
10	BODR Section 4.4	Conservative values were assumed where limited information was available, and yet a factor of safety of over 1.5 was achieved in all scenarios. Would reducing the factor safety be justified? Presumably using less conservative materials would result in cost savings.	Retained 1.5 factor of safety.
11	BODR Page 16/557	States that Pine River will be kept at elevation 719 by the City hydroelectric dam over the lifetime of the project. [I couldn't find what the lifetime is actually supposed to be.] It might be prudent to reexamine this assumption in light of climate change and infrastructure funding. What happens to the remedy if the dam is decommissioned?	Based on EPA's discussions with the City, this is an appropriate assumption.

Review Comment Tracking Form

Client: EPA

Project: Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall Remedial Design

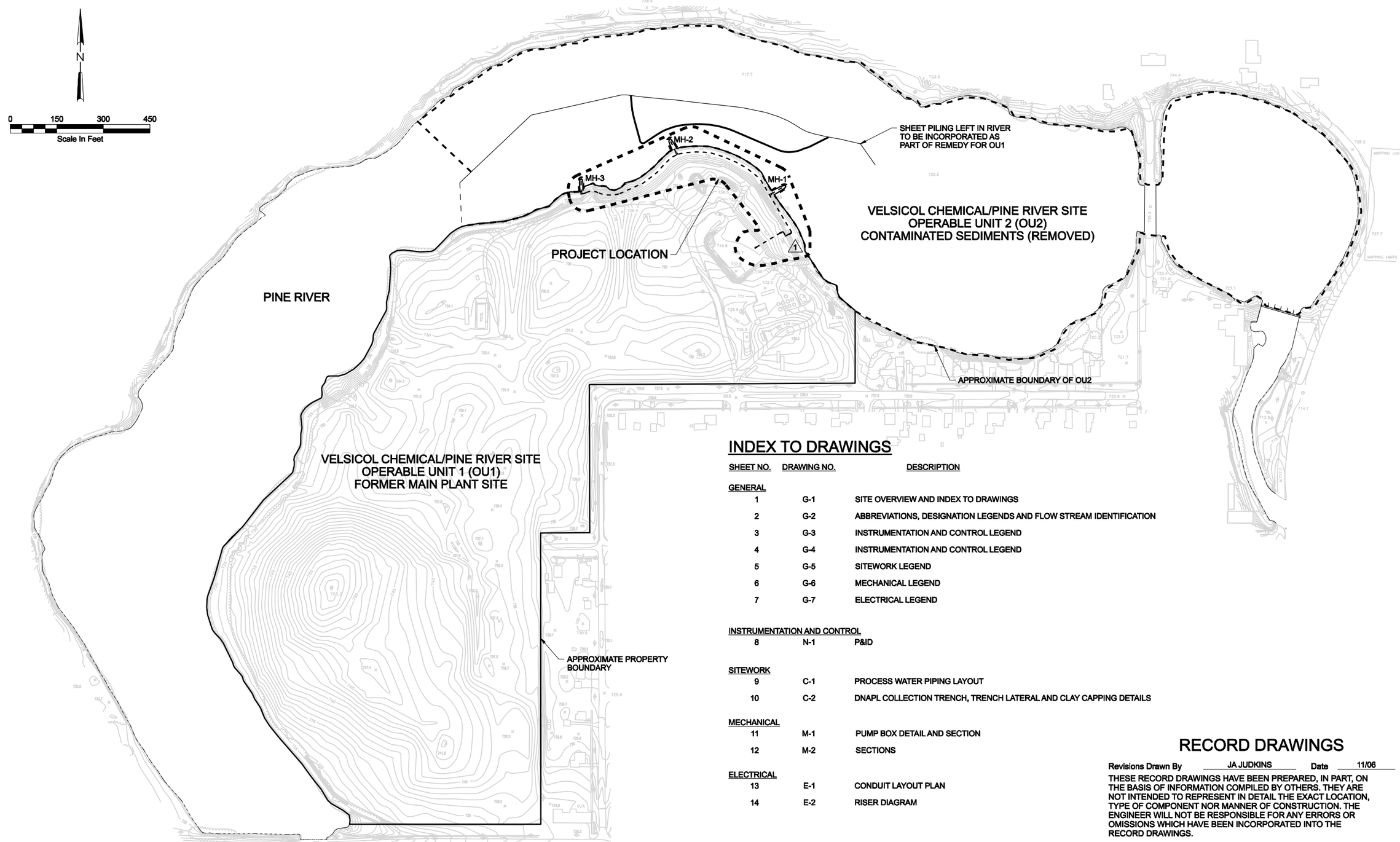
Project No.: D3542500

Submittal: Value Engineering - Review of Preliminary Basis of Design

Date: 3/27/2023

No.	Reference Page or Sheet No.	Review Comment	Response
12	BODR Page 17/557	Assumptions – States that sheets will be installed from the land side. In certain areas along the drive line this would result in excessively long distances from land to the sheet pile alignment. The specifications should not be prescriptive and leave it up to the bidders to determine the most economical place to drive the sheets.	The specifications will not mandate land-side or water-side installation.
13	BODR Section 4.2 Page 21/557	Talks about anomalies/debris that might make sheet pile installation difficult. Consider pre-clearing the drive line of anomalies and debris to save time/money during the sheet pile driving work.	The redesigned wall no longer requires installing the sheet piles to 10 ft below the top of till. Drilling the sockets should not be an issue, as EGLE's contractor (Weston) and EPA's contractor (CH2M) have successfully drilled many borings and wells into the till unit.
14	BODR Section 4.4 Page 22/557	States that no dredging will occur. Has anyone looked at potential scour due to the hard surface of the sheet piles, particularly at corners?	The river velocity is very low along the barrier wall alignment and scour will likely be minimal to none.
15	BODR Page 23/557	With regard to deadman wall stability, could requirements for the deadman sheet penetration into till be reduced by analyzing the combined stability of DGVBW/tie-rods/deadman wall in a FE model instead of the simplified assumption of ignoring active zone support of the wall?	Wall redesigned to act as a cantilevered element, eliminating need for anchorage / deadman support.
16	BODR Section 5.3.1 Page 29/557	As a cost saving measure, could clearing and/or grubbing materials be chipped and incorporated into the soil cover?	Yes, the clearing and grubbing material will be chipped and spread onsite.
17	NA	Corrosion control- If we continue with the deadman system, the tie-rods probably need to be grouted inside a poly sheath. Consider a sacrificial steel allowance for piles and hardware instead of relying on a coating system (which is easily scratched/chipped) or installing an HDPE liner in the back face of the wall.	Wall redesigned to act as a cantilevered element, eliminating need for anchorage / deadman support.

Appendix D
Groundwater Recovery System and DNAPL Collection Trench Record Drawings



INDEX TO DRAWINGS

SHEET NO.	DRAWING NO.	DESCRIPTION
GENERAL		
1	G-1	SITE OVERVIEW AND INDEX TO DRAWINGS
2	G-2	ABBREVIATIONS, DESIGNATION LEGENDS AND FLOW STREAM IDENTIFICATION
3	G-3	INSTRUMENTATION AND CONTROL LEGEND
4	G-4	INSTRUMENTATION AND CONTROL LEGEND
5	G-5	SITEWORK LEGEND
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7	G-7	ELECTRICAL LEGEND
INSTRUMENTATION AND CONTROL		
8	N-1	P&ID
SITEWORK		
9	C-1	PROCESS WATER PIPING LAYOUT
10	C-2	DNAPL COLLECTION TRENCH, TRENCH LATERAL AND CLAY CAPPING DETAILS
MECHANICAL		
11	M-1	PUMP BOX DETAIL AND SECTION
12	M-2	SECTIONS
ELECTRICAL		
13	E-1	CONDUIT LAYOUT PLAN
14	E-2	RISER DIAGRAM

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

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DSGN RA YOLO					
DR MA REICHERT					
CHK LA AMUNDSON	1	11/06	RECORD DRAWING.	JAJ	RCS
APVD RA YOLO		08/06	ADDED PB-4 AND VB-2.	PAK	RAY
	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL

2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL
SITE OVERVIEW
AND INDEX TO DRAWINGS

SHEET	1
DWG	G-1
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng001d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:00 PM

ABBREVIATIONS

@	AT
AB	ANCHOR BOLT
ABDN	ABANDONED
ACBD	ACOUSTICAL BOARD
ACCU	AIR-COOLED CONDENSING UNIT
ACST	ACOUSTICAL TILE
ACT	ACOUSTICAL
ACU	AIR CONDITIONING UNIT
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
AHR	ANCHOR
AHU	AIR HANDLING UNIT
AL	ALUMINUM
ALTN	ALTERNATE
ANOD	ANODIZED
APPROX	APPROXIMATE
APVD	APPROVED
ARCH	ARCHITECTURAL
ARD	ACID RESISTANT DRAIN
ASSY	ASSEMBLY
ASU	AIR SUPPLY UNIT
AVG	AVERAGE
BC	BOOSTER HEATING COIL
BETW	BETWEEN
BF	BOTTOM FACE
BG	LOW WALL GRILLE
BLDG	BUILDING
BM	BEAM
BOD	BOTTOM OF DUCT
BOD_5	BIOCHEMICAL OXYGEN DEMAND (5 DAY TEST)
BOT	BOTTOM
BRG	BEARING
CAB.	CABINET
C/C	CHLORINE CONTACT
CD	CEILING DIFFUSER
CEM PLAS	CEMENT PLASTER
CF	CEILING FAN
CG	CEILING GRILLE
CHEM	CHEMICAL
CHKD	CHECKERED
CFM	CUBIC FEET PER MINUTE
CJ	CONSTRUCTION JOINT
CI	CAST IRON
CISP	CAST IRON SOIL PIPE
CL	CENTER LINE
CL_2	CHLORINE
CLDI	CEMENT LINED DUCTILE IRON
CLG	CEILING
CLP	CLAY PIPE
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CMU	CONCRETE MASONRY UNITS
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
COR	CORNER
CP	CONCRETE PIPE
CPLG	COUPLING
CPVC	CHLORINATED POLYVINYL CHLORIDE
CR	CEILING REGISTER
C TO C	CENTER TO CENTER
CTR	CENTER
CTRD	CENTERED
CU FT	CUBIC FEET
C/W	COMPLETE WITH
△	CENTRAL ANGLE
DAF	DISSOLVED AIR FLOTATION
DBA	DEFORMED BAR ANCHOR
DBL	DOUBLE
DECHLOR	DECHLORINATION
DEG °	DEGREE
DET	DETAIL
DG	DOOR GRILLE
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DIR	DIRECTION
DISCH	DISCHARGE
DS	DOWNSPOUT
DN	DOWN
DRWR	DRAWER
DWG	DRAWING
DWL	DOWEL
E	EAST
E	EXTERNAL
EA	EACH
ELB	ELBOW
EC	ELECTRIC CONVECTOR
ECC	ECCENTRIC
EDH	ELECTRIC DUCT HEATER
EF	EACH FACE OR EXHAUST FAN
EFL	EFFLUENT
EL	ELEVATION
ELEC	ELECTRICAL
EQL	EQUAL
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
EW	EACH WAY
EXA	EXHAUST AIR
EXP JT	EXPANSION JOINT
EXT	EXTERIOR
EXST	EXISTING
FAB	FABRICATION
F FL EL	FINISHED FLOOR ELEVATION
FACIL	FACILITY
FC	FLEXIBLE CONNECTION
FCA	FLANGED COUPLING ADAPTER
FCTY, FACT.	FACTORY
F.EXT	FIRE EXTINGUISHER
FD	FLOOR DRAIN OR FIRE DAMPER
FDN	FOUNDATION
FLEX	FLEXIBLE
FLG	FLANGE
FLR	FLOOR
FNSH	FINISH
FRP	FIBERGLASS REINFORCED PLASTIC
FT	FEET
FTC	FIN TUBE CONVECTOR
G	GAS
GA	GAUGE
GAC	GRANULAR ACTIVATED CARBON
GB	GRAB BAR
GBD	GRAVITY BACKDRAFT DAMPER
GAL	GALLON
GALV	GALVANIZED
GALVS	GALVANIZED STEEL
GCL	GEOSYNTHETIC CLAY LINER
GIV	GRAVITY INTAKE VENTILATOR
GPD	GALLONS PER DAY
GRV	GRAVITY RELIEF VENTILATOR
GUH	GAS UNIT HEATER
GVL	GRAVEL
GWB	GYPSUM WALLBOARD
GYP PLAS	GYPSUM PLASTER
H.A.S	HEADED ANCHOR STUD
HCR	HIGH CAPACITY REGISTER
HD	HUB DRAIN
HDNR	HARDENER
HDR	HEADER
HGT	HEIGHT
HPT	HIGH POINT ELEVATION
HORIZ	HORIZONTAL
HM	HOLLOW METAL
HR	HOUR
HTR	HIGH THROW REGISTER
HV	HOSE VALVE
I&C	INSTRUMENTATION AND CONTROL
ID	INSIDE DIAMETER
IF	INSIDE FACE
INFL	INFLUENT
INSTL	INSTALL
INSUL	INSULATION
INVT	INVERT
ITG	INSULATED TEMPERED GLASS
JT	JOINT
L	LENGTH OF CURVE
LB	POUNDS
LB/D	POUNDS PER DAY
LCP	LOCAL CONTROL PANEL
LF	LINIER FEET
LG	LONG
LLV	LONG LEG VERTICAL
LNTL	LINTEL
LONG	LONGITUDINAL
LPT	LOW POINT ELEVATION
LR	LONG RADIUS
LT	LIGHT
MATL	MATERIAL
MAU	MAKE UP AIR UNIT
MAX	MAXIMUM
MB	MACHINE BOLT
MCC	MOTOR CONTROL CENTER
MD	MOTORIZED DAMPER
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MG/L	MILLIGRAMS PER LITER
MH	MANHOLE
MIN	MINIMUM
MIR	MIRROR
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MO	MASONRY OPENING
MON	MONUMENT
MTG	MOUNTING
MTL	METAL
MTRG	METERING
M&BH	MOP AND BROOM HOLDER
N	NORTH
NIC	NOT IN CONTRACT
NO.	NUMBER
NOM	NOMINAL
NORM	NORMAL
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OC	ON CENTER
OD	OUTSIDE DIAMETER OR OVERFLOW DRAIN
OF	OUTSIDE FACE
O/H	OVERHEAD
O TO O	OUT TO OUT
OPNG	OPENING
OPP	OPPOSITE
PC	POINT OF CURVATURE
PE	PLAIN END
PI	POINT OF INTERSECTION
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
PJF	PREMOLDED JOINT FILLER
PL	PLATE
PLAM	PLASTIC LAMINATE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLYWD	PLYWOOD
POC	POINT ON CURVE
POT	POINT ON TANGENT
PR	PAIR
PRCST	PRECAST
PS	PUMP STATION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT OF TANGENCY
PTD	PAPER TOWEL DISPENSER
PTD/R	PAPER TOWEL DISPENSER/RECEPTACLE
PVC	POINT OF VERTICAL CURVATURE OR POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
QDRNT	QUADRANT
R OR RAD	RADIUS OR RISER
RC	REINFORCED CONCRETE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN
RDCR	REDUCER
RDVF	ROTATING DRUM VACUUM FILTER
REHAB	REHABILITATION/REHABILITATED
REINF	REINFORCE
REQD	REQUIRED
RESIL	RESILIENT
RM	ROOM
RO	ROUGH OPENING
RR	REDUCER
RST	REINFORCING STEEL
S	SOUTH
SA	SUPPLY AIR
SAT	SUSPENDED ACOUSTICAL TILE
SCHED	SCHEDULE
SD	SOAP DISPENSER OR SLOT DIFFUSER
SECT	SECTION
SG	SAFETY GLASS
SH	SHEET
SHTG	SHEETING
SIM	SIMILAR
SLV	SHORT LEG VERTICAL
S.O.	SHUTOFF
SPECD	SPECIFIED
SPECS	SPECIFICATIONS
SPG	SPACING
SQ	SQUARE
SST	STAINLESS STEEL
STA	STATION
STD	STANDARD
STIF	STIFFENER
STOR	STORAGE
STR	STRAIGHT
STRUCT	STRUCTURAL
STL	STEEL
SYMM	SYMMETRICAL
T	TREAD OR TANGENT LENGTH
TAR	TRANSFER AIR REGISTER
T&B	TOP AND BOTTOM
TC	TOP OF CONCRETE
TCU	TERMINAL CONTROL UNIT
TEMP	TEMPERED
TF	TOP FACE
TG	TEMPERED GLASS
THK	THICK
THRD	THREADED
T.O.	TOP OF
TPD	TONS PER DAY OR TOILET PAPER DISPENSER
TPI	TURNOUT POINT OF INTERSECTION
TRANSV	TRANSVERSE
TSS	TOTAL SUSPENDED SOLIDS
TST	TOP OF STEEL
TTD	TOILET TISSUE DISPENSER
TW	TOP OF WALL
TYP	TYPICAL
UH	UNIT HEATER
UON	UNLESS OTHERWISE NOTED
V	VENT
VAT	VINYL ASBESTOS TILE
VERT	VERTICAL
VCP	VITRIFIED CLAY PIPE
VD	VOLUME DAMPER
VFD	VARIABLE FREQUENCY DRIVE
VTR	VENT THRU ROOF
VWC	VINYL WALL COVERING
W	WEST
W/	WITH
WD	WOOD
WG	WIRE GLASS
WH	WATER HEATER
WK	WEEK
WRB	WATER RESISTANT GYPSUM WALLBOARD
WR	WASTE RECEPTACLE
WS	WATER STOP OR WATER SURFACE OR WELDED STEEL
WSG	WALL SUPPLY GRILLE
WSR	WALL SUPPLY REGISTER
WWM	WELDED WIRE MESH
XFMR	TRANSFORMER
YR	YEAR

NOTE:

1. CONTACT THE ENGINEER FOR ABBREVIATIONS NOT LISTED.

DRAWING NUMBER DESIGNATION

C-1

INDICATES DRAWING NUMBER

INDICATES DISCIPLINE(S):

C	SITEWORK
G	GENERAL
M	MECHANICAL
N	INSTRUMENTATION AND CONTROL
E	ELECTRICAL

DETAIL, SECTION AND VIEW DESIGNATION

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION

B

C-3

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET)

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

DRAWING NUMBER WHERE SHOWN

ON DRAWING WHERE SECTION OR DETAIL IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN

FLOW STREAM IDENTIFICATION

GWD	GROUND WATER DOUBLE WALL
GWS	GROUND WATER SINGLE WALL

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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DSGN RA YOLO						
DR MA REICHERT						
CHK LA AMUNDSON						
APVD RA YOLO		11/06	RECORD DRAWING.	JAJ	RCS	
	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

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2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL

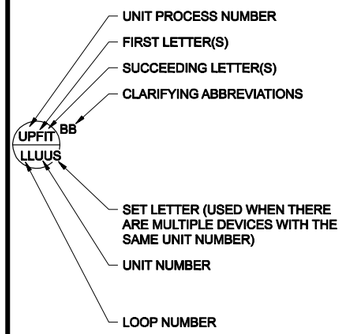
ABBREVIATIONS, DESIGNATION LEGENDS AND FLOW STREAM IDENTIFICATION

SHEET	2
DWG	G-2
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng002d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:09 PM

INSTRUMENT IDENTIFICATION

EXAMPLE SYMBOLS



INSTRUMENT IDENTIFICATION LETTERS TABLE

	FIRST-LETTER		SUCCEEDING-LETTERS		
LETTER	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS (+)		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE(*)	USER'S CHOICE(*)	USER'S CHOICE(*)
C	USER'S CHOICE(*)			CONTROL	
D	DENSITY (S.G)	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT, SENSOR		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE(*)		GLASS, GAUGE VIEWING DEVICE	GATE	
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTION	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		USER'S CHOICE(*)	USER'S CHOICE(*)	USER'S CHOICE(*)
O	USER'S CHOICE(*)		ORIFICE, RESTRICTION		
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD OR PRINT		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED (+)	X AXIS	UNCLASSIFIED (+)	UNCLASSIFIED (+)	UNCLASSIFIED (+)
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION	Z AXIS		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

TABLE BASED ON THE INSTRUMENTATION, SYSTEMS, AND AUTOMATION SOCIETY (ISA) STANDARD.

(+) WHEN USED, EXPLANATION IS SHOWN ADJACENT TO INSTRUMENT SYMBOL. SEE ABBREVIATIONS AND LETTER SYMBOLS.

(*) WHEN USED, DEFINE THE MEANING HERE FOR THE PROJECT

DIGITAL SYSTEM INTERFACES

- ▲ ANALOG INPUT
- ▼ ANALOG OUTPUT
- $\triangle_X$ DISCRETE INPUT
- ∇_X DISCRETE OUTPUT

WHERE X=
- A = ALARM
- H = MAINTAINED
- M = MOMENTARY
- S = STATUS

GENERAL INSTRUMENT OR FUNCTIONAL SYMBOLS

- FIELD MOUNTED
- REAR-OF-PANEL MOUNTED (OPERATOR INACCESSIBLE)
- PANEL MOUNTED (OPERATOR ACCESSIBLE)
- MCC MOUNTED
- COMPUTER FUNCTION
- PLC FUNCTION
- SHARED DISPLAY, SHARED CONTROL

SPECIAL CASES

YL OO — ON AND OFF EVENT LIGHTS

HS OO — ON-OFF HAND SWITCH. MAINTAINED CONTACT SWITCH (CONTROLLED DEVICE WILL RESTART ON RETURN OF POWER AFTER POWER FAILURE).

HS SS — STOP-START HAND SWITCH MOMENTARY CONTACT SWITCHES (CONTROLLED DEVICE WILL NOT RESTART ON RETURN OF POWER AFTER POWER FAILURE).

TRANSDUCERS

- A ANALOG
- D DIGITAL
- E VOLTAGE
- F FREQUENCY
- H HYDRAULIC
- I CURRENT
- P PNEUMATIC
- PF PULSE FREQUENCY
- PD PULSE DURATION
- R RESISTANCE

EXAMPLE:

FY I/P — CURRENT TO PNEUMATIC TRANSDUCER (BACK OF PANEL, IN A FLOW LOOP)

ACCESSORY DEVICES

EXAMPLE: TRANSMITTER AS AN ACCESSORY TO A FLOW ELEMENT

FT / T

- A = ALARM
- C = CONTROLLER
- I = INDICATOR
- R = RECORDER
- S = SWITCH
- T = TRANSMITTER
- X = UNCLASSIFIED

LINE LEGEND

- PROCESS (CLOSED CONDUIT, DASHED LINE INDICATES ALTERNATE FLOW STREAM)
- PROCESS (OPEN CHANNEL)
- ANALOG SIGNAL (4 TO 20 mAdc, ETC.)
- DISCRETE SIGNAL (ON/OFF, ETC.)
- PNEUMATIC SIGNAL
- FILLED SYSTEM SIGNAL
- HYDRAULIC SYSTEM SIGNAL
- DATA LINK
- BUILDING OR FACILITY BOUNDARY
- PACKAGE SYSTEM EQUIPMENT

PARALLELING LINES

(2) 3(2)

(A) (B)

(A) TOTAL OF 2 SIGNALS

(B) 3 TYPICAL SETS OF 2 SIGNALS EACH. TOTAL OF 6 SIGNALS.

- CONNECTING LINES
- NON-CONNECTING LINES

INTERFACE SYMBOLS

S WA

WA D

- = PROCESS INTERFACE
- = SIGNAL INTERFACE

W = SOURCE UNIT PROCESS NO. (1 OR 2 DIGITS)

A = INTERFACE NO. (2 DIGITS)

D = DESTINATION DRAWING NO.

S = SOURCE DRAWING NO.

N — PROCESS OR SIGNAL LINE CONTINUATION N=1,2,3,ETC

N — INTERFACE TO OR FROM PROCESS EXTERNAL TO PROJECT

SELF CONTAINED VALVE & EQUIPMENT TAG NUMBERS

W-D-X-Y

W = UNIT PROCESS NUMBER

D:
- ARV = AIR RELEASE VALVE
- AVRV = AIR AND VACUUM RELEASE VALVE
- E = EJECTOR
- G = GATE
- M = MECHANICAL EQUIPMENT
- P = PUMP
- T = TANK

X = LOOP NUMBER

Y = UNIT NUMBER

ABBREVIATIONS & LETTER SYMBOLS

AC	ALTERNATING CURRENT
AM	AUTO-MANUAL
CAM	COMPUTER-AUTO-MANUAL
CCS	CENTRAL CONTROL SYSTEM
CL_2 etc.	CHLORINE (TYPICAL: USE STANDARD CHEMICAL ELEMENT ABBREVIATION)
CM	COMPUTER-MANUAL
COD	CHEMICAL OXYGEN DEMAND
CP-X	CONTROL PANEL NO. X
DC	DIRECT CURRENT
DCS	DISTRIBUTED CONTROL SYSTEM
DCU	DISTRIBUTED CONTROL UNIT
DO	DISSOLVED OXYGEN
FCL_2	FREE CHLORINE RESIDUAL
FOS	FAST-OFF-SLOW
FOSA	FAST-OFF-SLOW-AUTO
FOSR	FAST-OFF-SLOW-REMOTE
FP-W-X	FIELD PANEL NO. WX (W = UNIT PROCESS NUMBER X = PANEL NUMBER)
FR	FORWARD-REVERSE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
!SR	INTRINSICALLY SAFE RELAY
LEL	LOWER EXPLOSIVE LIMIT
LOS	LOCKOUT STOP
LR	LOCAL-REMOTE
MA	MANUAL-AUTO
MC	MODULATE-CLOSE
MCC-X	MOTOR CONTROL CENTER NO. X
MSC	MANUFACTURER SUPPLIED CABLE
OC	OPEN-CLOSE (D)
OCR	OPEN-CLOSE-REMOTE
OCA	OPEN-CLOSE-AUTO
OO	ON-OFF
OOA	ON-OFF-AUTO
OOR	ON-OFF-REMOTE
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN-STOP-CLOSE
pH	HYDROGEN ION CONCENTRATION
PLC	PROGRAMMABLE LOGIC CONTROLLER
RIO	REMOTE I/O UNIT
RM-X	REMOTE MULTIPLEXING MODULE NO. X
RTU-X	REMOTE TELEMETRY UNIT NO. X
SF	SLOWER-FASTER
SS	START-STOP
SSC	SUPERVISORY SET POINT CONTROL
TCL_2	TOTAL CHLORINE RESIDUAL
TOC	TOTAL ORGANIC CARBON
TOD	TOTAL OXYGEN DEMAND
TURB	TURBIDITY
VHC	VOLATILE HYDROCARBONS
VIB	VIBRATION
Δ	DIFFERENCE
Σ	SUM
X	MULTIPLY
÷	DIVIDE
f(x)	CHARACTERIZED
X^n	RAISE TO THE Nth POWER
$\sqrt{\ }$	SQUARE ROOT
AVG	AVERAGE
1:1	REPEAT OR BOOST
>	SELECT HIGHEST SIGNAL
<	SELECT LOWEST SIGNAL
}	BIAS
%	GAIN OR ATTENUATE

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

GENERAL NOTES

1. COMPONENTS AND PANELS SHOWN WITH A SINGLE ASTERISK (*) ARE TO BE PROVIDED AS PART OF A PACKAGE SYSTEM.
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (**) ARE TO BE PROVIDED UNDER DIVISION 16, ELECTRICAL.
3. THIS IS A STANDARD LEGEND. THEREFORE, NOT ALL OF THIS INFORMATION MAY BE USED ON THIS PROJECT.
4. FOR FLOW STREAM IDENTIFICATION, SEE DRAWING G-2.
5. PIPES SHOWN ON P&IDS ARE SHOWN FOR REFERENCE ONLY. PIPES SHOWN ON MECHANICAL DRAWINGS TAKE PRECEDENCE OVER P&IDS UNLESS OTHERWISE NOTED.

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DR MA REICHERT					
CHK LA AMUNDSON		11/06	RECORD DRAWING.	JAJ	RCS
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2005 SEDIMENT REMEDIAL ACTION GROUNDWATER RECOVERY SYSTEM AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE ST. LOUIS, MICHIGAN

GENERAL

INSTRUMENTATION AND CONTROL LEGEND

SHEET	3
DWG	G-3
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng003d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:20 PM

VALVE SYMBOLS

- GATE
- KNIFE GATE
- BUTTERFLY
- GLOBE
- BALL
- VEE- BALL
- PLUG
- SEAT PORT ECCENTRIC PLUG
- DIAPHRAGM
- PINCH
- NEEDLE
- SWING CHECK
- BALL CHECK
- BACKFLOW PREVENTER
- ROTARY
- PRESSURE RELIEF
- AIR AND/OR VACUUM RELEASE
- REGULATED SIDE PRESSURE CONTROL
- MULTI-PORT VALVES (GATE VALVE SHOWN. FOR OTHER VALVE TYPES, APPROPRIATE VALVE SYMBOL SHOWN.) SEAT PORTS ARE IMPLIED BY INDICATED FLOW PATTERN.
- ANGLE GATE
- TELESCOPE
- SAMPLE
- MUD
- PRESSURE REGULATING (CLAY-TYPE)

GATE SYMBOLS

- SLUICE
- BUTTERFLY
- FABRICATED SLIDE
- FLAP
- STOP LOG

ACTUATOR SYMBOLS

- XX PNEUMATIC DIAPHRAM SPRING-OPPOSED, SINGLE OR DOUBLE ACTING
- XX PNEUMATIC CYLINDER SINGLE OR DOUBLE ACTING ACTUATED BY ONE INPUT
- XX ELECTRIC MOTOR
- XX SOLENOID
- XX HYDRAULIC
- VALVE POSITIONER
- MANUAL
- XX ELECTROHYDRAULIC
- DIAPHRAGM, DIFFERENTIAL PRESSURE

NOTE:
ON LOSS OF PRIMARY POWER (PNEUMATIC, ELECTRICAL OR HYDRAULIC)
XX: FO =FAIL OPEN
FC =FAIL CLOSED
FLP=FAIL TO LAST POSITION

PRIMARY ELEMENT SYMBOLS

- PARSHALL FLUME
- WEIR
- ORFICE PLATE
- FLOW TUBE
- PITOT-STATIC
- VORTEX METER
- ULTRASONIC FLOWMETER
- ELECTROMAGNETIC FLOWMETER
- PROPELLER OR TURBINE METER
- THERMAL FLOWMETER
- FI ROTAMETER
- DE DENSITY METER
- XX GENERIC
- LE LEVEL (ULTRASONIC)
- LEVEL (BUBBLER TUBE)
- LS LEVEL (FLOAT)

MISCELLANEOUS SYMBOLS

- DIAPHRAGM SEAL
- BLIND FLANGE
- AIR GAP
- V VENT TO ATMOSPHERE
- AERATOR
- PLUG
- RECEPTACLE
- A SELF CONTAINED AIR SUPPLY
- SD D COMPOSITE SAMPLER (DIPPER TYPE)
- SS COMPOSITE SAMPLER (SUCTION TYPE)
- TV TV CAMERA
- I OR I INTERLOCK. SEE CONTROL DIAGRAMS
- X PURGE SET X : W = WATER A = AIR SEE
- XX AIR SET XX= SUPPLY PRESSURE IN PSIG.
- FILTER/ REGULATOR/ GAUGE SET
- FLEXIBLE CONNECTOR
- PULSATION DAMPENER
- FILTER
- T DRIP TRAP
- FLAME TRAP
- STRAINER
- HORN
- 120V 120 VOLT, 60 HZ POWER
- 480V 480 VOLT, 60 HZ POWER
- ANNULAR DIAPHRAGM SEAL
- RUPTURE DISK (PRESSURE)
- RUPTURE DISK (VACUUM)
- PIG INSERT POINT
- OR PIG CATCH POINT
- MIXER
- M ELECTRIC MOTOR
- TV TV MONITOR
- A B AND C LOGIC ELEMENT: IF A AND NOT B THEN C
- A B OR C LOGIC ELEMENT: IF A OR B THEN C
- F FLUSHING CONNECTION
- HOSE ADAPTOR
- S SEAL WATER SET
- SIGHT GLASS
- FFLCPLLLX PANEL CONTINUED ON SAME OR OTHER DRAWING
- PANEL OUTLINE
- PANEL NAME
- SKIMMING MECHANISM
- SCREW
- SCREW CONVEYOR
- INLINE SILENCER
- PIPE CAP
- CALIBRATION COLUMN

PUMP AND COMPRESSOR SYMBOLS

NOTE: XX: AS ADJUSTABLE SPEED
CS-1 CONSTANT SPEED (SINGLE SPEED)
CS-2 CONSTANT SPEED (TWO SPEED)

- XX CENTRIFUGAL PUMP (DRY PIT)
- XX CENTRIFUGAL WET PIT PUMP OR TURBINE PUMP
- XX RECIPROCATING OR METERING PUMP (POSITIVE DISPLACEMENT)
- XX DIAPHRAGM PUMP
- XX GEAR PUMP OR BLOWER (POSITIVE DISPLACEMENT)
- XX PISTON PUMP
- XX PROGRESSIVE CAVITY PUMP
- XX COMPRESSOR (CENTRIFUGAL)
- XX COMPRESSOR (PISTON)
- XX BLOWER OR FAN (CENTRIFUGAL)
- EJECTOR
- XX SUBMERSIBLE SUMP PUMP
- VACUUM PUMP
- ROTARY PUMP
- SCREW PUMP

LINE SIZE AND MATERIAL IDENTIFICATION

FOR FLOW STREAM IDENTIFICATION SEE DRAWING G-2.

FLOW STREAM IDENTIFICATION
PIPE DIAMETER IN INCHES
PIPE MATERIAL ABBREVIATION
3"x6" GWD HDPE

A"xB" DENOTES DOUBLE WALL PIPING

GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL

INSTRUMENTATION AND CONTROL LEGEND

SHEET	4
DWG	G-4
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng004d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:34 PM

GENERAL SITE NOTES:

1. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
2. UNLESS SHOWN ON THE LANDSCAPING PLANS, ALL DISTURBED AREAS NOT RECEIVING A HARD SURFACE SHALL BE COVERED WITH GRASS.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION.
4. CONTRACTOR SHALL TAKE ALL OTHER MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE. CONTRACTOR TO SUBMIT EROSION CONTROL PLAN.

GENERAL YARD PIPING AND UTILITIES NOTE:

1. EXISTING UNDERGROUND UTILITIES OBTAINED FROM AS-BUILTS AND FROM FIELD SURVEY. CONTRACTOR SHALL FIELD VERIFY DEPTH AND LOCATION PRIOR TO EXCAVATION. PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION.

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ONTHIS PROJECT.

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SITEWORK LEGEND

EXISTING	THIS CONTRACT	
× 157.7	⊗ 158.5	SPOT ELEVATION
155	155	CONTOUR LINE
	3:1	EMBANKMENT AND SLOPE
		DRAINAGEWAY OR DITCH
		CATCH BASIN OR INLET
		TRENCH DRAIN
	OR	SIGN
		MANHOLE
		ELECTRICAL MANHOLE
		ELECTRIC HANDHOLE
		POST OR GUARD POST
		GUY ANCHOR
		FIRE HYDRANT
		UTILITY POLE
		LIGHT POLE
		BENCH MARK
		SURVEY CONTROL POINT OR POINT OF INTERSECTION
		BRUSH/TREE LINE
		TREE
		PROPERTY LINE
		CENTER LINE, BUILDING, ROAD, ETC.
		STAGING OR WORK AREA LIMITS
	N 1000.00 E 1000.00	STRUCTURE, BUILDING OR FACILITY LOCATION POINT - COORDINATES
	B-1	BORING LOCATION AND NUMBER
	TP-2	TEST PIT LOCATION AND NUMBER
	P-3	PIEZOMETER LOCATION AND NUMBER
OR	OR	DEMOLITION
OR	OR	STRUCTURE, BUILDING OR FACILITY
		ASPHALT CONCRETE PAVEMENT
		GRAVEL SURFACING
		CONCRETE PAVEMENT
		CURB
		CURB AND GUTTER
		SINGLE SWING GATE
		DOUBLE SWING GATE
		SLIDING GATE
		GUARD RAIL
		CHAIN LINK FENCE
		ARCHITECTURAL FENCE
		WIRE FENCE
		CULVERT

YARD PIPING LEGEND

EXISTING	THIS CONTRACT	
		NOMINAL PIPE DIAMETER
		PIPE USE IDENTIFICATION
8" PE	8" PE	PIPING < 30" DIAMETER
		PIPING ≧ 30" DIAMETER
		EXISTING PIPE TO BE ABANDONED
		EXISTING PIPE TO BE REMOVED
		NON-FREEZE HOSE VALVE (V-X) X = NO. IN SPECIFICATIONS
		NON-FREEZE HOSE VALVE WITH HOSE RACK (V-X) X = NO. IN SPECIFICATIONS
		INDICATOR POST VALVE
		GATE VALVE AND VALVE BOX
		BUTTERFLY VALVE AND VALVE BOX
		PLUG VALVE AND VALVE BOX
		FLEXIBLE COUPLING
		90° ELBOW UP
		90° ELBOW DOWN
		BEND < 90° UP
		BEND < 90° DOWN
		CONCENTRIC REDUCER
		CAP OR PLUG
		CLEANOUT
		FIRE HYDRANT

EROSION CONTROL LEGEND

COVER PRACTICES	SYMBOL
TEMPORARY SEEDING	TS
MULCHING AND MATTING	MU
CLEAR PLASTIC COVERING	CPC
BUFFER ZONES	BZ
PERMANENT SEEDING AND PLANTING	PS
CONSTRUCTION ENTRANCE	
INTERCEPTOR DIKE	ID
INTERCEPTOR SWALE	IS
CHECK DAMS	
OUTLET PROTECTION / RIPRAP	
FILTER FENCE	
STRAW BALE BARRIER (BIOFILTER)	
SEDIMENT TRAP (OR SUMP)	
SEDIMENT POND OR BASIN	

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2005 SEDIMENT REMEDIAL ACTION
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AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL

SITEWORK LEGEND

SHEET	5
DWG	G-5
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng005d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:44 PM

PIPE AND FITTING SYMBOLS

DOUBLE LINE	SINGLE LINE	
		EXISTING PIPE
		NEW PIPE
		EXISTING PIPE TO BE ABANDONED
		EXISTING PIPE TO BE REMOVED
		FLANGED COUPLING ADAPTER
		FLEXIBLE COUPLING
		METAL BELLOWS EXP JOINT
		ELASTOMER BELLOWS EXP JOINT
		ELBOW UP
		ELBOW DOWN
		TEE UP
		TEE DOWN
		LATERAL UP
		LATERAL DOWN
		CONCENTRIC REDUCER
		ECCENTRIC REDUCER
		REDUCING BUSHING
		UNION
		CAP
		ANCHOR
		ELBOW, 90 DEGREE
		CROSS
		TEE
		ELBOW, 45 DEGREE
		LATERAL

NOTES:

1. ONLY FLANGED END CONNECTIONS ARE SHOWN HERE FOR DOUBLE LINE FITTINGS. FITTINGS WITH OTHER END PATTERNS ARE SHOWN SIMILARLY ON THE CONSTRUCTION DRAWINGS. ALSO SEE PIPING SPECIFICATIONS.
2. SYMBOLS SHOWN HERE FOR SINGLE LINE FITTINGS ARE GENERIC ONLY. REFER TO PIPING SPECIFICATIONS FOR SPECIFIC END CONNECTIONS FOR SINGLE LINE PIPE AND FITTINGS.
3. EXISTING PIPE AND EQUIPMENT IS SHOWN LIGHT-LINED AND/OR SCREENED AND IS NOTED AS EXISTING. NEW PIPING AND EQUIPMENT IS SHOWN HEAVY-LINED.

MECHANICAL LEGEND AND NOTES

GENERAL PIPING NOTES

1. LAY PIPE TO UNIFORM GRADE BETWEEN INDICATED ELEVATION POINTS.
2. SIZE OF FITTINGS SHOWN ON PLANS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE THE SAME AS SHOWN FOR ADJACENT STRAIGHT RUN OF PIPE.
3. LOCATION AND NUMBER OF PIPE HANGERS AND PIPE SUPPORTS, IF SHOWN, IS ONLY APPROXIMATE. FINAL SUPPORT REQUIREMENTS SHALL BE AS REQUIRED IN THE SPECIFICATIONS.
4. ALL JOINTS SHALL BE WATERTIGHT. WALL PIPES SHALL BE USED WHEREVER PIPING PASSES FROM A STRUCTURE TO BACKFILL.
5. ALL FLEXIBLE CONNECTORS AND FLANGED COUPLING ADAPTERS SHALL BE PROVIDED WITH THRUST TIES, BLOCKS, AND ANCHORS, UNLESS OTHERWISE NOTED. THRUST PROTECTION SHALL BE ADEQUATE FOR TEST PRESSURES SPECIFIED.
6. SYMBOLS, LEGENDS, AND PIPE USE IDENTIFICATIONS SHOWN SHALL BE FOLLOWED THROUGHOUT THE PLANS, WHEREVER APPLICABLE. NOT ALL OF THE VARIOUS PIPING COMPONENTS ARE NECESSARILY USED IN THE PROJECT.
7. ALL BURIED PIPING SPECIFIED TO BE PRESSURE TESTED, EXCEPT FLANGED, WELDED, OR SCREWED PIPING, SHALL BE PROVIDED WITH CONCRETE THRUST BLOCKS AT ALL DIRECTION CHANGES, UNLESS OTHERWISE NOTED.
8. NUMBER AND LOCATION OF UNIONS SHOWN ON PLANS IS ONLY APPROXIMATE. PROVIDE ALL UNIONS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.
9. WHERE A GROOVED END COUPLING IS SHOWN, IT SHALL BE THE RIGID JOINT TYPE, UNLESS OTHERWISE SPECIFIED. WHERE A FLANGED COUPLING ADAPTER IS SHOWN, A STANDARD FLANGE SHALL BE JOINED TO THE COUPLING ADAPTER.
10. FOR FLOWSTREAM IDENTIFICATION SEE DRAWING G-2.
11. SEE INSTRUMENTATION AND CONTROL LEGEND FOR ADDITIONAL VALVE SYMBOLS.

MISCELLANEOUS PIPING SYMBOLS

- STRAINER
- SIGHT GLASS
- FLEXIBLE (ELASTOMER) PIPE CONNECTION
- GAUGE WITH COCK
- THERMOMETER
- ROTAMETER
- PIG LAUNCHER
- PIG CATCHER
- REDUCER
- FLEXIBLE HOSE
- FLEXIBLE CONNECTOR
- PS 26-1-2 — TYPICAL INSTRUMENT SYMBOL (SEE I&C LEGEND)
- GAUGE GLASS WITH COCKS
- FS — FLOW SWITCH
- FM X — FLOW METER X = NO. SHOWN IN SPECS
- PS — PRESSURE SWITCH

VALVE DESIGNATIONS

MANUAL VALVES AND CHECK VALVES

3" - V 400

- VALVE TYPE, SEE SPECIFICATIONS
- VALVE DESIGNATION
- SIZE OF VALVE

VALVE SYMBOLS

- HOSE VALVE

PLANT AIR LEGEND

- AP — AIR PURGE SET
- XX — AIR SET XX = SUPPLY PRESSURE IN PSIG

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL

MECHANICAL LEGEND

SHEET	6
DWG	G-6
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng006d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:44:53 PM

ELECTRICAL LEGEND

SYMBOL	DESCRIPTION
	CONNECTION POINT TO EQUIPMENT SPECIFIED. FURNISHED AND INSTALLED UNDER OTHER DIVISIONS. RACEWAY, CONDUCTOR AND CONNECTION SPECIFIED IN DIVISION 16. COORDINATE FINAL CONNECTION WITH EQUIPMENT SUPPLIER.
MCC-A	MAJOR ELECTRICAL COMPONENT OR DEVICE - NAME OR IDENTIFYING SYMBOL AS SHOWN.
	BRANCH CIRCUIT PANELBOARD
UH	UNIT HEATER
TTC	TELEPHONE TERMINAL CABINET
CTC	COMPUTER TERMINAL CABINET
TJB	TERMINAL JUNCTION BOX
M	MOTOR, SQUIRREL CAGE INDUCTION, HORSEPOWER INDICATED ON ONE-LINE DIAGRAM, (M) SHOWN ON PLANS
1	LUMINAIRE, SEE SCHEDULE
2	LUMINAIRE, SEE SCHEDULE
3	LUMINAIRE, UNSWITCHED, SEE SCHEDULE
4	LUMINAIRE AND POLE, SEE SCHEDULE
5	WALL MOUNTED LUMINAIRE, SEE SCHEDULE
6	EMERGENCY LIGHTING UNIT
	EXIT LIGHTS, SEE SCHEDULE
Sa or 2a	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT IN PANELBOARD.
LA-2	HOME RUN - DESTINATION SHOWN
or G	EXPOSED CONDUIT AND CONDUCTORS*
or G	CONCEALED CONDUIT AND CONDUCTORS*

NOTE:
* ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO.12 CONDUCTORS IN CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO. 12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.

SYMBOL	DESCRIPTION
[ ]	CIRCUIT CALLOUT, [1*C,3#8,1#10G] CONDUIT, CONDUCTOR, AND NUMBER INDICATED. [2-3"C,3-350 KCMIL, 1#1/0G EA]; INDICATES TWO CONDUITS, EACH WITH CONDUCTORS INDICATED.
	GROUND TEST WELL
	GROUND ROD
	CROSSHATCHES WITH BAR INDICATE #10 CONDUCTOR. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
	CONDUIT DOWN
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED AS SHOWN
B	BUS DUCT, SEE SPECIFICATIONS
CE	CONCRETE ENCASED CONDUIT
DB	DIRECT BURIED CONDUIT
G	GROUND
P	TRENCHING FOR UTILITY COMPANY PRIMARY POWER CIRCUITS
T	TRENCHING FOR TELEPHONE COMPANY CIRCUITS
S	SWITCH:

WALL SWITCH:
- 2- DOUBLE POLE
- 3- THREE WAY
- 4- FOUR WAY
- CRE- CORROSION RESISTANT
- D- DIMMER
- K- KEY OPERATED
- P- PILOT LIGHT
- WP- WEATHERPROOF

MOTOR SWITCH:
- M- MOTOR RATED TOGGLE SWITCH WITHOUT OVERLOADS
- MS- MANUAL MOTOR STARTER WITH OVERLOADS

SYMBOL	DESCRIPTION
	CONVENIENCE RECEPTACLE - DUPLEX UNLESS SPECIFIED OTHERWISE WP- WEATHERPROOF C- CLOCK HANGER TL- TWIST LOCK CRE- CORROSION RESISTANT
30	RECEPTACLE - 240V, 1PH, AMPERAGE INDICATED
30	RECEPTACLE, SPECIAL PURPOSE - AMPERAGE INDICATED
	DUPLEX CONVENIENCE RECEPTACLE - FLUSH IN FLOOR
	MULTI-OUTLET ASSEMBLY
	CLOCK HANGER CONVENIENCE RECEPTACLE
	TELEPHONE RECEPTACLE (OUTLET BOX ONLY) FLUSH IN FLOOR
	TELEPHONE RECEPTACLE (OUTLET BOX ONLY)
	DATA RECEPTACLE (OUTLET BOX ONLY)
HH	GENERAL CONTROL OR WIRING DEVICE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE.
CS	CONTROL STATION, SEE CONTROL DIAGRAMS FOR TYPE.
J	CONDUIT FITTING OR JUNCTION BOX
S	EXPLOSION PROOF SEAL
30	NONFUSED DISCONNECT SWITCH, SIZE INDICATED, 3 POLE UNLESS INDICATED OTHERWISE.
60/40 F	FUSED DISCONNECT SWITCH, SIZE INDICATED (60/40, 60 = SWITCH RATING: 40 = FUSE RATING) 3 POLE UNLESS INDICATED OTHERWISE.
2	CONTACTOR, MAGNETIC, NEMA SIZE INDICATED.
30 L	LIGHTING CONTACTOR, CURRENT RATING INDICATED. FOR NUMBER OF POLES, SEE CONTROL DIAGRAM.
2	STARTER MAGNETIC NEMA SIZE INDICATED, SEE CONTROL DIAGRAM.
2	COMBINATION (FUSE OR CIRCUIT BREAKER AS INDICATED) MAGNETIC STARTER, NEMA SIZE INDICATED, SEE CONTROL DIAGRAM.
	METERING FACILITIES
	GROUND ROD
	MULTI-PARTY DESK TOP COMMUNICATIONS SYSTEM STATION WITH REMOTE AMPLIFIER
W	MULTI-PARTY WALL MOUNTED COMMUNICATIONS SYSTEM STATION WITH INTEGRAL AMPLIFIER
	CONE TYPE PAGING SPEAKER, CEILING MOUNTED
	INTERIOR PAGING TRUMPET SOUND REPRODUCER, WITH REMOTE AMPLIFIER, SURFACE MOUNTED.
	OUTDOOR PAGING TRUMPET SOUND REPRODUCER, WITH REMOTE AMPLIFIER, SURFACE MOUNTED.
	TERMINAL CABINET FOR COMMUNICATIONS SYSTEM

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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SYMBOL	DESCRIPTION
1	CONTACT - NORMALLY OPEN WITH NEMA SIZE INDICATED AS APPLICABLE
	CONTACT - NORMALLY CLOSED
	OVERLOAD RELAY HEATER
1	MAGNETIC STARTER WITH NEMA SIZE INDICATED
100/M	CIRCUIT BREAKER, MAGNETIC TRIP ONLY, FRAME SIZE SHOWN, 3 POLE UNLESS INDICATED OTHERWISE.
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE UNLESS INDICATED OTHERWISE.
100	SWITCH - CURRENT RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE.
225	FUSE - RATING INDICATED
	DRAWOUT CIRCUIT BREAKER, LOW VOLTAGE
	DRAWOUT CIRCUIT BREAKER, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH, MEDIUM VOLTAGE
	SURGE ARRESTER
10	CAPACITOR - KVAR INDICATED
VS V 0-600V	METER WITH SWITCH - SCALE RANGE SHOWN
	GROUND
120V or 120/240V 15 KVA, 1PH	TRANSFORMER, SECONDARY VOLTAGES, PHASE AND RATING INDICATED AS APPLICABLE
GFR 25A 0.1	PICK-UP SETTING / TIME CURRENT CHARACTERISTIC — GROUND FAULT RELAY WITH CURRENT TRANSFORMER
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH-BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH BUTTON SWITCH, MAINTAINED CONTACTS WITH MECHANICAL INTERLOCK
	NORMALLY CLOSED, TIME DELAY OPENING
	NORMALLY CLOSED, TIME DELAY CLOSING
	NORMALLY OPEN, TIME DELAY CLOSED
	NORMALLY OPEN, TIME DELAY OPEN
	REMOTE DEVICE
O H A X00 00X	SELECTOR SWITCH - MAINTAINED CONTACT - CHART IDENTIFIES OPERATION:
(3)	CURRENT TRANSFORMER, NUMBER INDICATED
A	INDICATING LIGHT, PUSH-TO-TEST, LETTER INDICATES COLOR
A	INDICATING LIGHT - LETTER INDICATES COLOR A - AMBER G - GREEN B - BLUE R - RED C - CLEAR W - WHITE

CKT	POSITION HAND	OFF	AUTO
1	X	O	O
2	O	O	X

X - CLOSED CONTACT
O - OPEN CONTACT

ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
A	AMMETER, AMPERE, AMBER
AF	AMPERE FRAME
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AS	AMMETER SWITCH, AMPERE SENSOR
ASU	AIR SUPPLY UNIT
AT	AMPERE TRIP
ATC	AUTOMATIC THROWOVER CONTROL
ATS	AUTOMATIC TRANSFER SWITCH
BC	BARE COPPER
BRKR	BREAKER
C	CONDUIT, CONTACTOR
CB	CIRCUIT BREAKER
CC	CONTROL CABLE
CKT	CIRCUIT
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CRE	CORROSION-RESISTANT
CRS	COATED RIGID STEEL CONDUIT
CT	CURRENT TRANSFORMER
DC	DIRECT CURRENT
DIV	DIVISION
E	EMPTY
EO	ELECTRIC OPERATOR
EQPT	EQUIPMENT
ESS	EMERGENCY SHUTDOWN SWITCH
ETM	ELAPSED TIME METER
EXST	EXISTING
FDR	FEEDER
F	FUSE
FLR	FLOOR
FLUOR	FLUORESCENT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
G	GREEN, GROUND
GALV	GALVANIZED
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFR	GROUND FAULT RELAY
GND	GROUND
H	HIGH SPEED
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HPS	HIGH PRESSURE SODIUM
HS	HAND SWITCH
IC	INTERRUPTING CAPACITY
I &C	INSTRUMENTATION AND CONTROL
INCAND	INCANDESCENT
INST	INSTANTANEOUS
J, J-BOX	JUNCTION BOX
K	KEY INTERLOCK
L	LIGHTING CONTACTOR, LOW SPEED
LOS	LOCKOUT STOP PUSH BUTTON
LR	LATCHING RELAY
LT FLEX	LIQUID TIGHT FLEX CONDUIT
LTS	LIGHTS
M	MAGNETIC CONTACTOR COIL
MCC	MOTOR CONTROL CENTER
MH	MANHOLE, METAL HALIDE
MO	MOTOR OPERATOR
MS	MOTOR STARTER
MT	MOUNT
MTD	MOUNTED
N	NEUTRAL
NA	NON-AUTOMATIC
NC	NORMALLY CLOSED
NL	NIGHT LIGHT
NO	NORMALLY OPEN
NP	NAMEPLATE
OC	ON CENTER
OL	OVERLOAD RELAY
PB	PULL BOX, PUSH BUTTON SWITCH
PC	PHOTOCELL
PH	PHASE
PMR	PHASE MONITOR RELAY
PNL	PANEL
PS	PRESSURE SWITCH
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE CONDUIT
R	RED
RCPT	RECEPTACLE
REQD	REQUIRED
RM	REMOTE MULTIPLEXER
RS	RIGID STEEL CONDUIT
RT	REMOTE TELEMETRY
RVNR	REDUCED VOLTAGE NON-REVERSING
RVR	REDUCED VOLTAGE REVERSING
SA	SURGE ARRESTOR
SCCR	SHORT CIRCUIT CURRENT RATING
S/N	SOLID NEUTRAL
SPD	SPEED
SST	STAINLESS STEEL
SV	SOLENOID VALVE
SW	SWITCH
T	THERMOSTAT
TB	TERMINAL BOARD
TC	TIME CLOSE
TD	TEMPERATURE DETECTOR RELAY
TDR	TIME DELAY RELAY
TJB	TERMINAL JUNCTION BOX
T.O.	TIME OPEN
TS	AUTO TRANSFORMER TEMPERATURE SWITCH
TSP	TWISTED SHIELDED PAIR
TST	TWISTED SHIELDED TRIAD
TYP	TYPICAL
UH	UNIT HEATER
UVR	UNDER VOLTAGE RELAY
V	VOLTMETER, VOLT
VS	VOLTMETER SWITCH
W	WATT
WHD	WATTHOUR DEMAND METER
WP	WEATHERPROOF
XFDR	TRANSDUCER
XFMR	TRANSFORMER
XFPR	TRANSPONDER

NOTES:
1. THIS IS A STANDARD LEGEND SHEET. SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS DRAWING AND NOT ON THE PLANS.
2. FOR ADDITIONAL ABBREVIATIONS OF OTHER DIVISIONS (HVAC, MECHANICAL, AND STRUCTURAL/ARCHITECTURAL), SEE OTHER LEGENDS.

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DSGN	RE NAGEL				
DR	MA REICHERT				
CHK	BM WILLIAMS				
APVD	RE NAGEL	NO.	DATE	REVISION	BY	APVD
			11/06	RECORD DRAWING.	JAJ	RCS

VERIFY SCALE
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0 1"
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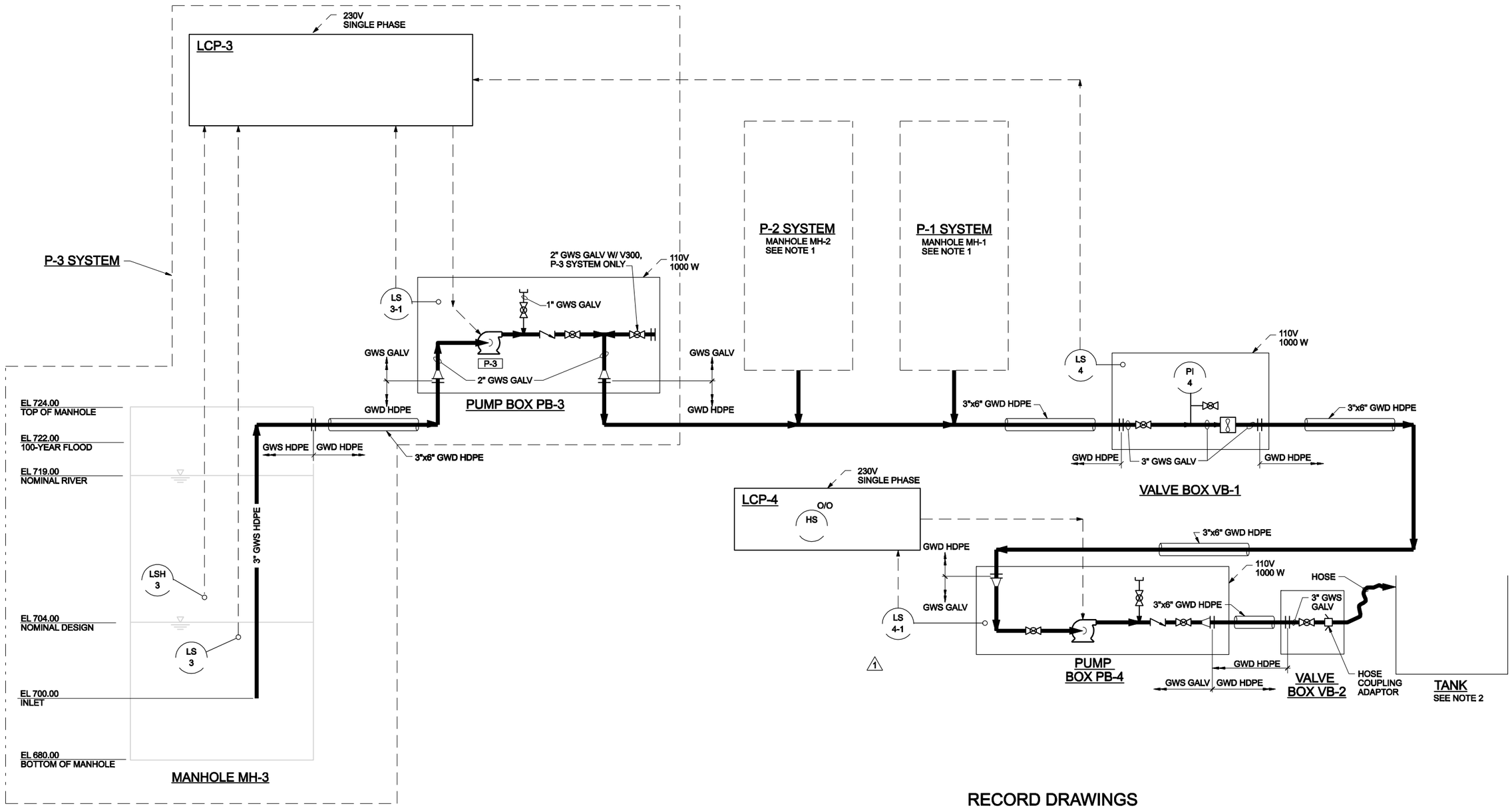
CH2MHILL

2005 SEDIMENT REMEDIAL ACTION GROUNDWATER RECOVERY SYSTEM AND DNAPL COLLECTION TRENCH
VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

GENERAL
ELECTRICAL LEGEND

SHEET	7
DWG	G-7
DATE	MARCH 2005
PROJ	184199

FILENAME: PRng007d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:01 PM



RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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NOTES:
1. P-3 SYSTEM SHOWN, TYPICAL FOR SYSTEMS P-1 AND P-2.
2. TANK AND HOSE TO BE PROVIDED BY OTHERS.

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DSGN RA YOLO					
DR MA REICHERT					
CHK LA AMUNDSON	1	11/06	RECORD DRAWING.	JAJ	RCS
APVD RA YOLO		8/06	ADDED PB-4 AND VB-2.	PAK	RAY
	NO.	DATE	REVISION	BY	APVD

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CH2MHILL

2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

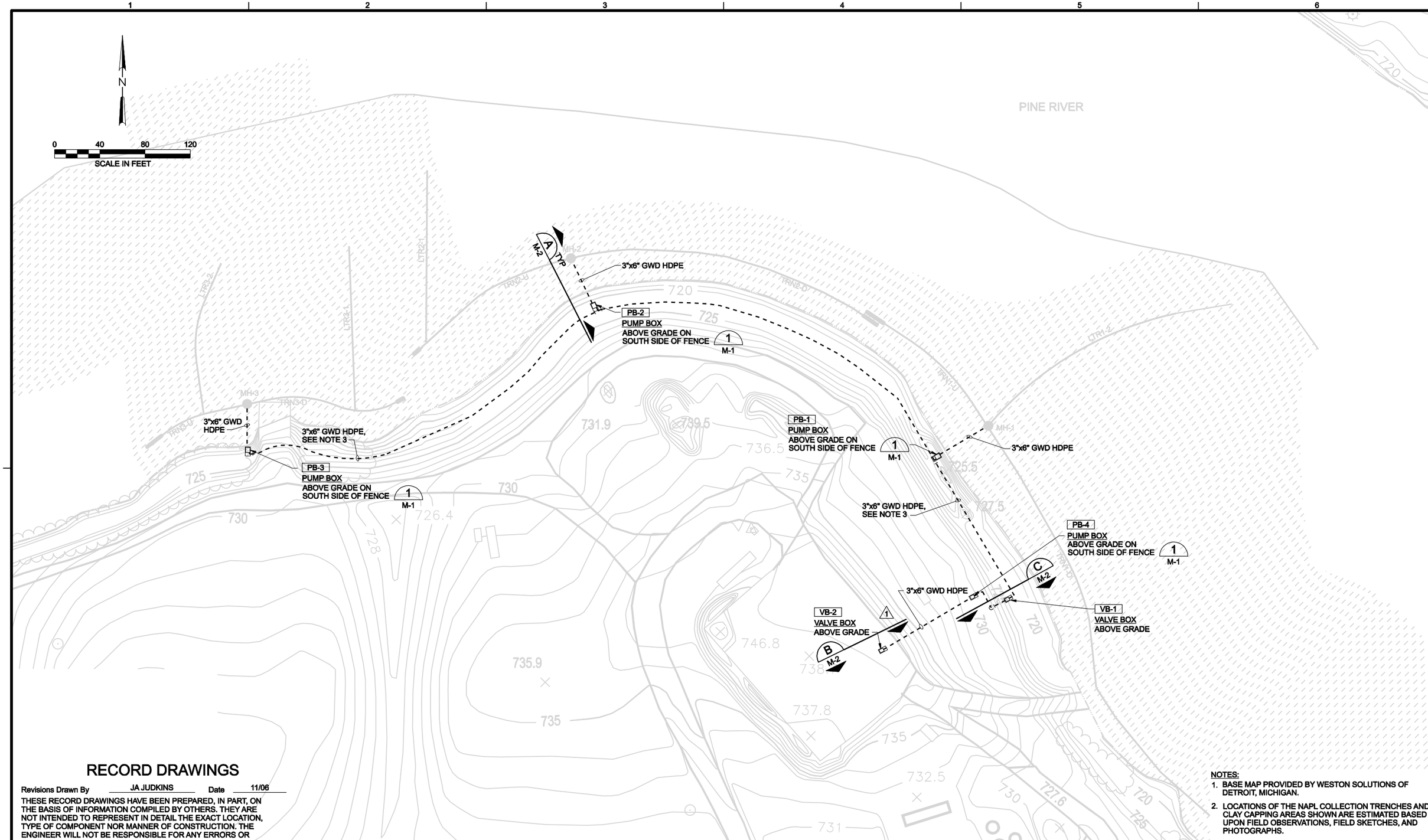
VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

INSTRUMENTATION AND CONTROL

P&ID

SHEET	8
DWG	N-1
DATE	MARCH 2005
PROJ	184199

FILENAME: PRnn001d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:11 PM



RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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NOTES:

1. BASE MAP PROVIDED BY WESTON SOLUTIONS OF DETROIT, MICHIGAN.
2. LOCATIONS OF THE NAPL COLLECTION TRENCHES AND CLAY CAPPING AREAS SHOWN ARE ESTIMATED BASED UPON FIELD OBSERVATIONS, FIELD SKETCHES, AND PHOTOGRAPHS.
3. GENERALLY RUN PIPE ON TOP OF CAP AND RUN FLAT OR SLOPE FROM PUMP BOX PB-3 TO VALVE BOX VB-1.

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DSGN RA YOLO					
DR JM ZAFFKE					
CHK LA AMUNDSON	1	11/06	RECORD DRAWING.	JAJ	RCS
APVD RA YOLO		08/06	ADDED PB-4 AND VB-2.	PAK	RAY
	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
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2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

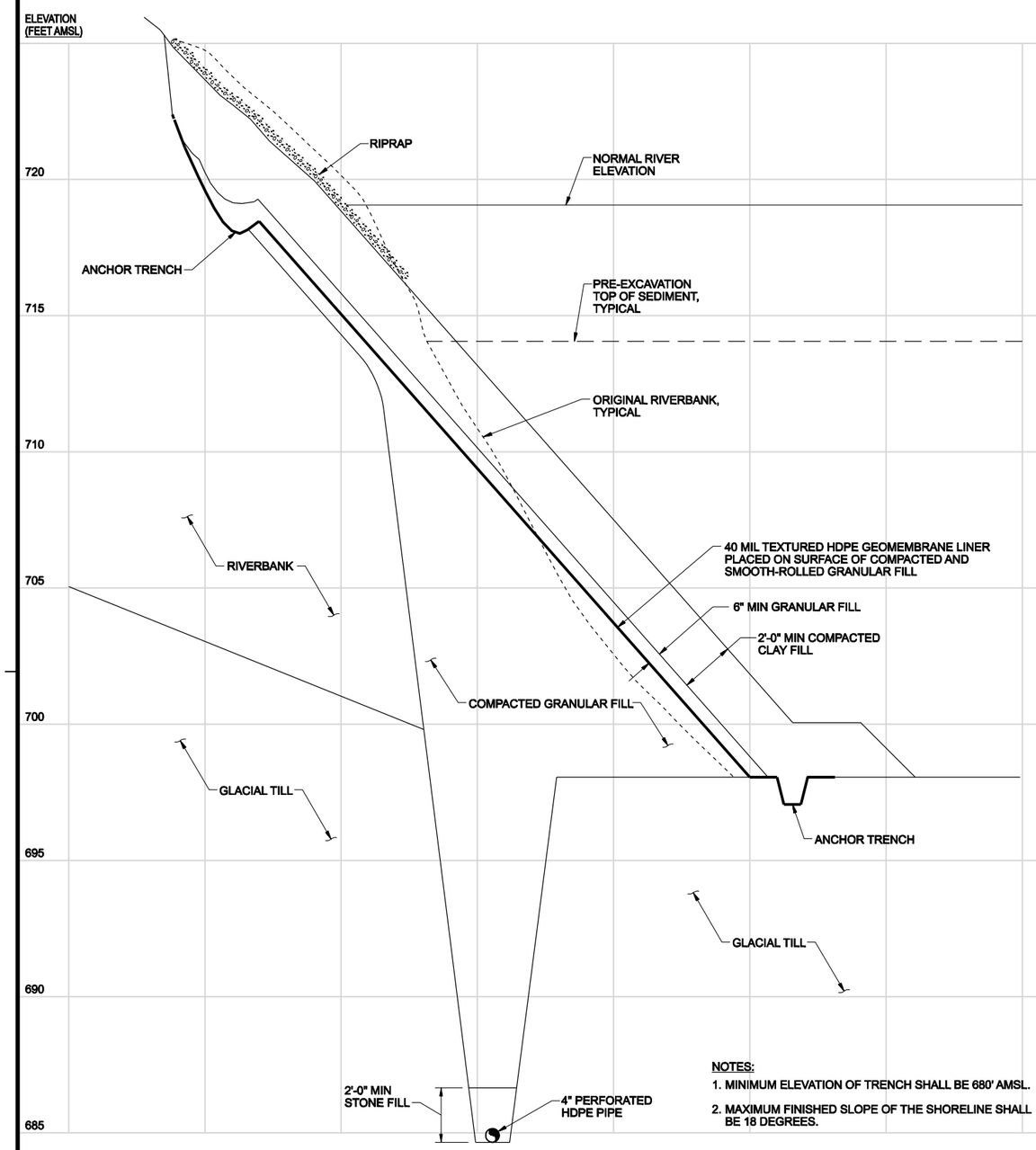
VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

SITEWORK

PROCESS WATER PIPING LAYOUT

SHEET	9
DWG	C-1
DATE	MARCH 2005
PROJ	184199

FILENAME: PRnc001d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:21 PM

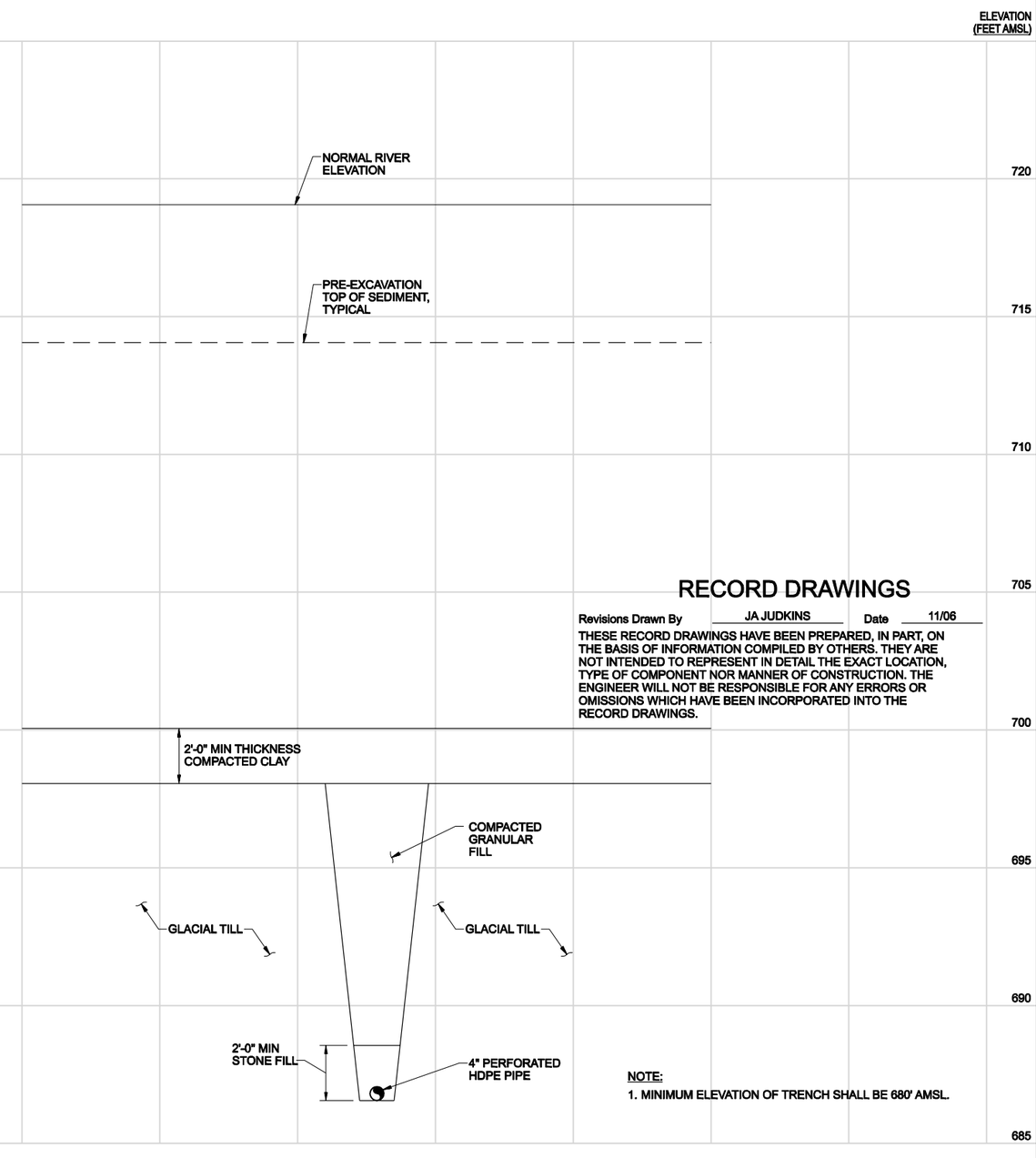


NOTES:

1. MINIMUM ELEVATION OF TRENCH SHALL BE 680' AMSL.
2. MAXIMUM FINISHED SLOPE OF THE SHORELINE SHALL BE 18 DEGREES.

DNAPL COLLECTION TRENCH AND CLAY CAPPING DETAIL

1"=10' HORIZONTAL
1"=2.5' VERTICAL



NOTE:

1. MINIMUM ELEVATION OF TRENCH SHALL BE 680' AMSL.

DNAPL COLLECTION TRENCH LATERAL AND CLAY CAPPING DETAIL

1"=10' HORIZONTAL
1"=2.5' VERTICAL

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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DSGN RC STRYKER					
DR JM ZAFFKE					
CHK RC STRYKER		11/06	RECORD DRAWING.	JAJ	RCS
APVD DJ OLSON	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
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CH2MHILL

2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

SITEWORK
DNAPL COLLECTION TRENCH, TRENCH LATERAL AND CLAY CAPPING DETAILS

SHEET	10
DWG	C-2
DATE	MARCH 2005
PROJ	184199

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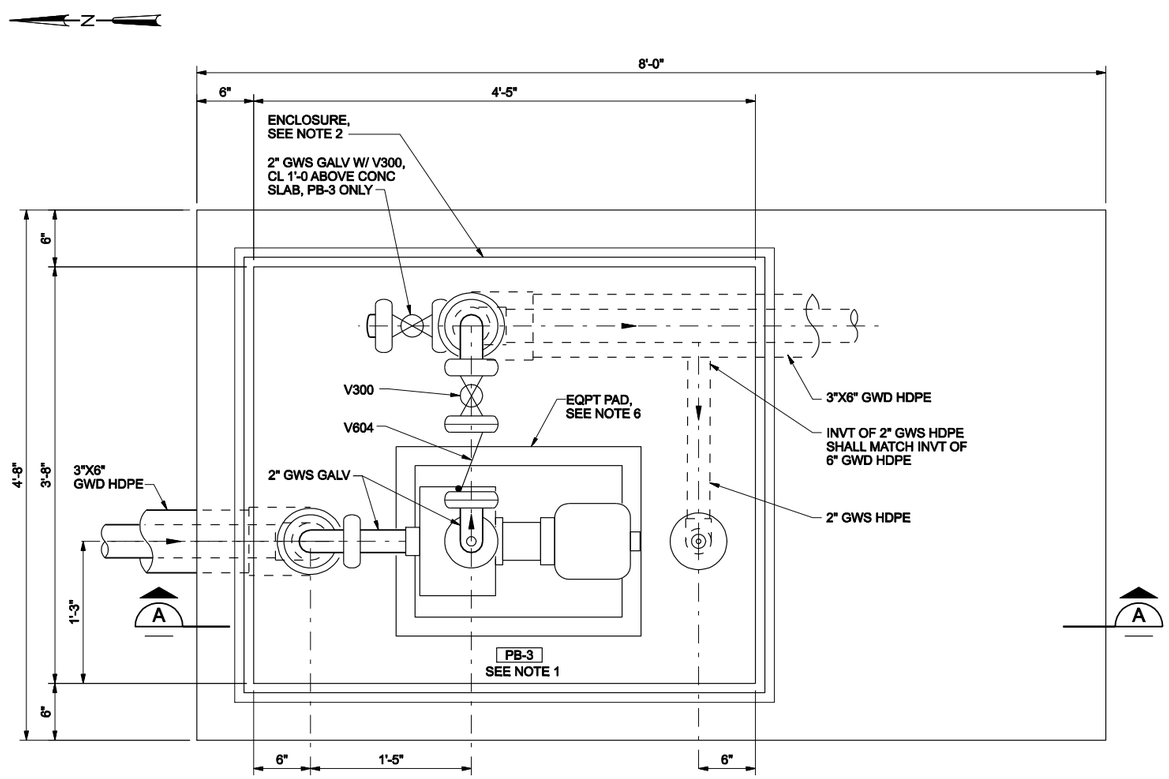
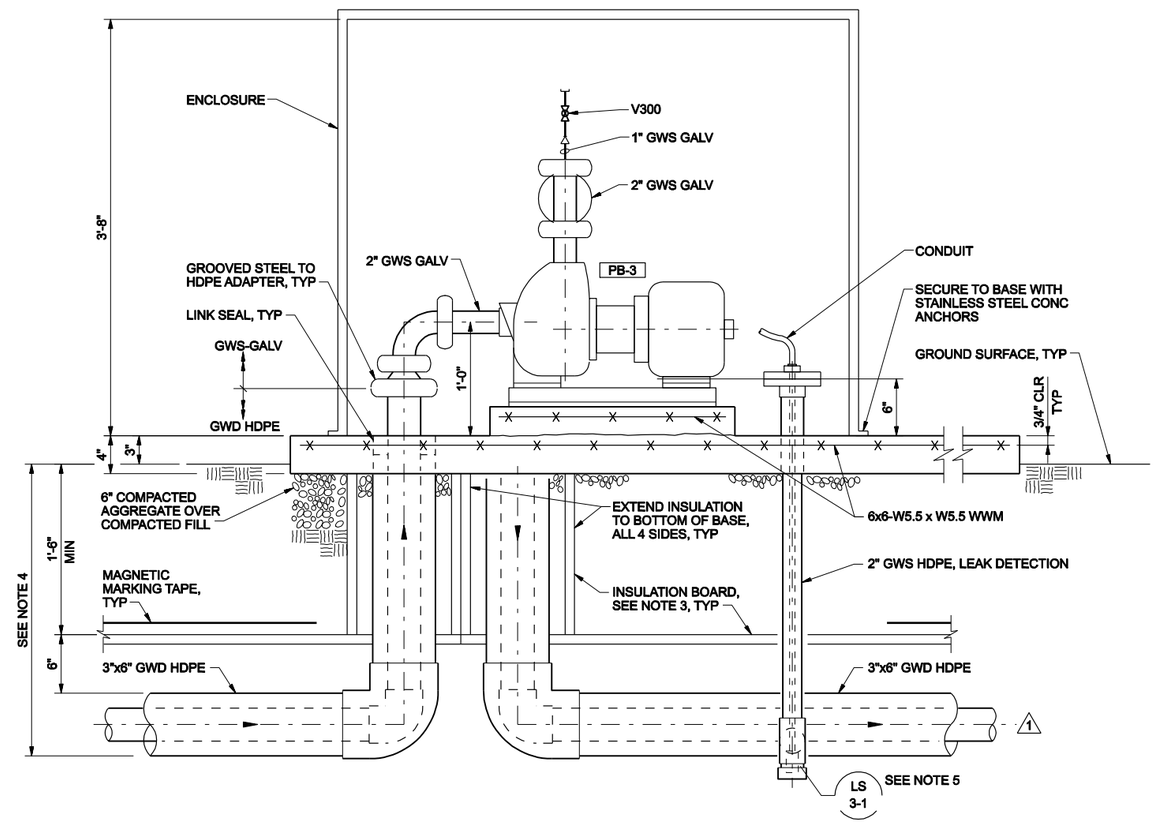


PUMP BOX PB-1, 2, 3 AND 4 DETAIL 1 (C-1, M-2)

1 1/2"=1'-0"



SECTION A

1 1/2"=1'-0"

NOTES:

1. PUMP BOX 3 SHOWN, PUMP BOXES 1, 2 AND 4 ARE THE SAME AS PB-3 EXCEPT AS NOTED.
2. PUMP ENCLOSURE PB-1, 2, 3 AND 4: (53"L x 44"W x 44"H) HOTBOX STANDARD MODEL NO. PG4000F "PUMP GUARD" INSULATED FIBERGLASS FLIP-TOP ENCLOSURE WITH INTERNAL ANCHORING KIT AND 120-VOLT, 1000 WATT REGULATED HEAT SOURCE.
3. 1-INCH THICK EXTRUDED POLYSTYRENE FOAM INSULATION, 4-FEET WIDE, CENTERED OVER ENTIRE LENGTH OF PIPE.
4. 30-INCHES NOMINAL THICKNESS OF CAP. DO NOT DIG BELOW CAP.
5. LEVEL SWITCH - KOBOLD TYPE NCP 2554 WITH PVC STEM AND 2" FLANGE.
6. EQUIPMENT PAD SHALL BE INSTALLED LEVEL. ANCHOR PUMP PER MANUFACTURERS RECOMMENDATIONS WITH CONCRETE ANCHORS. ANCHORS SHALL BE INSTALLED WITH 4" MINIMUM EDGE DISTANCE IN EACH DIRECTION.
7. CONCRETE SLAB AND EQUIPMENT PAD SHALL BE 3,000 PSI CONCRETE.

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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DSGN RA YOLO						VERIFY SCALE
DR BR LEHMAN						BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"
CHK LA AMUNDSON	1	11/06	RECORD DRAWING.	JAJ	RCS	IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
APVD RA YOLO		08/06	ADDED PB-4 AND VB-2.	PAK	RAY	
	NO.	DATE	REVISION	BY	APVD	

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2005 SEDIMENT REMEDIAL ACTION GROUNDWATER RECOVERY SYSTEM AND DNAPL COLLECTION TRENCH

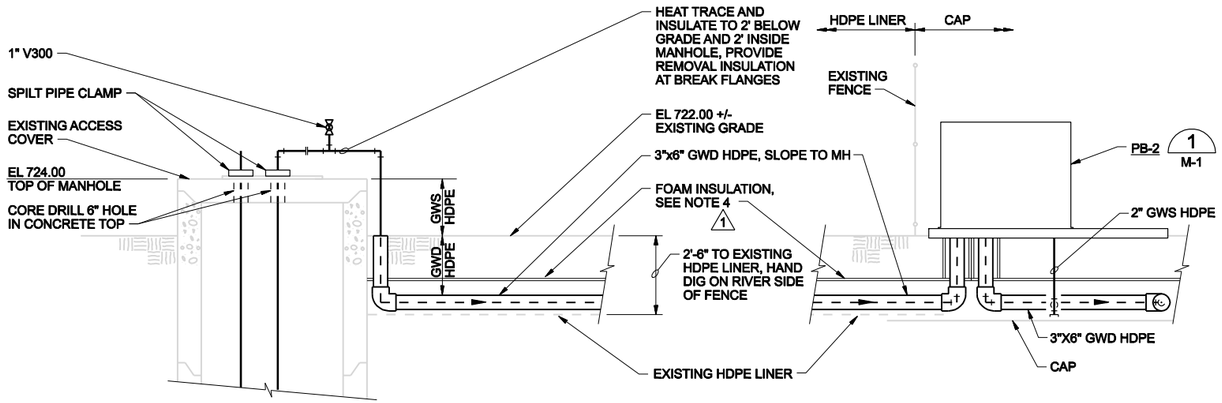
VELSICOL/PINE RIVER SITE ST. LOUIS, MICHIGAN

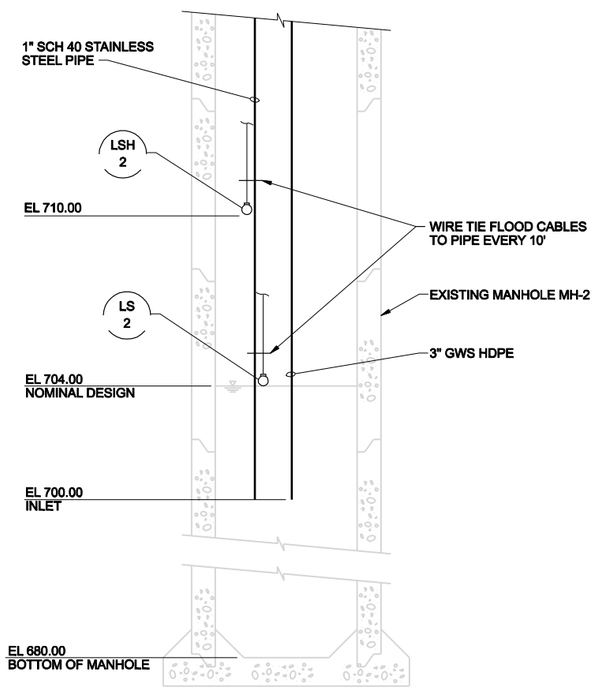
MECHANICAL

PUMP BOX DETAIL AND SECTION

SHEET	11
DWG	M-1
DATE	MARCH 2005
PROJ	184199

FILENAME: PRnm001d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:37 PM





(TYPICAL FOR MANHOLES MH-1 AND MH-3)

1 MANHOLE MH-2 SECTION (A) C-1

3/8"=1'-0"

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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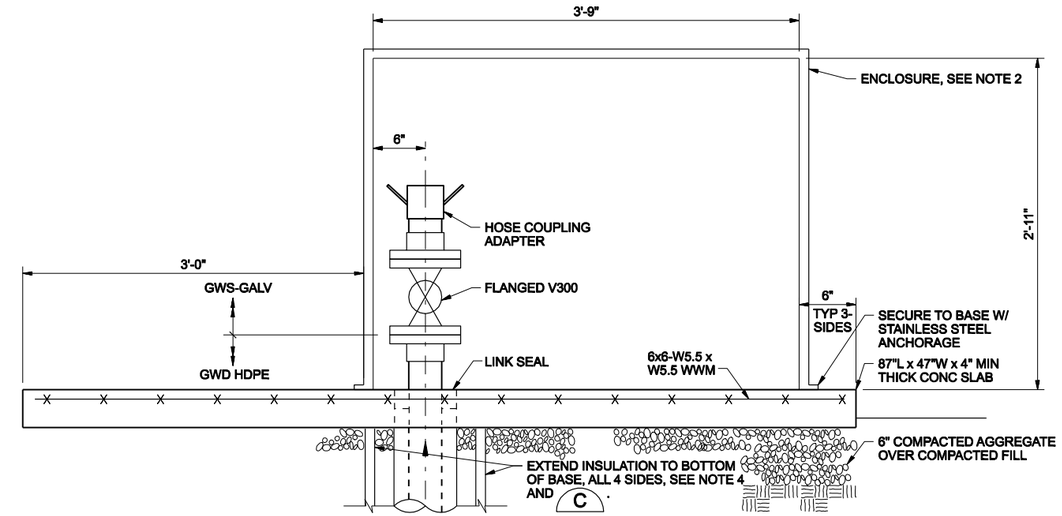
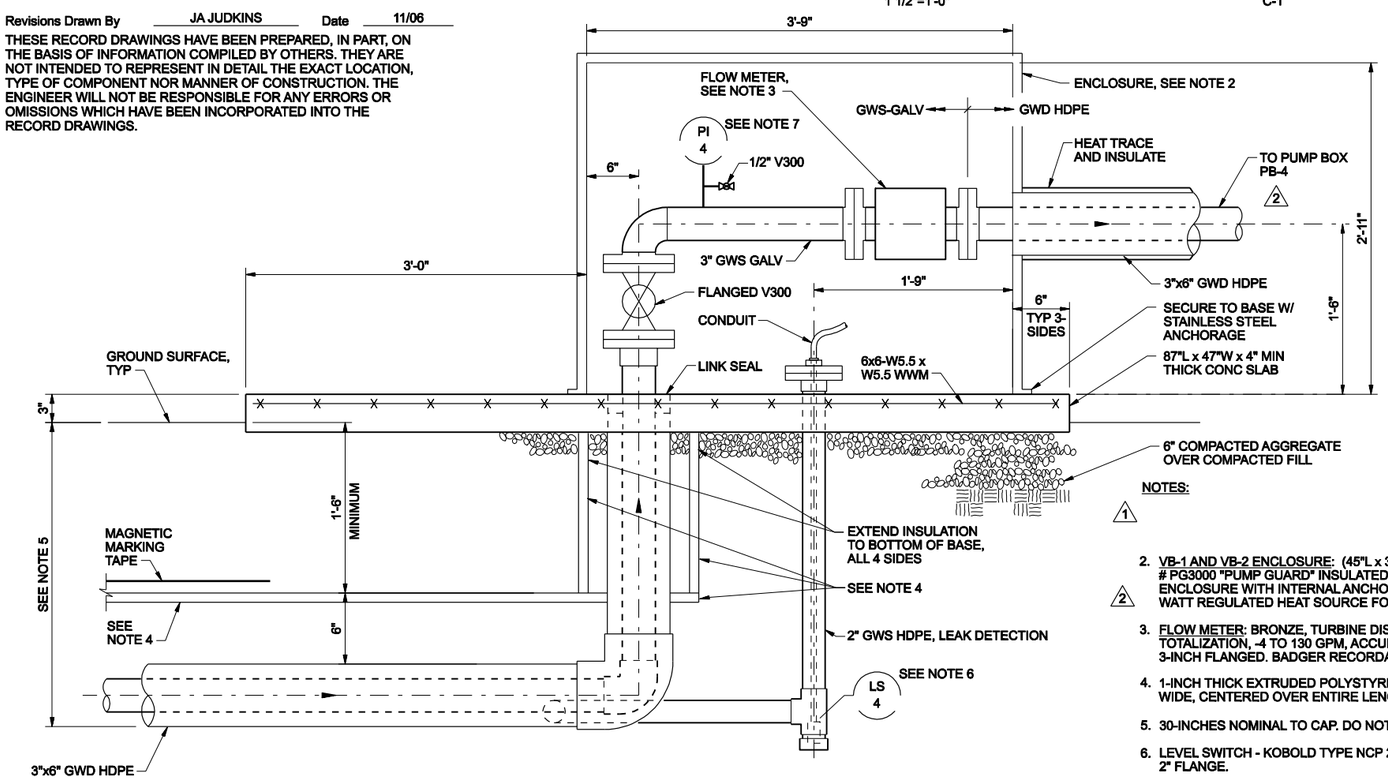


2 VALVE BOX VB-2 SECTION (B) C-1

1 1/2"=1'-0"



2 VALVE BOX VB-1 SECTION (C) C-1

1 1/2"=1'-0"

NOTES:

1

2. VB-1 AND VB-2 ENCLOSURE: (45"L x 35"W x 35"H) HOTBOX STANDARD # PG3000 "PUMP GUARD" INSULATED FIBERGLASS FLIP-TOP ENCLOSURE WITH INTERNAL ANCHORING KIT. PROVIDE 120-VOLT, 1000 WATT REGULATED HEAT SOURCE FOR VB-1.

2

3. FLOW METER: BRONZE, TURBINE DISC TYPE METER, RATE AND TOTALIZATION, -4 TO 130 GPM, ACCURACY 1 1/2% OF READING, 3-INCH FLANGED. BADGER RECORDALL TURBO RCDL, OR EQUAL.
4. 1-INCH THICK EXTRUDED POLYSTYRENE FOAM INSULATION, 4-FEET WIDE, CENTERED OVER ENTIRE LENGTH OF PIPE.
5. 30-INCHES NOMINAL TO CAP. DO NOT DIG INTO CAP.
6. LEVEL SWITCH - KOBOLD TYPE NCP 2554 WITH PVC STEM AND 2" FLANGE.
7. PRESSURE GAUGE 0-25 PSI STAINLESS STEEL ITT BARTON OR EQUAL.

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DSGN RA YOLO					
DR MA REICHERT	2	11/06	RECORD DRAWING.	JAJ	RCS
CHK LA AMUNDSON		08/06	ADDED PB-4 AND VB-2.	PAK	RAY
APVD RA YOLO	1	07/05	REVISED MANHOLE, PIPING, NOTES, AND LEVEL SWITCHES	PAK	RAY
	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
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CH2MHILL

2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

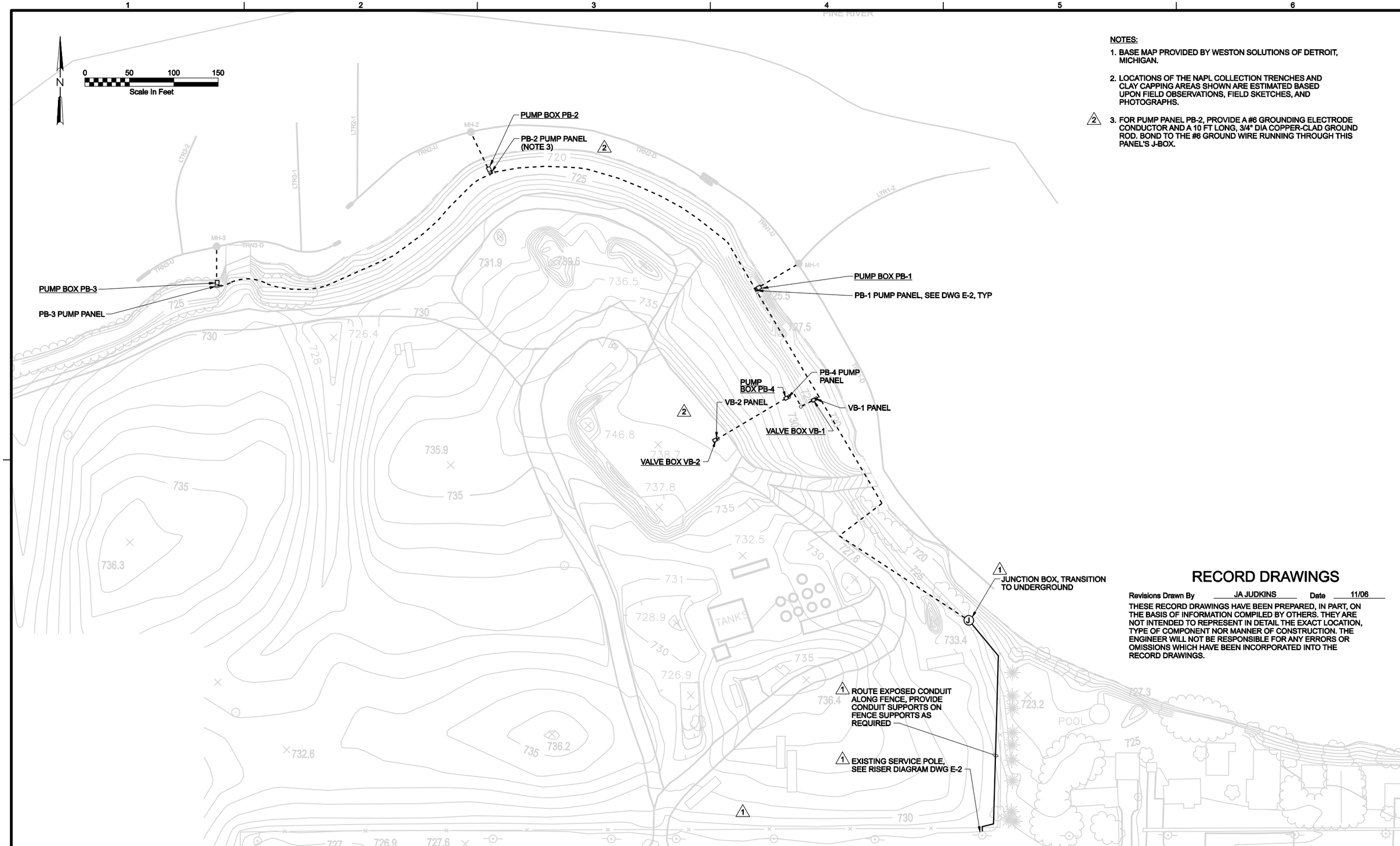
VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

MECHANICAL

SECTIONS

SHEET	12
DWG	M-2
DATE	MARCH 2005
PROJ	184199

FILENAME: PRnm002d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:45 PM



NOTES:

1. BASE MAP PROVIDED BY WESTON SOLUTIONS OF DETROIT, MICHIGAN.
2. LOCATIONS OF THE NAPL COLLECTION TRENCHES AND CLAY CAPPING AREAS SHOWN ARE ESTIMATED BASED UPON FIELD OBSERVATIONS, FIELD SKETCHES, AND PHOTOGRAPHS.
3. FOR PUMP PANEL PB-2, PROVIDE A #6 GROUNDING ELECTRODE CONDUCTOR AND A 10 FT LONG, 3/4" DIA COPPER-CLAD GROUND ROD. BOND TO THE #6 GROUND WIRE RUNNING THROUGH THIS PANEL'S J-BOX.

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

THESE RECORD DRAWINGS HAVE BEEN PREPARED, IN PART, ON THE BASIS OF INFORMATION COMPILED BY OTHERS. THEY ARE NOT INTENDED TO REPRESENT IN DETAIL THE EXACT LOCATION, TYPE OF COMPONENT NOR MANNER OF CONSTRUCTION. THE ENGINEER WILL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH HAVE BEEN INCORPORATED INTO THE RECORD DRAWINGS.

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DSGN RE NAGEL						
DR MA REICHERT	2	11/06	RECORD DRAWING.	JAJ	RCS	VERIFY SCALE
CHK BM WILLIAMS		08/06	ADDED PB-4 AND VB-2.	PAK	RAY	BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"
APVD RE NAGEL	1	07/05	REVISED CONDUIT.	PAK	BMW	IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.
	NO.	DATE	REVISION	BY	APVD	

CH2MHILL

2005 SEDIMENT REMEDIAL ACTION GROUNDWATER RECOVERY SYSTEM AND DNAPL COLLECTION TRENCH

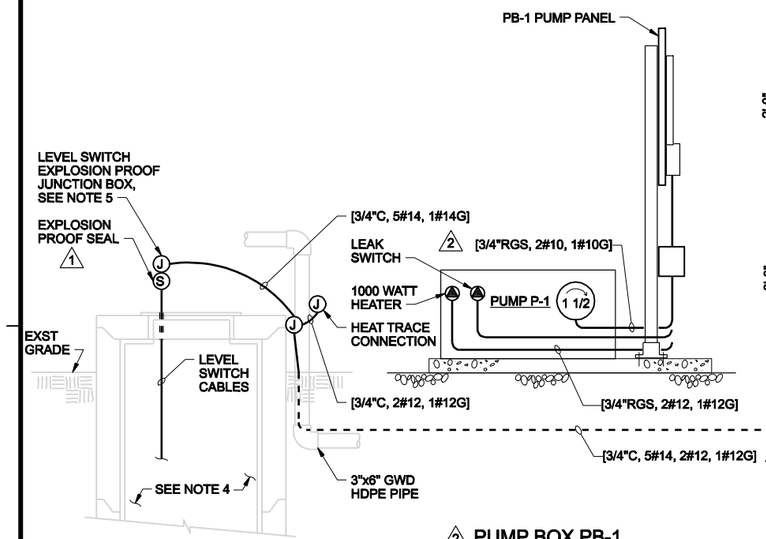
VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

ELECTRICAL

CONDUIT LAYOUT PLAN

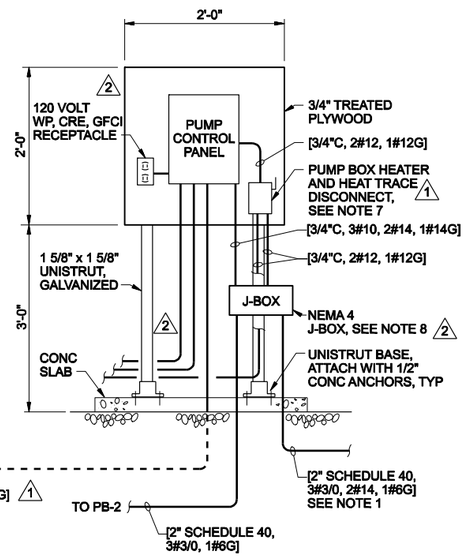
SHEET	13
DWG	E-1
DATE	MARCH 2005
PROJ	184199

FILENAME: PRne001d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:45:55 PM



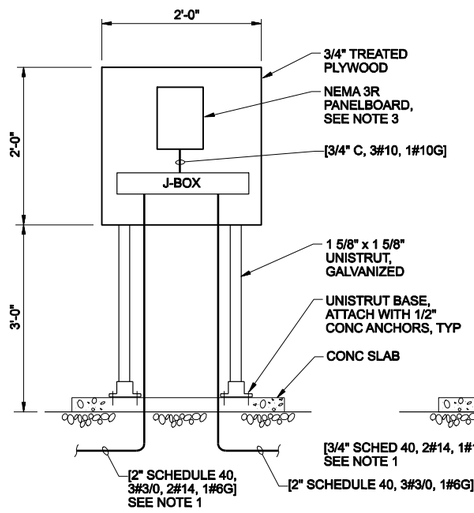
1 EXISTING MANHOLE MH-1
(MH-2 AND MH-3 SIMILAR)

2 PUMP BOX PB-1
(TYPICAL FOR PUMP BOXES PB-2, PB-3 AND PB-4)



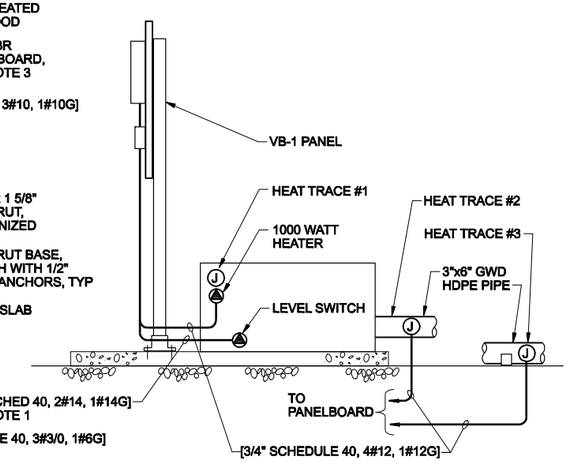
PB-1 PUMP PANEL

2 (SIMILAR FOR PANELS PB-2 AND PB-3. PB-4 PANEL IS SIMILAR BUT HAS NO LEVEL SWITCH INPUT.)

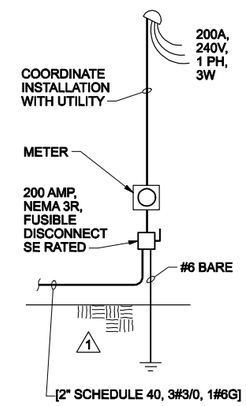


VALVE BOX VB-1 PANEL

2 (VALVE BOX VB-2 SIMILAR EXCEPT WITH 1P/20 GFI WEATHER PROOF OUTLET, NO EXTERNAL HEAT TRACE CONNECTIONS, NO LEVEL SWITCH AND NO HEATER.)



VALVE BOX VB-1



1 SERVICE CONNECTION

1 RISER DIAGRAM
NTS

NOTES:

1. PULL 2 #14's FROM VALVE BOX #1 LEVEL SWITCH THROUGH 2-INCH CONDUIT TO PUMP PANEL 1 AT PB-1 TO INDICATE LEAKS.
2. DIRECT BURY DUCTBANK MAXIMUM 2 FEET BELOW FINISHED GRADE.
3. NEMA 3R PANELBOARD WITH 30 AMP MAIN, ONE 1P/15 TO VALVE BOX HEATER, THREE 1P/20 GFI TO HEAT TRACING J-BOXES. BALANCE THE 120V LOADS ACROSS THE HOT LEGS. (2)
4. INTERIOR OF MANHOLES ARE CLASSIFIED AS CLASS 1, DIVISION 1, GROUP D.
5. INSTALL LEVEL SWITCHES IN MANHOLES WITH LEVEL AS INDICATED ON DRAWING M-2.
6. ABOVE GRADE CONDUIT TO BE RIGID GALVANIZED STEEL. BELOW GRADE CONDUIT TO BE SCHEDULE 40 PVC.
7. (1) PROVIDE UL-LISTED DISCONNECT SWITCH, GFCI CIRCUIT BREAKER TYPE, NEMA 4X ENCLOSURE SUITABLE FOR 20 AMPS, 120 VOLT, 1-POLE CIRCUITS AS INDICATED. DISCONNECT SWITCH SHALL SERVE HEAT TRACE AND PUMP BOX HEATER LOADS.
8. (2) BALANCE THE 120V LOADS ACROSS THE HOT LEGS.

RECORD DRAWINGS

Revisions Drawn By JA JUDKINS Date 11/06

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DSGN RE NAGEL						
DR MA REICHERT	2	11/06	RECORD DRAWING.	JAJ	RCS	
		08/06	ADDED PB-4 AND VB-2.	PAK	RAY	
CHK BM WILLIAMS	1	07/05	REVISED CONDUIT AND ADDED HEAT TRACE CONNECTION.	PAK	BMW	
APVD RE NAGEL	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL

2005 SEDIMENT REMEDIAL ACTION
GROUNDWATER RECOVERY SYSTEM
AND DNAPL COLLECTION TRENCH

VELSICOL/PINE RIVER SITE
ST. LOUIS, MICHIGAN

ELECTRICAL

RISER DIAGRAM

SHEET	14
DWG	E-2
DATE	MARCH 2005
PROJ	184199

FILENAME: PRne002d_184199.dgn PLOT DATE: 10/31/2006 PLOT TIME: 2:48:03 PM

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Appendix E
MISS DIG 811 Documentation

Ticket No: 2022061701421 Rev: 000

User Reference: Not Supplied

Excavator Details

Caller Id:	2068139	**Phone:**	906-281-3539
Contact:	Rachel Vaughan	**Mobile:**	Not Supplied
Company:	JACOBS	**Email:**	rlblink@gmail.com

Dig Site and Ticket Details

Open Map

NTIRE RIVER & THE BANKS. SEE POLYGON

Ticket Status	Original		
Previous Ticket No.	Not Supplied		
Ticket Type	Design		
Ticket Date	06/17/2022 10:26		
Work to Begin Date	07/01/2022 10:20		
Work Legal Start Date	07/01/2022 10:26		
Work Expiration Date	06/17/2032 23:59		
Address	W Washington Ave St. Louis		
Nearest Cross Street	N Mill st		
Lot Number/Subdivision			
Type of Work	Groundwork		
Activity	Retain Walls		
Excavation Method	Machine Excavating		
Excavation Depth	>48in		
Working for	Other Business		
Onsite Company	EPA		
Onsite Contact Name	Not Supplied		
Onsite Contact Phone	Not Supplied		
Private Locate	No	**Area Pre-marked**	No
Pet on Property	No	**Work in Water**	Yes

Your Responsibilities

- Be sure the work location is accessible to facility owners/operators and their contract locators.
- Do not proceed with your works until the legal start date/response due date has arrived and ALL facility owners/operators have responded that it is safe to dig.
- When working within 48" of any facility marking, hand dig to expose the line prior to using power equipment.
- If you make contact with a line, you are required to contact the facility owner immediately.
- **If you need assistance, please contact Web Ticket Support at webticketdept@missdig811.org**

Utility Owner Details

The public utility owners listed below with a Status of "Notification Sent" have been requested to respond to your request. They may contact you directly for clarification of your request details.

Station Code	Authority Name	Phone	Status
CHARCTV	CHARTER COMMUNICATIONS CABLE TV	8007789140	Notification Sent
CHARFBR	CHARTER COMMUNICATIONS FIBER OPTICS	8007789140	Notification Sent
CEEDIS	CONSUMERS ENERGY ELECTRIC	2488777744	Notification Sent
CEGDIS	CONSUMERS ENERGY GAS	800-477-5050	Notification Sent
DE0017	DTE ENERGY (ELECTRIC) ELECTRIC	313-407-5364	Notification Sent
EVERST	EVERSTREAM FIBER OPTICS	6163930138	Notification Sent
VERZ01PH	FRONTIER/VERIZON TELEPHONE	8007789140	Notification Sent
GRATCDR	GRATIOT COUNTY DRAIN COMMISSION EXEMPT	9898755207	Notification Sent
GLGPR	GREAT LAKES GPR [Private Locator]	7347806849	Not Notified

PINESANI2	PINE RIVER TOWNSHIP SANITARY SEWER	9896813644	Notification Sent
STLOUIELE	ST. LOUIS CITY ELECTRIC	9893300321	Notification Sent
STLOUIWTR	ST. LOUIS CITY POTABLE WATER	9896813567	Notification Sent
STLOUISANI	ST. LOUIS CITY SANITARY SEWER	989-875-9260	Notification Sent
STLOUISTRM	ST. LOUIS CITY STORM SEWER	989-875-9260	Notification Sent

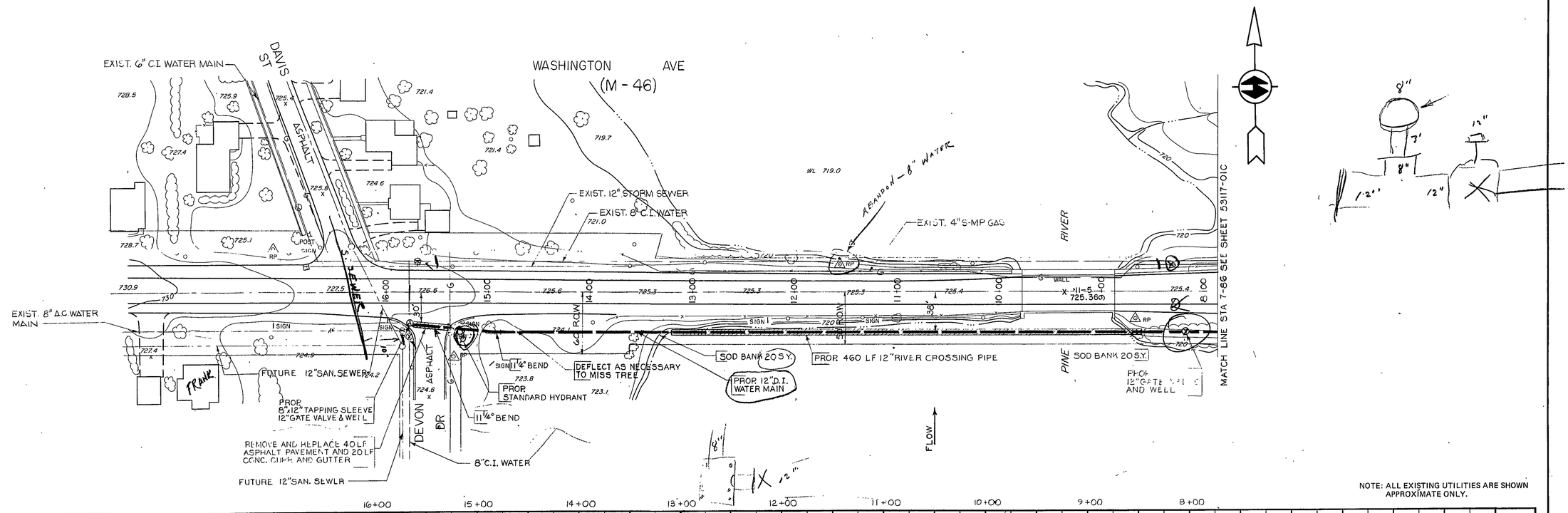
END OF UTILITIES LIST

From:	Rachel Blink
To:	Vaughan, Rachel/DET
Subject:	[EXTERNAL] Fwd: MISS DIG Design Ticket
Date:	Wednesday, June 22, 2022 12:21:39 PM
Attachments:	ROWE_MainStreet_09M0003-RECORD_DRAWING13.pdf ROWE_MainStreet_09M0003-RECORD_DRAWING14.pdf STR-056.pdf WM - M-46 - River x-ing (southside detail).PDF WM - M46 Northside.pdf WM M46 - River to drive entrance.pdf WM M-46 Northside - profile.pdf WM Southside M46 - River x-ing.PDF Screenshot 2022-06-20 151247.jpg Screenshot 2022-06-20 151547.jpg Screenshot 2022-06-20 151649.jpg Screenshot 2022-06-20 151756.jpg

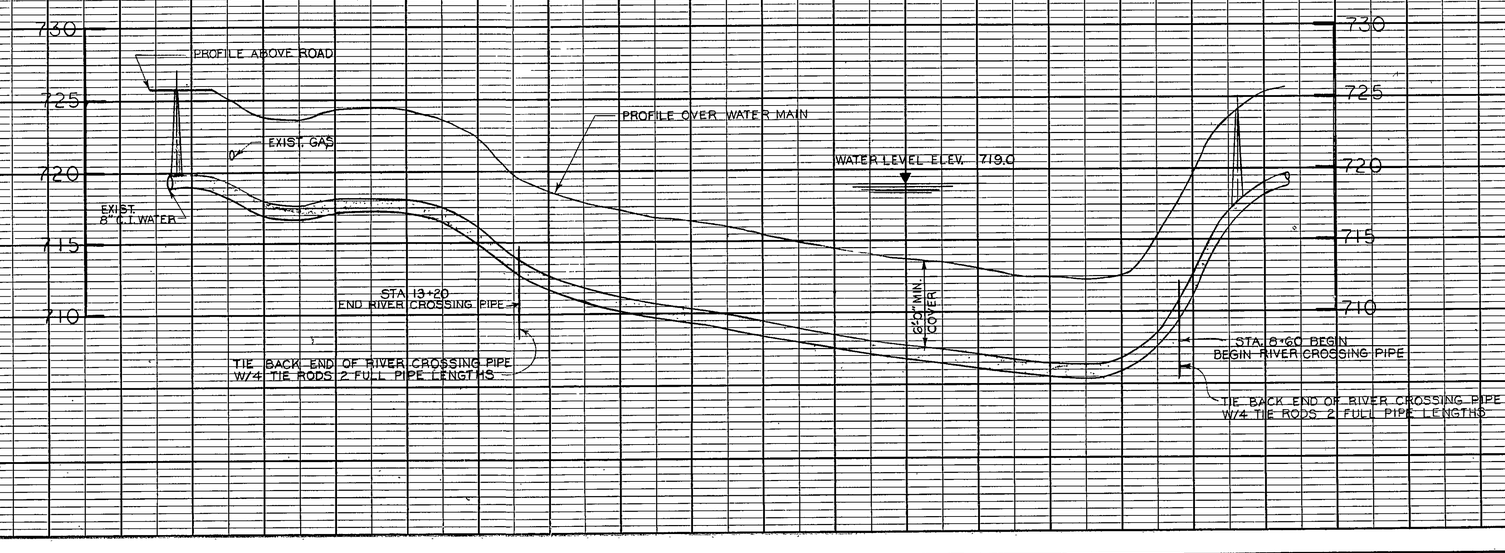
---

---------- Forwarded message ---------
From: **Keith Risdon** <krisdon@stlouismi.com>
Date: Wed, Jun 22, 2022, 11:31 AM
Subject: MISS DIG Design Ticket
To: rlblink@gmail.com <rlblink@gmail.com>

Here is the information which we have for sewer and water. We has little to no information on any of the storm outlets along the river bank. Generally this information was picked up in the past by floating along the river and identifying discharge pipes.



NOTE: ALL EXISTING UTILITIES ARE SHOWN APPROXIMATE ONLY.



BENCH MARKS	
ELEVATION	DESCRIPTION
731.21	℄ WALK INTERSECTION NE CORNER SAGINAW & WATSON

REV.		
REV.		
REV.		
REV.		
REV.		
REV.		
	10/77	ORIGINAL ISSUE

DRAWN BY: K. J. CHECKED BY: dwd

AYRES, LEWIS, NORRIS & MAY, INC.
engineers - architects
OCT 13 1977
Ann Arbor, Michigan 48104
SEALED:

CITY OF ST. LOUIS, MICHIGAN
WATER SYSTEM IMPROVEMENTS

WASHINGTON STREET
WATER MAIN

AYRES, LEWIS, NORRIS & MAY, INC.
engineers architects
ANN ARBOR, MICHIGAN

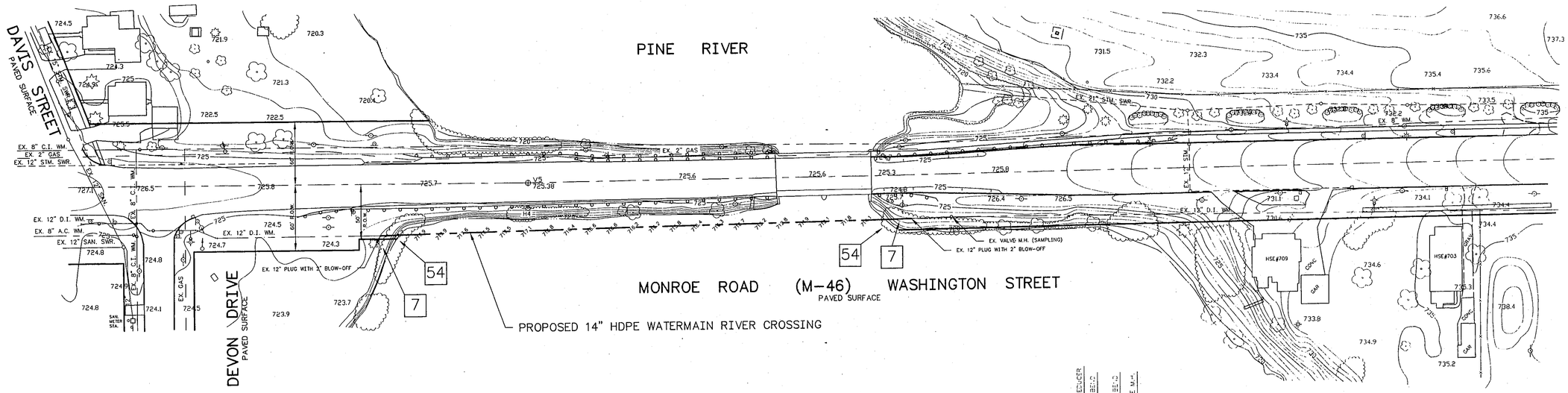
SCALE: VERT. 1"=5' HOR. 1"=50'

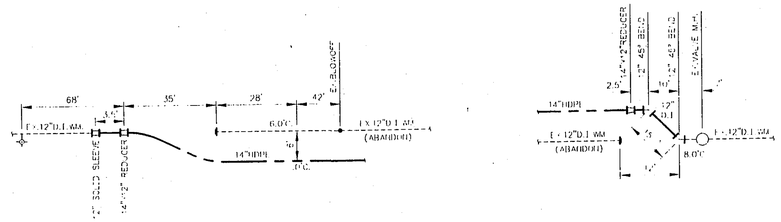
37117-02

REVISION

DW-3308

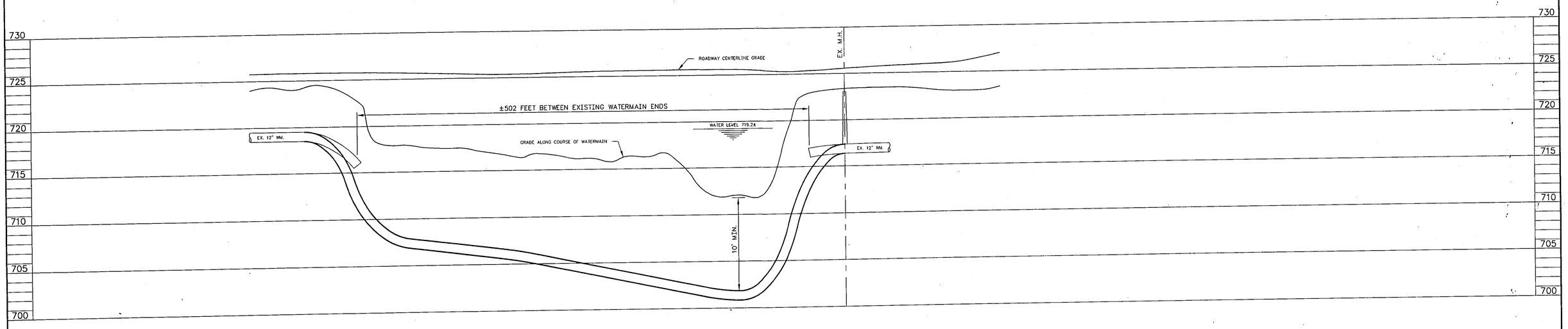
A.A.S.C. 15352





WATERMAIN RIVER CROSSING NOTES:

1. HORIZONTALLY DIRECTIONAL DRILL 14" HDPE DR11 (160 PSI) AWWA C-906 NSF APPROVED WATERMAIN CROSSING UNDER THE PINE RIVER AND CONNECT TO EXISTING 12" D.I. WATERMAIN ON BOTH SIDES OF THE RIVER. THE COST FOR THE RIVER CROSSING SHALL BE A TOTAL LUMP SUM FOR ALL LABOR, MATERIALS, EQUIPMENT AND TOOLS REQUIRED AND SHALL INCLUDE, BUT IS NOT LIMITED TO, THE DIRECTIONAL DRILLING, PIPE, FITTINGS, FLANGES, FLANGE ADAPTORS AND ANY OTHER MATERIALS REQUIRED FOR THE CONNECTION, TESTING, CHLORINATION, SAMPLING AND RESTORATION COMPLETE.
2. IF THE CONTRACTOR PROPOSES TO CONNECT TO THE EXISTING 12" D.I. WATERMAIN EAST OF THE SAMPLING MANHOLE, THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COST OF CONSTRUCTING A REPLACEMENT SAMPLING MANHOLE.
3. CONTRACTOR SHALL PREPARE AND SUBMIT AS-CONSTRUCTED DOCUMENTATION OF THE HORIZONTAL AND VERTICAL LOCATION OF THE 14" HDPE WATERMAIN.



67

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By	Date	Revisions	CAD
DWB	8/4/97	REVISED IN ACCORDANCE WITH CONSTRUCTION DOCUMENTATION	X

Drawn	DWB	Designed	LDK
Checked	LDK	Horz. Scale	1" = 50'
Field Survey	MEG/AMT	Vert. Scale	------
Water Permit Date		Sewer Permit Date	

PINE RIVER (M-46) WATERMAIN CROSSING
1996 WATER AND WATERMAIN SYSTEM IMPROVEMENTS
CITY OF ST. LOUIS
GRATIOT COUNTY, MICHIGAN

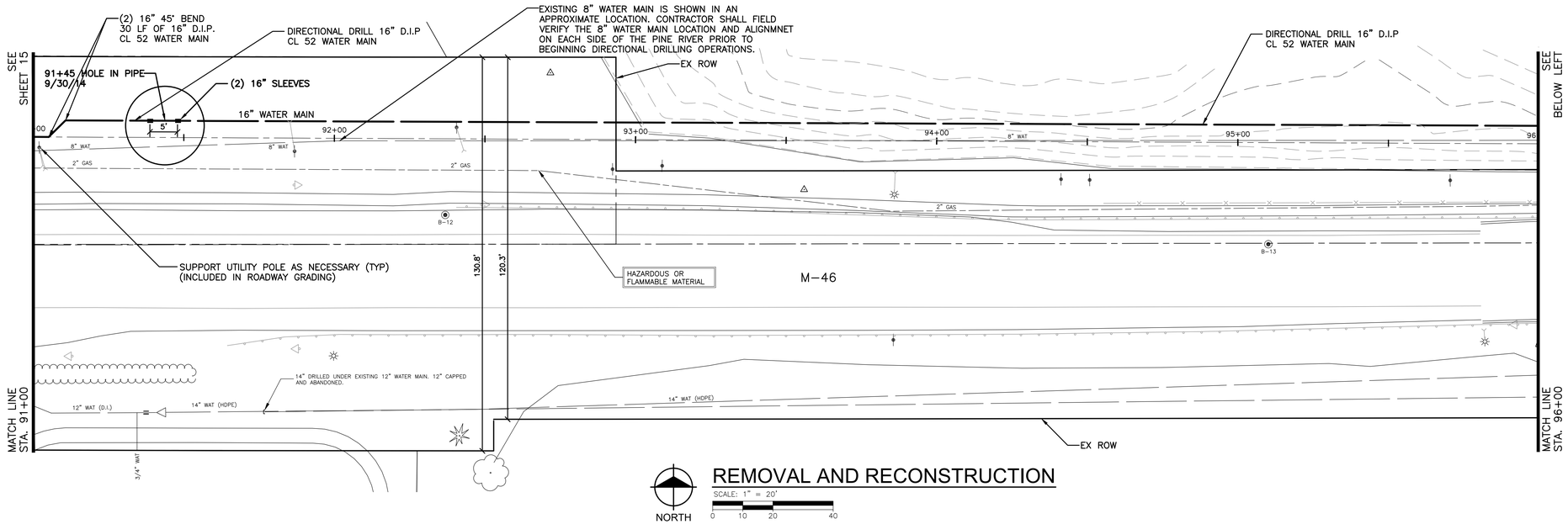
Bartow & King Engineers
2500 E. Midland Road, Bay City, Michigan 48706
Tel. (517) 684-8850
Fax. (517) 684-8404

Date: AUGUST, 1996
Sheet Number: 5 of 9

DW-3181

71

\960211\96021105 Mon Aug 4 12:24:36 1997

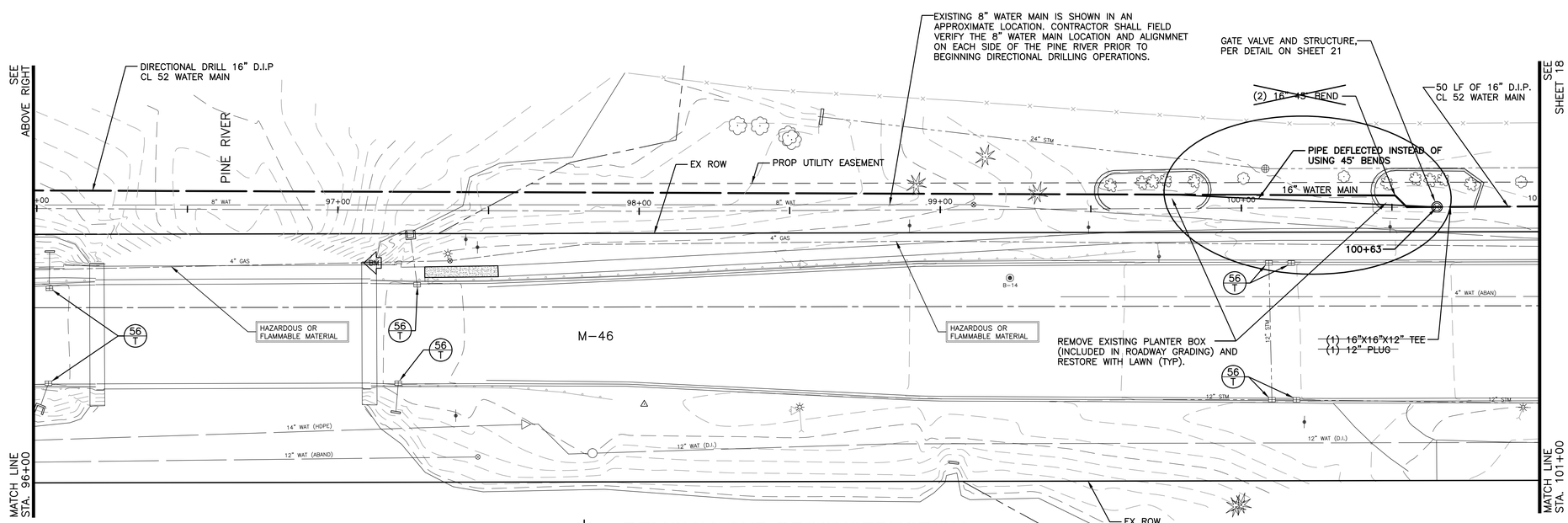


NORTH

REMOVAL AND RECONSTRUCTION

SCALE: 1" = 20'

0 10 20 40



NORTH

REMOVAL AND RECONSTRUCTION

SCALE: 1" = 20'

0 10 20 40

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Michigan's One-Call
Utility Notification Organization
1-800-482-7171
on the net at: www.missdig.org

fTC&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

LEGEND

REMOVE EXISTING SIDEWALK AND PLACE PROPOSED 4" OR 6" SIDEWALK PER DETAIL ON SHEET 22.

NOTES

1. SUPPORT AND PROTECT EXISTING GAS UTILITIES AT ALL CROSSINGS. COORDINATE CROSSING WITH GAS UTILITIES. IF NECESSARY, RELOCATE GAS MAIN AND GAS SERVICES FOR INSTALLATION OF NEW UTILITIES (BY GAS UTILITY). CONTRACTOR TO COORDINATE RELOCATION OF UTILITIES.
2. SUPPORT AND PROTECT EXISTING TELEPHONE UTILITIES AT ALL CROSSINGS. COORDINATE CROSSING WITH UTILITY COMPANY.
3. ALL EARTHWORK AND GRADING NECESSARY TO CONSTRUCT THE ENTIRE WIDTH OF THE STREET, INCLUDING INTERSECTIONS, DRIVEWAYS AND SIDEWALKS, WILL NOT BE PAID FOR SEPARATELY, BUT WILL BE INCLUDED IN PAYMENT FOR ROADWAY GRADING.
4. MAINTAIN 18" OF VERTICAL SEPARATION AT CROSSING BETWEEN WATER MAIN AND STORM OR SANITARY SEWER (UNLESS NOTED OTHERWISE).
5. ALL REMOVAL LIMITS SHALL BE SAWCUT TO CREATE A SQUARE JOINT TO PAVE AGAINST. THIS INCLUDES THE ROADWAY, CURB AND GUTTER, SIDEWALK AND DRIVEWAY LIMITS.
6. THE TRANSMISSION WATER MAIN SHALL HAVE A MINIMUM COVER OF 6'. IT SHALL GET PLACED AT A MINIMUM DEPTH OF 10' BELOW THE RIVER BOTTOM ACROSS THE PINE RIVER.
7. UTILIZE SHEET PILING AS NECESSARY TO PROTECT EXISTING ROADWAY (INCLUDED IN PAYMENT FOR THE WATER MAIN).
8. CONTRACTOR MAY ONLY LEAVE UP TO 2000 LINEAR FEET OF UTILITY TRENCH UNRESTORED AT ANY ONE TIME. REMOBILIZATION FOR THE PURPOSE OF RESTORATION SHALL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE UNIT PRICE FOR LAWN RESTORATION.
9. EXISTING PAVED DRIVEWAYS MAY ONLY REMAIN UNPAVED FOR A CONSECUTIVE PERIOD OF 2 WEEKS. REMOBILIZATION FOR THE PAVING OPERATION SHALL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE UNIT PRICE FOR "BITUMINOUS PAVING, 4C."

RECORD DRAWINGS

Constructed by: CRAWFORD
Inspected by: FTC&H
Date: 1/20/2016

City of St. Louis

City of Saint Louis, Gratiot County, Michigan

Saint Louis Water Supply Replacement
North Transmission Main - Phase II

1/20/2016	REVISED IN ACCORDANCE WITH CONST. RECORDS
4/2/2014	BIDS AND CONSTRUCTION

Drawn By	MB2
Designer	DJS
Reviewer	DJS
Manager	DJS

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G120617FP3

SHEET NO.
16

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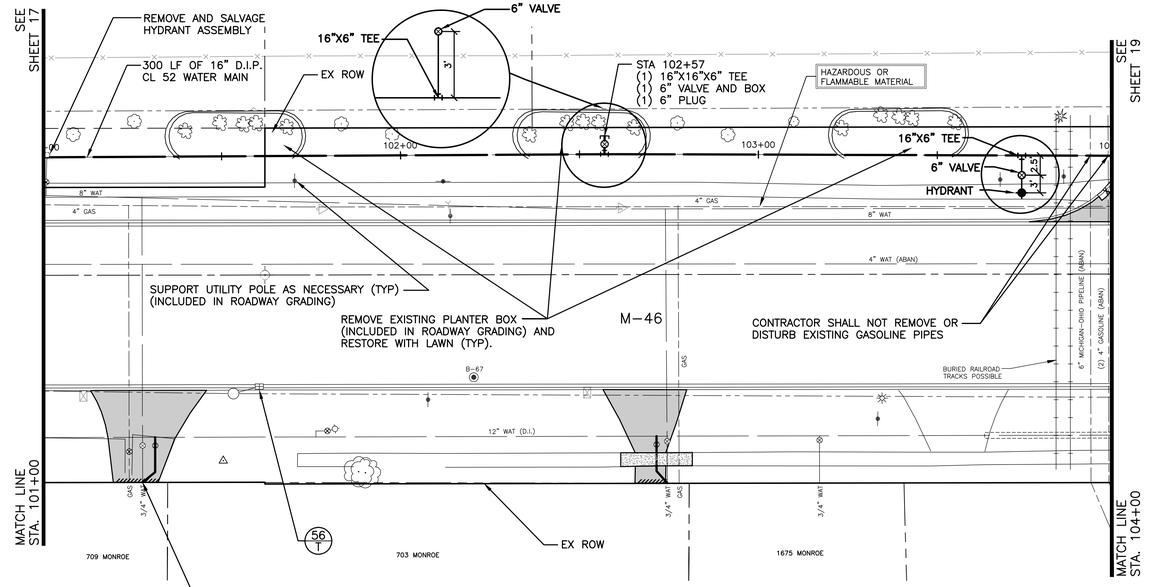
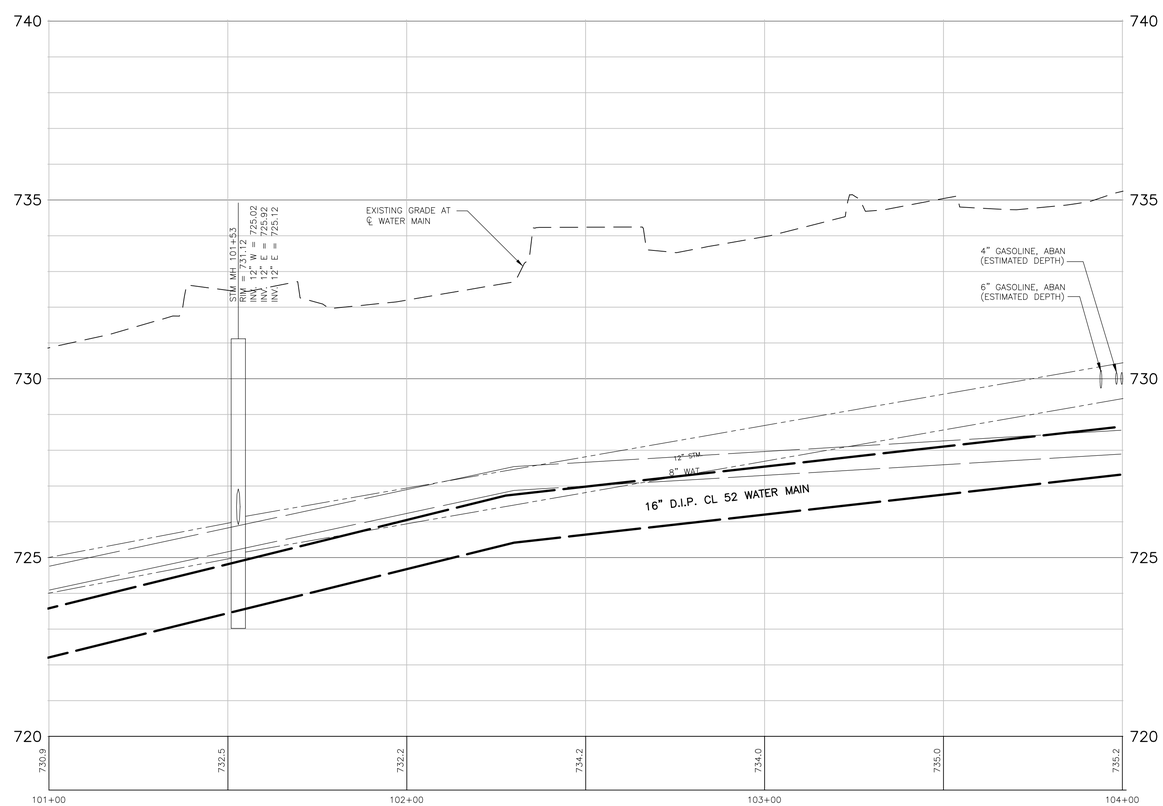
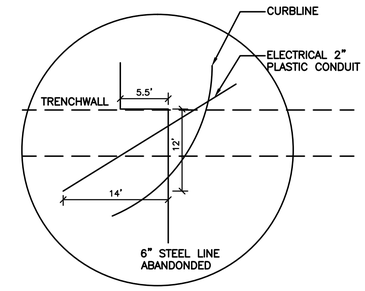
PLOT INFO: Z:\2012\120617FP3\CAD\CDM-46 SHEETS\C0161206 17FP3.DWG LAYOUT: 16 DATE: 1/28/2016 TIME: 10:36:00 AM USER: NB



REMOVAL AND RECONSTRUCTION

SCALE: 1" = 20'
0 10 20 40
VERTICAL SCALE: 1" = 2'





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engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

LEGEND

- REMOVE EXISTING PAVEMENT (FULL DEPTH) AND PLACE BITUMINOUS PAVEMENT (SEE PROPOSED CROSS SECTION ON SHEET 20)
- REMOVE EXISTING SIDEWALK (FULL DEPTH) AND PLACE 6" CONCRETE SIDEWALK
- SAWCUT
- (R) · X · X · X · X · X · X · X · REMOVE AND REPLACE CURB AND GUTTER

NOTES

1. SUPPORT AND PROTECT EXISTING GAS UTILITIES AT ALL CROSSINGS. COORDINATE CROSSING WITH GAS UTILITIES. IF NECESSARY, RELOCATE GAS MAIN AND GAS SERVICES FOR INSTALLATION OF NEW UTILITIES (BY GAS UTILITY). CONTRACTOR TO COORDINATE RELOCATION OF UTILITIES.
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RECORD DRAWINGS

Constructed by: CRAWFORD
Inspected by: FTC&H
Date: 1/20/2016

City of St. Louis

City of Saint Louis, Gratiot County, Michigan

Saint Louis Water Supply Replacement
North Transmission Main - Phase II

1/20/2016	REVISED IN ACCORDANCE WITH CONST. RECORDS
4/2/2014	BIDS AND CONSTRUCTION

Drawn By	MB2
Designer	DJS
Reviewer	DJS
Manager	DJS

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G120617FP3

SHEET NO.
18

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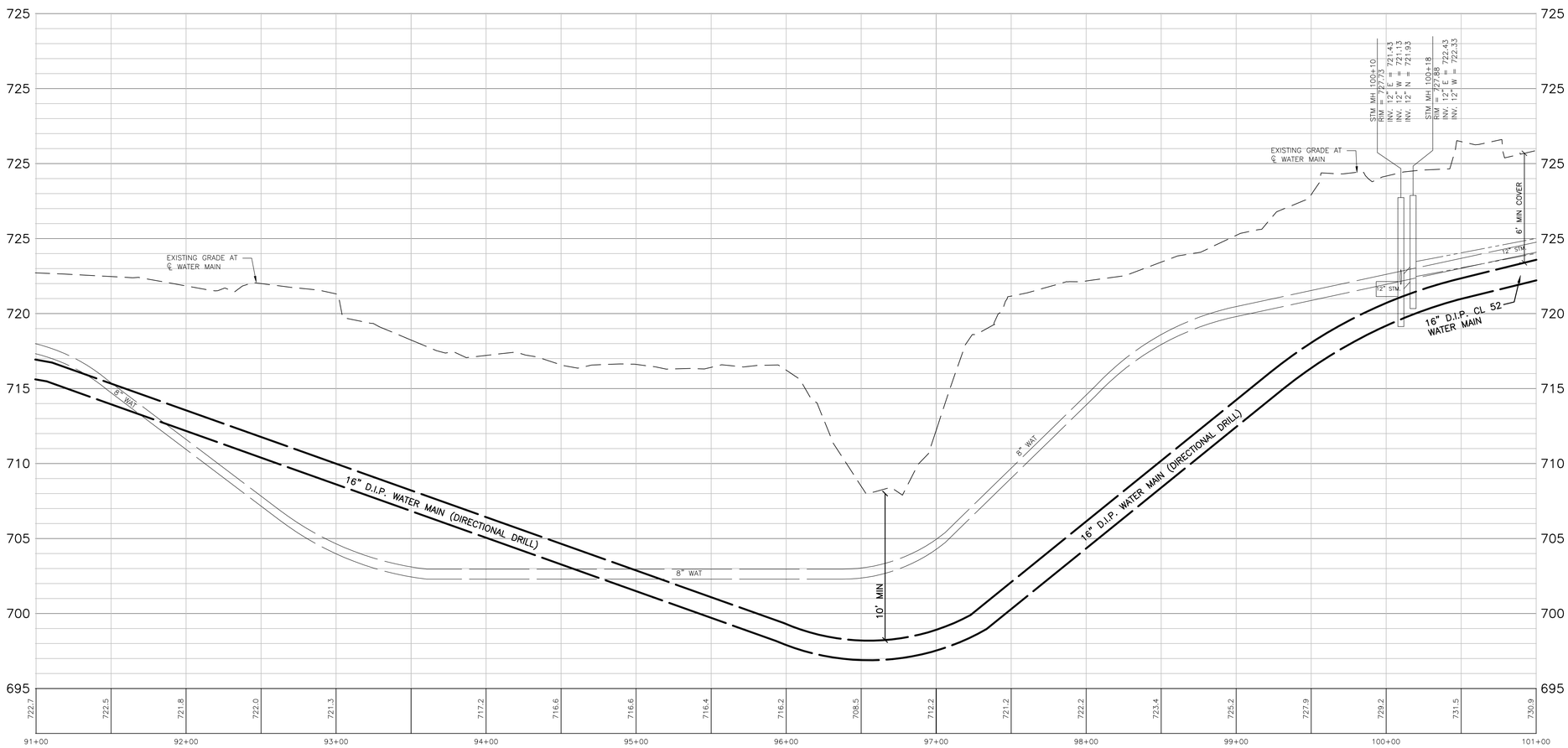
PLOT INFO: Z:\2012\120617FP3\CAD\CDM-46 SHEETS\G018120617FP3.DWG LAYOUT: 18 DATE: 1/28/2016 TIME: 10:37:17 AM USER: NB



PROFILE 91+00 TO 101+00

SCALE: 1" = 40'

0 20 40 80

VERTICAL SCALE: 1" = 10'

RECORD DRAWINGS

Constructed by: CRAWFORD

Inspected by: FTC&H

Date: 1.20.2016

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3 full working days before you dig:
Michigan's One-Call
Utility Notification Organization
1-800-482-7171
on the net at: www.missdig.org

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

City of St. Louis

City of Saint Louis, Gratiot County, Michigan

Saint Louis Water Supply Replacement
North Transmission Main - Phase II

1/20/2016	REVISED IN ACCORDANCE WITH CONST. RECORDS
4/2/2014	BIDS AND CONSTRUCTION

Drawn By	MB2
Designer	DJS
Reviewer	DJS
Manager	DJS

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.

G120617FP3

SHEET NO.

17

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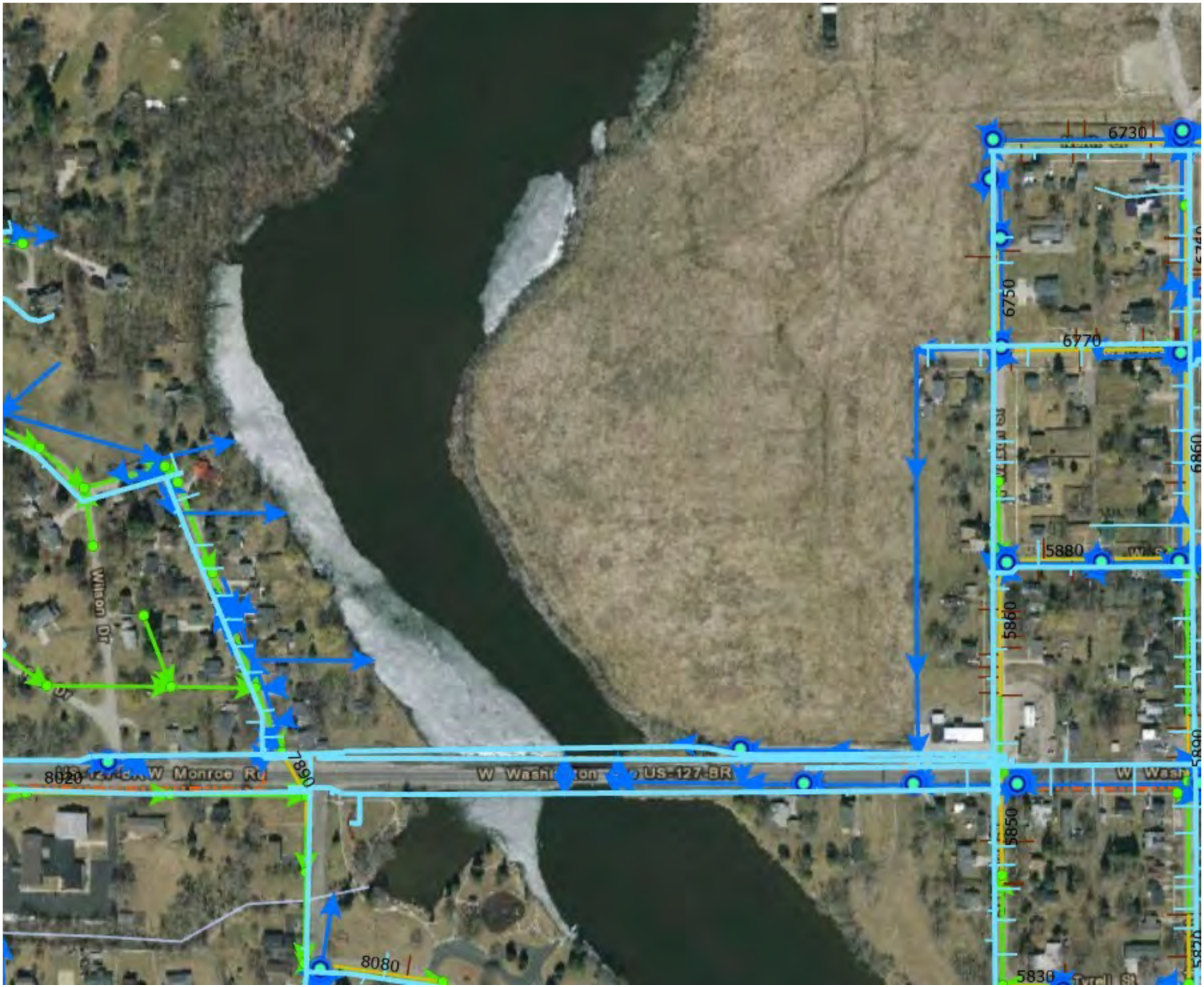
PLOT INFO: Z:\2012\120617FP3\CAD\CDM-46 SHEETS\C017120617FP3.DWG LAYOUT: 17 DATE: 1/28/2016 TIME: 10:36:35 AM USER: NB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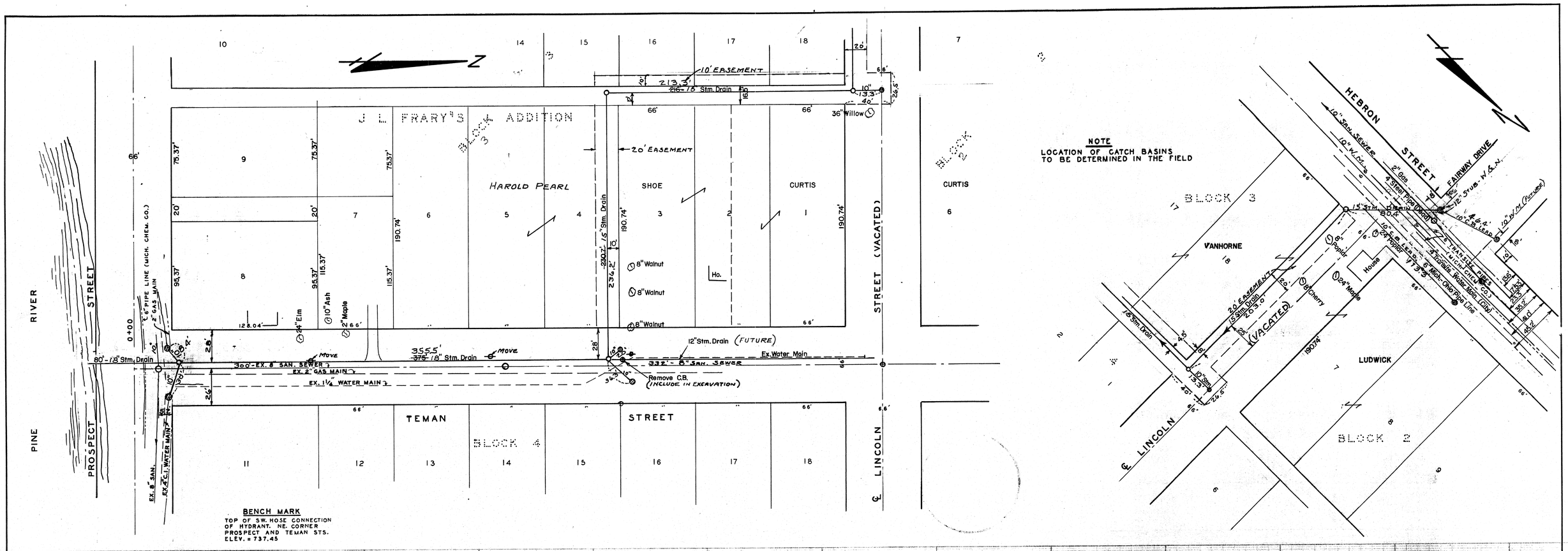
Wilson Dr
Tyrell St



DATE	REVISIONS	DATE	APPROVED
			CITY MANAGER
			Donald E. Hunter ENGINEER
		3/68	DR. BY E. J. E. CHK. BY
			SCALE: 1" = 40' HORZ 1" = 4' VERT

STATE OF MICHIGAN REGISTERED PROFESSIONAL ENGINEER DONALD E. HUNTER ENGINEER No. 19177 FINAL REC'A BY

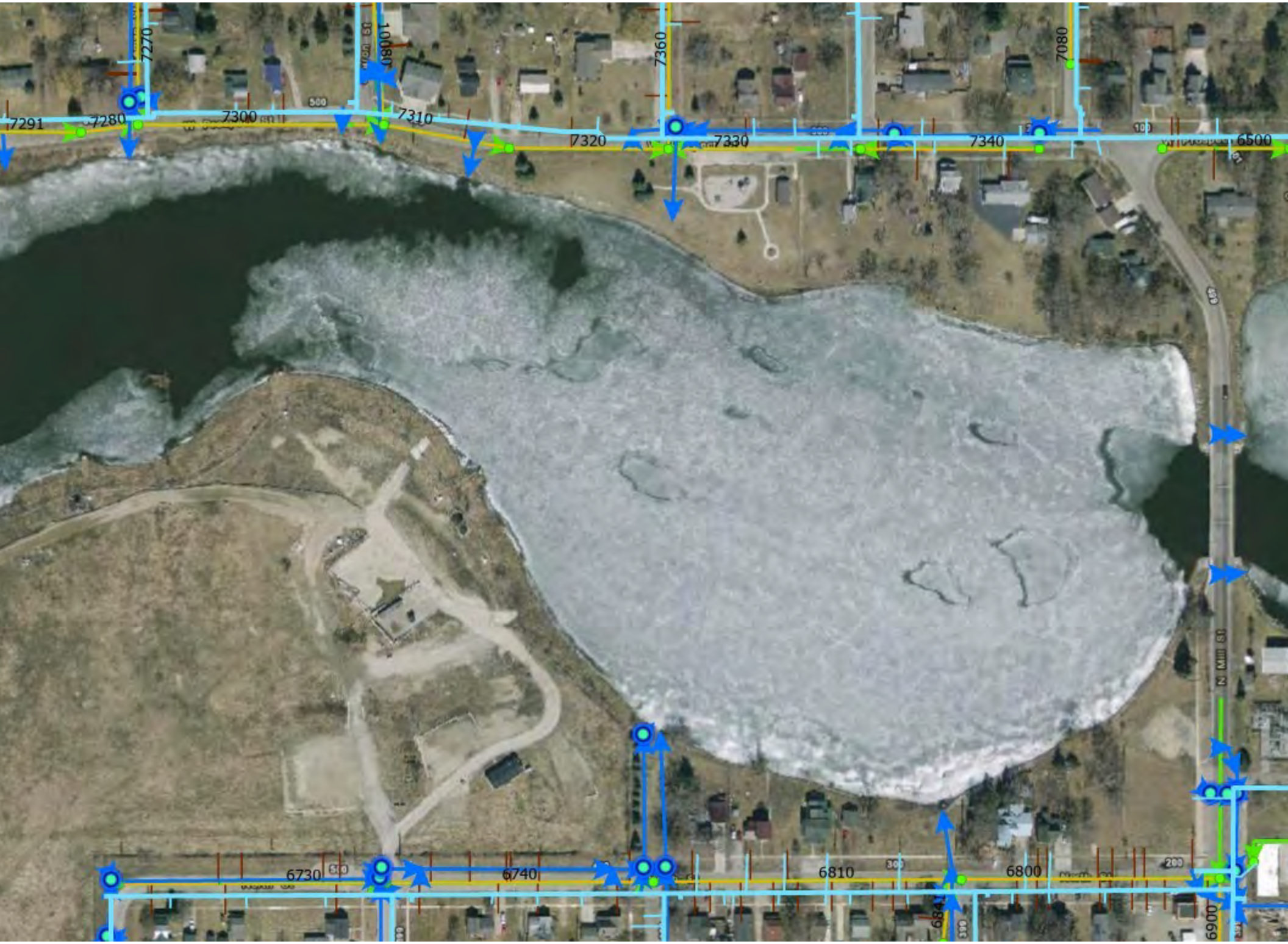
HUNTER - WHITTIER AND ASSOC.
ENGINEERS & SURVEYORS
MIDLAND, MICHIGAN

1976 TEMAN-HEBRON DRAIN

CITY OF ST. LOUIS, MICHIGAN

SHEET ___ OF ___ SHEETS

SAN (170) STR. (056) DR-2086-2 As BUILT - 6/1/77. 421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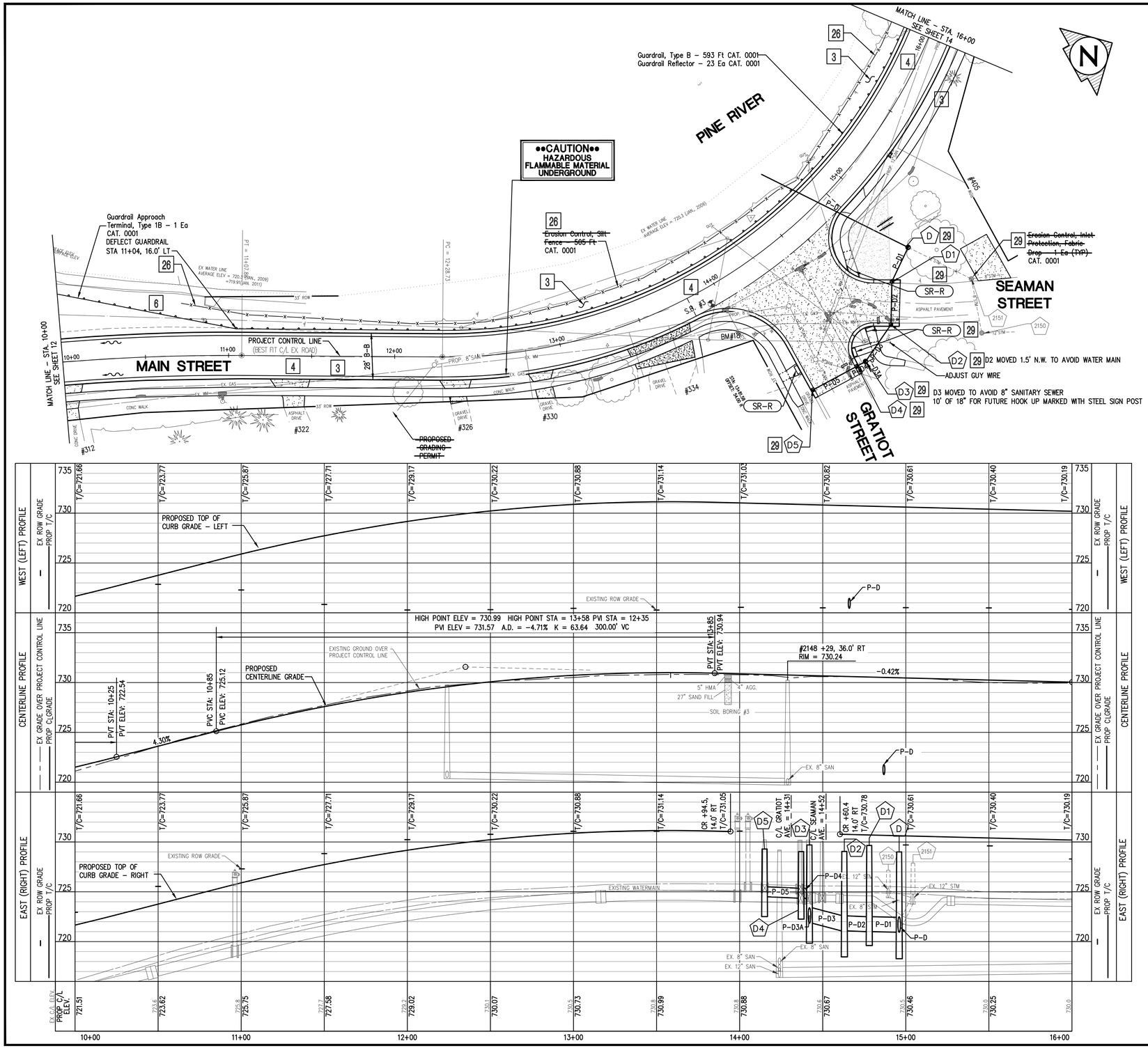

BENCHMARK #18
TOP S'LY FLANGE BOLT HYD AT SE QUAD MAIN & GRATIOT
ELEVATION = 731.96

STORM SEWER PIPE SCHEDULE

PIPE NUMBER	PIPE SLOPE (%)	Sewer, Cl A, 18 inch, Tr Det B (Ft) CAT. 0001	Sewer, Cl A, 12 inch, Tr Det B (Ft) CAT. 0001
P–D	0.28	~~99~~ 104	–
P–D1	0.28	~~23~~ 24	–
P–D2	0.28	26	–
P–D3	0.28	~~27~~ 26	–
P–D3A	0.28	~~8~~ 10	–
P–D4	0.48	–	~~8~~ 7
P–D5	0.48	–	~~30~~ 48

STORM SEWER STRUCTURE SCHEDULE

STRUCTURE NUMBER	Dr Structure, – inch dia CAT. 0001	COVER TYPE	RIM OR T/C ELEVATION	PIPE INVERT	STATION *	OFFSET *
D	48	G	RIM = 729.65	P–D = 720.94 SW P–D1 = 720.94 SE EX. 12" CLAY = 722.81±	14+96	58.1' R
D1	48	K	T/C = 729.53	P–D1 = 721.01 NW P–D2 = 721.01 SE	14+78	65.2' R
D2	48	K	T/C = 729.66	P–D2 = 721.08 NW P–D3 = 721.08 S	14+63	83.6' R
D3	48	G	RIM = 729.70	P–D3 = 721.84 N P–D4 = 724.33 S P–D3A = 721.84 E	14+42	90.7' R
D4	48	K	T/C = 728.92	P–D4 = 724.36 W P–D5 = 724.36 E	14+37	89.7' R
D5	24	K	T/C = 728.93	P–D5 = 724.50 W	14+15	85.9' R

* STATION/ OFFSETS FOR PROPOSED MANHOLES ARE TO CENTER OF STRUCTURE.
STATION OFFSETS FOR PROPOSED CURB CATCH BASINS ARE TO CENTER OF CASTING

PROPOSED DRIVEWAY TABLE

STATION	EX. MATERIAL	LENGTH OF DRIVE "D" (Ft)	PROPOSED DRIVE SLOPE (%)	EXISTING DRIVE SLOPE (%)	Driveway Opening, Conc, Det L (Ft)**	Driveway, Nonreinf Conc, 6 inch, Modified (Syd) CAT. 0001	HMA Approach (Ton) CAT. 0001	Aggregate Base, 4 inch, Modified (Syd) CAT. 0001
10+02 RT	C	21.3	8.3	9.3	25	28	–	–
11+40 RT	A	16.9	8.8	7.2	24	–	3	22
12+38 RT	C	13.2	9.4	6.1	20	13	–	–
12+86 RT	G/C	16.1	5.0	4.5	20	15	–	–
13+62 RT	G	9.5	2.0	1.2	40	–	6.5	47
14+94 RT	G	22.0	2.0	–	–	–	9	52

G = GRAVEL DRIVE, C = CONCRETE DRIVE, A = ASPHALT DRIVE

QUANTITIES – THIS SHEET

DESCRIPTION	QUANTITY CAT. 0001	QUANTITY CAT. 0003	UNIT
Aggregate Base, 5 inch, Modified	2,119	–	Syd
Subbase, CIP	853	–	Cyd
Underdrain, Subbase, 6 inch	1,323	–	Ft
HMA, 13A	370	–	Ton
HMA Approach	164	–	Ton
Curb and Gutter, Conc, Det F4	1,323	–	Ft
Sidewalk, Conc, 4 inch	2,806	–	Sft
Sidewalk, Conc, 6 inch	287	–	Sft
Sidewalk Ramp, Conc, 6 inch	287	–	Sft
Machine Grading, Modified	6	–	Sta
Detectable Warning Surface	23	–	Ft
Aggregate Base, 4 inch, Modified	121	–	Syd

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FOR THE LOCATION OF UNDERGROUND FACILITIES

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	2/9/16	RECORD DRAWINGS	AJW

PLAN DATE: OCTOBER, 2012
PROJECT MGR: CJC
REVIEWER: JBM
SCALE: 1"=30'

ROWE PROFESSIONAL SERVICES COMPANY
O: (989) 772-2138
F: (989) 773-7757
www.rowepsc.com
127 S. Main Street
Mt. Pleasant, MI 48858

PREPARED FOR
CITY OF ST. LOUIS
MAIN STREET RECONSTRUCTION
PLAN AND PROFILE
STA. 10+00 TO STA. 16+00

REV:
SHT# 13 OF 21
JOB No: 09M0003

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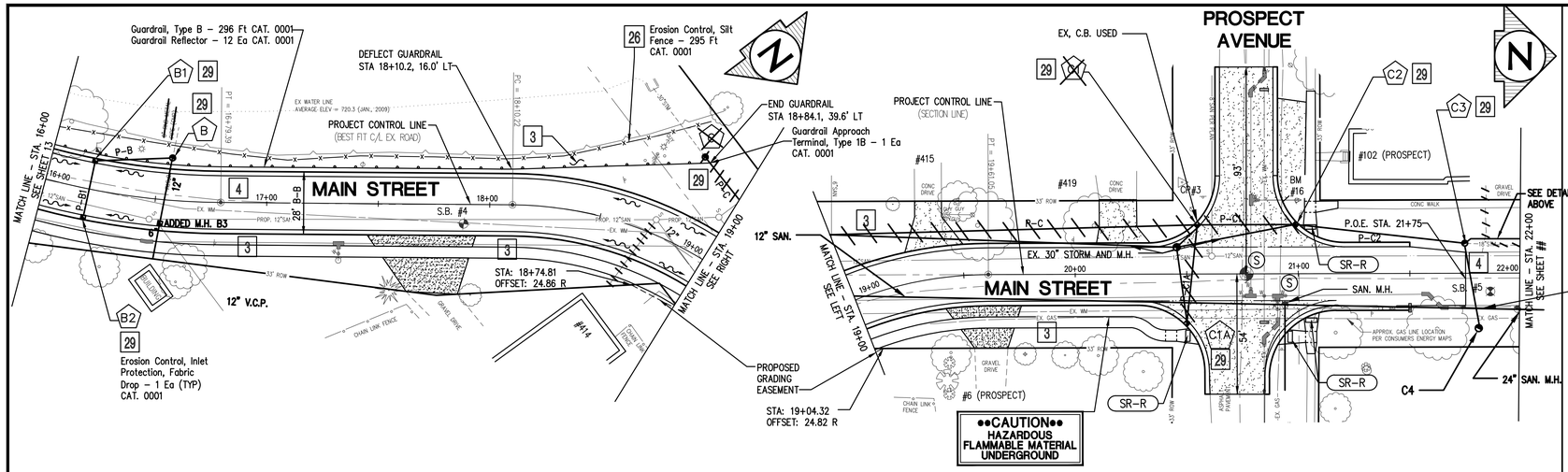
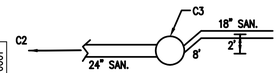


BENCHMARK #16
TOP NORTH FLANGE BOLT HYD AT NW QUAD MAIN & PROSPECT
ELEVATION = 734.66

STORM SEWER PIPE SCHEDULE

PIPE NUMBER	PIPE SLOPE (%)	Sewer, Cl B, 30 inch, Tr Det B (Ft) CAT. 0001	Sewer, Cl A, 24 inch, Tr Det B (Ft) CAT. 0001	Sewer, Cl A, 12 inch, Tr Det B (Ft) CAT. 0001
P–B	2.00			35
P–B1	2.00			26
P–C	0.22	189	–	–
P–C1	0.38	–	44	–
P–C1A	1.00	–		46
P–C2	0.38	–	76	–



STORM SEWER STRUCTURE SCHEDULE

STRUCTURE NUMBER	Dr. Structure, inch dia CAT. 0001	COVER TYPE	RIM OR T/C ELEVATION	PIPE INVERT	STATION *	OFFSET *
B	48	G	RIM = 729.8	P–B = 724.65 SE EX. 8" CMP = 721.6±	16+56	19.0' L
B1	48	K	T/C = 730.19	P–B = 725.34 NW P–B1 = 725.44 NE	16+20	13.0' L
B2	48	K	T/C = 730.19	P–B1 = 725.96 SW	16+20	13.0' R
C	60	G	RIM = 735.0	P–C = 720.35 N EX. 30" CONC = 720.3±	18+82	41.0' L
C1	60	K	T/C = 732.65	P–C = 720.77 S P–C1A = 728.00 E P–C1 = 721.09 N	20+55	22.1'L
C1A	48	K	T/C = 732.40	P–C1A = 728.46 W	20+50	22.1' R
C2	60	K	T/C = 732.40	P–C1 = 721.26 S P–C2 = 721.36 N	20+99	22.1' L
C3	48	G	RIM = 732.13	P–C1 = 721.64 S EX. 18" CONC = 722.19±	21+75	13.5' L

* STATION/ OFFSETS FOR PROPOSED MANHOLES ARE TO CENTER OF STRUCTURE.
STATION OFFSETS FOR PROPOSED CURB CATCH BASINS ARE TO CENTER OF CASTING

ADDED C4

PROPOSED DRIVEWAY TABLE

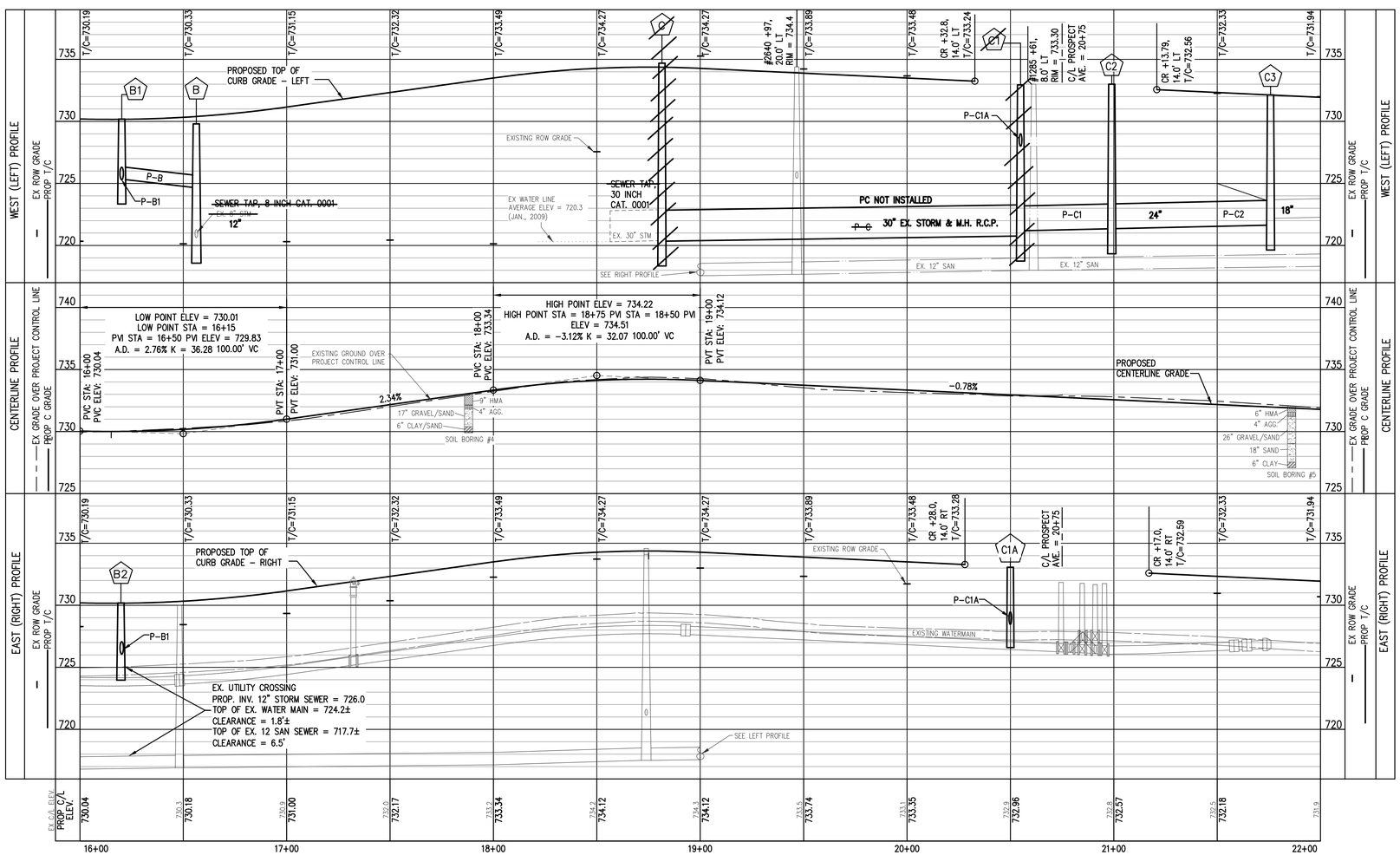
STATION	EX. MATERIAL	LENGTH OF DRIVE "D" (Ft)	PROPOSED DRIVE SLOPE (%)	EXISTING DRIVE SLOPE (%)	Driveway Opening, Conc, Det L (Ft)**	Driveway, Nonreinf Conc, 6 inch, Modified (Syd)	HMA, Approach (Ton) CAT. 0001	Aggregate Base, 4 inch, Modified (Syd) CAT. 0001
17+74 RT	G	25.7	–3.0	–2.3	49	–	10.9	80
19+62 RT	G	19.0	–5.6	–4.6	34	–	5.4	39
19+39 LT	C	20.8	6.9	5.7	26	37	–	–
20+19 LT	C	19.5	3.2	3.2	24	40	–	–
21+10 LT	A	13.2	2.8	20.1	48	–	7.9	58

G = GRAVEL DRIVE, C = CONCRETE DRIVE, A = ASPHALT DRIVE

** NOT A PAY ITEM FOR INFORMATION ONLY

QUANTITIES – THIS SHEET

DESCRIPTION	QUANTITY CAT. 0001	QUANTITY CAT. 0003	UNIT
Aggregate Base, 5 inch, Modified	1,968	–	Syd
Subbase, CIP	802	–	Cyd
Underdrain, Subbase, 6 inch	1,228	–	Ft
HMA, 13A	455	–	Ton
HMA Approach	167	–	Ton
Curb and Gutter, Conc, Det F4	1,228	–	Ft
Sidewalk, Conc, 4 inch	2,176	–	Sft
Sidewalk, Conc, 6 inch	150	–	Sft
Sidewalk Ramp, Conc, 6 inch	277	–	Sft
Machine Grading, Modified	6	–	Sta
Detectable Warning Surface	20	–	Ft
Aggregate Base, 4 inch, Modified	148	–	Syd
Monument Box Adjust	1	–	Ea
Monument Preservation	1	–	Ea



3 WORKING DAYS
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FOR THE LOCATION OF UNDERGROUND FACILITIES

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	2/9/16	RECORD DRAWINGS	AJW

PLAN DATE: OCTOBER, 2012
PROJECT MGR: CJC
REVIEWER: JBM
SCALE: 1"=30'

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REV:
SHT# 14 OF 21
JOB No: 09M0003

PLOTTED: 2/8/2016 8:38 AM
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6500
6510
6960
6520
6540
6530
6470
76840
6480

Vaughan, Rachel

From: Rachel Blink <rlblink@gmail.com>
Sent: Wednesday, June 29, 2022 9:45 AM
To: Vaughan, Rachel/DET
Subject: [EXTERNAL] Fwd: TICKET: 2022061701421-000 Original Design
Attachments: image001.png

---------- Forwarded message ---------
From: **Caleb M. Langley** <Caleb.Langley@cmsenergy.com>
Date: Wed, Jun 29, 2022, 9:42 AM
Subject: RE: TICKET: 2022061701421-000 Original Design
To: rlblink@gmail.com <rlblink@gmail.com>

Consumers Energy has no electric distribution underground facilities mapped for the area you requested. **Please note, underground service wires are not shown on these maps.** If you need more information, please contact me.

Caleb Langley

Cooporative Assistant

LVD Design

Caleb.Langley@cmsenergy.com

From: PO Box: CE Central Michigan 3rd Party <POBoxCECentralMichigan3rdParty@cmsenergy.com>
Sent: Wednesday, June 29, 2022 5:15 AM
To: PO Box: Miss Dig LVD Electric Design Tickets <POBoxMissDigLVDElectricDesignTickets@cmsenergy.com>
Subject: FW: TICKET: 2022061701421-000 Original Design

From: Lisa M. Gall <Lisa.Gall@cmsenergy.com> **On Behalf Of** PO Box: Miss Dig Design Tickets
Sent: Tuesday, June 28, 2022 12:34 PM
To: Benjamin Lewis <Benjamin.Lewis@cmsenergy.com>; PO Box: CE Central Michigan 3rd Party <POBoxCECentralMichigan3rdParty@cmsenergy.com>
Cc: rlblink@gmail.com
Subject: FW: TICKET: 2022061701421-000 Original Design

This MISS DIG Design Ticket is to notify you that the design of a third party construction project is in the works near our gas and/or electric facilities in your area. Please contact the person noted as the "contact" on the ticket within 14 days to discuss the location of Consumers Energy facilities in the area of the proposed design and the project's potential to conflict with our facilities.

A copy of this correspondence is being sent to the party that initiated the ticket so that they can make note of the email address of the appropriate engineering contact(s) at Consumers Energy for the location of the proposed design. There may be multiple contacts at Consumers Energy if there are multiple energy types in the area (gas and electric distribution facilities, gas transmission facilities and/or electric transmission facilities

When responding to this email, please make sure that you include THE PERSON THAT REQUESTED THE INFORMATION - and not back to the Miss Dig Design Ticket PO Box.

-----Original Message-----
From: OCARS_PRO@missdig.org <OCARS_PRO@missdig.org>
Sent: Friday, June 17, 2022 10:29 AM
To: PO Box: Miss Dig Design Tickets <missdigdesigntickets@cmsenergy.com>
Subject: TICKET: 2022061701421-000 Original Design(CEGDIS)

MISS DIG 811

Call +1 800-482-7171

https://urldefense.com/v3/__http://www.missdig811.org__;!!OiWemrRCwA!0nKvCFPhz0VXYf6DWKQiJYvBROqIwSJJWNBMKJDHNLpqToQqNcQEvM89pNTTsn-2QlmxDtRHgSGIoOjX72m6w_FDjO2Qwbc$ [missdig811[.]org]

Please be advised the person below has requested a locate of underground assets in your jurisdiction. You are required to respond within the required time frame and reference the Ticket Number, Sequence Number and the User Reference (where supplied).

[REFERRAL DETAILS]

MESSAGE VERSION NO= 1.0.10

FROM= MISS DIG 811

REQUEST MEDIUM= Phone

UTILITY ID= 24294

STATION CODE= CEGDIS

UTILITY NAME= CONSUMERS ENERGY GAS

TO= Dispatch

TICKET NO= 2022061701421

TICKET REVISION NO= 000

PREVIOUS TICKET NO=

SEQUENCE NO= 607

REQUEST DATE= 2022-06-17T10:26:43-04:00

WORK TO BEGIN DATE= 2022-07-01T10:20:00-04:00

WORK LEGAL START DATE= 2022-07-01T10:26:43-04:00

WORK COMPLETION DATE= 2022-07-22T00:00:00-04:00

WORK EXPIRATION DATE= 2032-06-17T23:59:59-04:00

EMERGENCY= No

TICKET STATUS= Original

TICKET TYPE= Design

WORK TYPE= Groundwork

ACTIVITY= Retain Walls

EXCAVATION METHOD= Machine Excavating

EXCAVATION DEPTH= >48in

EXCAVATION SIZE= 3170206 Sq Ft

AREA MARKED= No

USER REF=

WORKING FOR AUTHORITY= Other

AUTHORITY NAME= Other Business

STATION LIST= GLGPR, CEGDIS, DE0017, CEEDIS, PINESANI2, VERZ01PH, CHARFBR, GRATCDR, EVERST, CHARCTV, STLOUIWTR, STLOUISANI, STLOUISTRM, STLOUIELE

[CALLER DETAILS]

CUSTOMER ID= 2068139

CONTACT NAME= Rachel Vaughan

COMPANY= JACOBS

STREET ADDRESS= 1135 OAK HOLLOW DRIVE

TOWN/CITY=

STATE= MI

ZIPCODE= 48380

USER TYPE= Other

INDUSTRY=

PHONE= 906-281-3539

MOBILE=

EMAIL ADDRESS= rlblink@gmail.com

[LOCATION DETAILS]

ADDRESS= W Washington Ave

CITY/TOWN= St. Louis

STATE=

NEAREST CROSS ST= N Mill st

SECOND NEAREST CROSS ST=

PRIVATE LOCATE= No

ONSITE CONTACT COMPANY= EPA

ONSITE CONTACT NAME=

ONSITE CONTACT PHONE=

PET ON PROPERTY= No

IN BODY OF WATER= Yes

URBAN/RURAL= Urban

LOT NO/SUBDIVISION=

LATITUDE= 43.411501

LONGITUDE= -84.620216

REMARKS= NTIRE RIVER & THE BANKS. SEE POLYGON

Please DO NOT REPLY TO THIS EMAIL as it has been automatically generated and replies are not monitored. Should you wish to advise MISS DIG 811 of any issues with the attached ticket information, please email membersupport@missdig811.org

Rachel Blink Sign Out ?

#secure MissDig Ticket- 2022061701421-000

SK

Sara A Kipp <sara.force@dteenergy.com>
Wed 6/29, 8:06 AM
rlblink@gmail.com

Reply all |

Encrypt: This message is encrypted. Recipients can't remove encryption.

DTE Electric Planning Bo...
626 KB

DTE Electric Facility Leg...
87 KB

DTE Meeting
146 KB

4 attachments (926 KB)

TICKET #: 2022061701421-000

SEQUENCE #:2

AREA REQUESTED IS OUT OF DTE ELECTRIC SERVICE AREA

Your map request is attached.
For questions regarding further planning with DTE Energy please refer to the DTE Electric Planning Boundaries PDF attached to this email, where you will find the correct contact information for your project area.

Please look over all of the attached information:
DTE Meeting FAQ sheet
DTE Electric Conduit Legend
DTE Electric Facility Legend
DTE Electric Planning Boundaries

Sara Kipp
Associate Facilitator – Customer Mapping
sara.force@dteenergy.com

Message Encryption by Microsoft Office 365

Planning and Design Service Area map

Satellite Office Location

Satellite Office Boundry

Location for:

Regional Centers

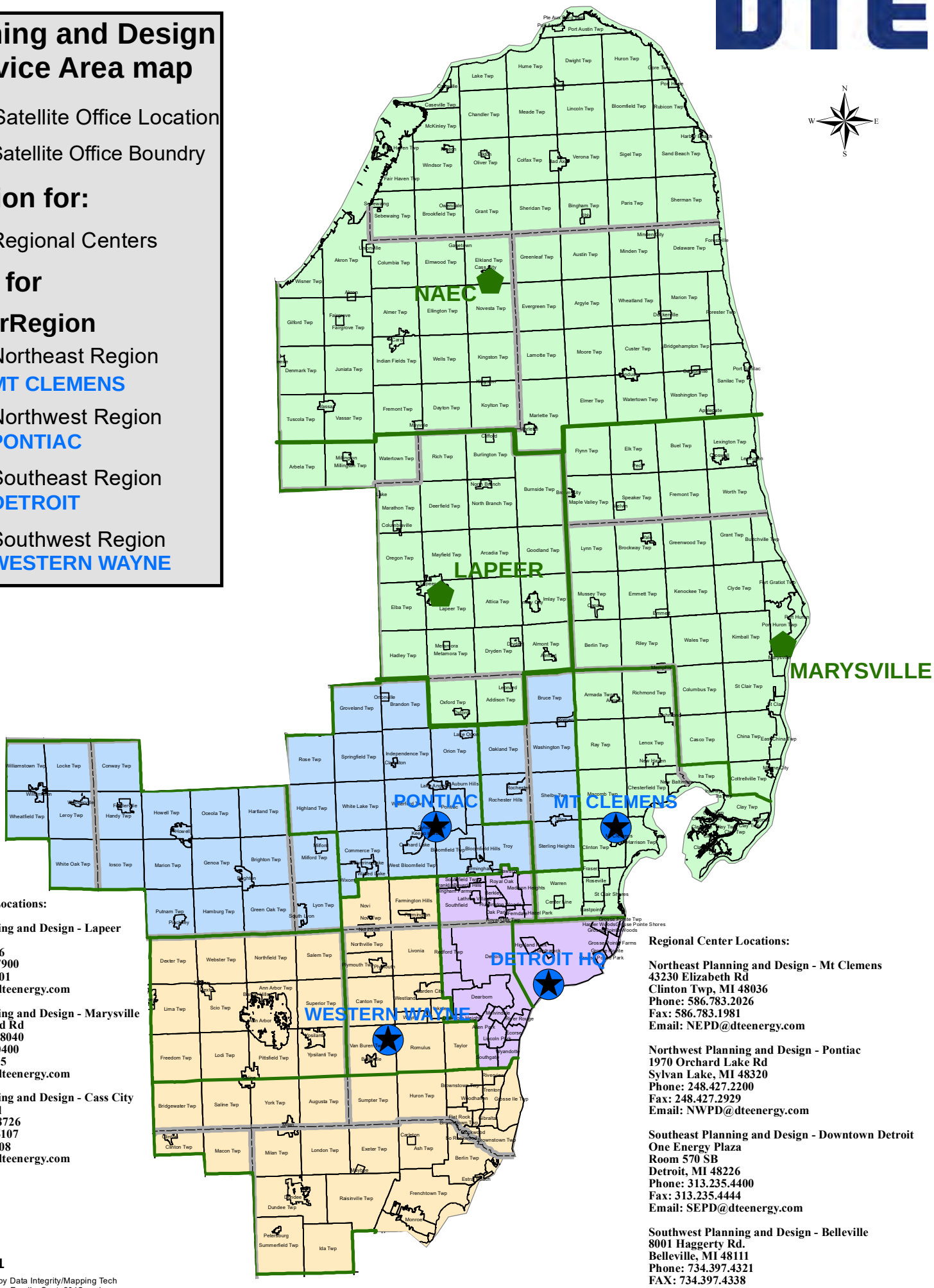
Areas for ClusterRegion

Northeast Region
MT CLEMENS

Northwest Region
PONTIAC

Southeast Region
DETROIT

Southwest Region
WESTERN WAYNE



Satellite Office Locations:

Northeast Planning and Design - Lapeer
1100 Clark Rd
Lapeer, MI 48446
Phone: 810.667.7900
FAX: 810.667.7901
Email: NEPD@dteenergy.com

Northeast Planning and Design - Marysville
3223 Ravenswood Rd
Marysville, MI 48040
Phone: 810.364.0400
Fax: 810.364.0455
Email: NEPD@dteenergy.com

Northeast Planning and Design - Cass City
4100 Doerr Road
Cass City, MI 48726
Office: 989.872.6107
FAX: 989.872.6108
Email: NEPD@dteenergy.com

Regional Center Locations:

Northeast Planning and Design - Mt Clemens
43230 Elizabeth Rd
Clinton Twp, MI 48036
Phone: 586.783.2026
Fax: 586.783.1981
Email: NEPD@dteenergy.com

Northwest Planning and Design - Pontiac
1970 Orchard Lake Rd
Sylvan Lake, MI 48320
Phone: 248.427.2200
Fax: 248.427.2929
Email: NWPD@dteenergy.com

Southeast Planning and Design - Downtown Detroit
One Energy Plaza
Room 570 SB
Detroit, MI 48226
Phone: 313.235.4400
Fax: 313.235.4444
Email: SEPD@dteenergy.com

Southwest Planning and Design - Belleville
8001 Haggerty Rd.
Belleville, MI 48111
Phone: 734.397.4321
FAX: 734.397.4338
Email: SWPD@dteenergy.com

22-OCT-2021

Revised 09-30-2015 by Data Integrity/Mapping Tech
File: Plng_Des_Bdry_w Emails_Sept_2015.mxd

REVISION		
DATE	COMMENTS	NAME
08/27/98	OPTICS LEGEND ADDED	G.D

REVISION ENTRY

CONDUIT MAP CELLS

	CABLE POLE	
CP1	CABLE POLE TEXT	
0000p000	*	FIELDBOOK NUMBER
	MANHOLE	
00000	*	MANHOLE TEXT
00	*	2 DIGIT PSC
000	*	3 DIGIT PSC
0000	*	4 DIGIT PSC
00000	*	5 DIGIT PSC
STREET NAME 000'		STREET NAME/R.O.W.
		JOINT HOLE
JT. HOLE		JOINT HOLE TEXT
F	*	FIBER OPTIC (3 DUCT SLEEVES)
F	*	FIBER OPTIC (4 DUCT SLEEVES)
XXXX 00000 XXXXX	*	CABLE NOMENCLATURE
NEUT XXXXX	*	CABLE NEUTRAL
XXXXX – XXXXX	*	CABLE 120KV BETWEEN STA.'S
XX-XXXX F XX-XXXX XX-XXXX	*	FIBER OPTIC LEGEND(3 DUCT SLEEVES)
XX-XXXX XX-XXXX F XX-XXXX XX-XXXX	*	FIBER OPTIC LEGEND(3 DUCT SLEEVES)

* DO NOT DROP ELEMENT ON THESE CELLS

000'-00" → 1 X 1 DUCT FACE

000'-00" → 2 X 1 DUCT FACE

000'-00" → 2 X 2 DUCT FACE

000'-00" → 2 X 3 DUCT FACE

000'-00" → 2 X 4 DUCT FACE

000'-00" → 3 X 1 DUCT FACE

000'-00" → 3 X 2 DUCT FACE

000'-00" → 3 X 3 DUCT FACE

000'-00" → 3 X 4 DUCT FACE

36"

000'-00" TO PT#00 → 36" STEEL SLEEVE

N

NORTH ARROW

LINE SYMBOLOGY	RGB NUMBER RED	GREEN	BLUE
DECO (PROPOSED)	255	0	255
DECO (EXISTING)	255	0	0

CELL SYMBOLOGY		RGB NUMBER RED	GREEN	BLUE
LV=52,CO=22,LC=0,WT=2	FIBER OPTIC LEGENDS	255	0	255
LV=53,CO=5,LC=6,WT=3	DECO (PROPOSED)	255	0	255
LV=54,CO=0,LC=0,WT=2	CABLE NOMENCLATURE, CABLE NEUTRAL, 120KV CABLE	255	255	255
LV=55,CO=0,LC=0,WT=2	FIBER OPTIC SLEEVES	255	255	255
LV=56,CO=6,LC=0,WT=2	BUILDING, PROPERTY LINE, ASSOC. TEXT	255	127	0
LV=57,CO=5,LC=0,WT=2	FIELD BOOK NUMBER	255	0	255
LV=58,CO=2,LC=0,WT=2	PRIMARY SWITCH CABINET	0	255	0
LV=59,CO=0,LC=0,WT=2	DUCT FACE, ASSOC. TEXT, ASSOC. DIMENSIONS	255	255	255
LV=60,CO=3,LC=0,WT=3	MANHOLE, C. POLE, JT. HOLE, CONDUIT RUN, ASSOC. TEXT	255	0	0
LV=61,CO=1,LC=0,WT=2	STREET NAME, R.O.W.	0	0	255
LV=62,CO=31,LC=0,WT=4	BORDER	0	225	225
LV=63,CO=31,LC=0,WT=5	TITLE SHEET	0	225	225

NOTE:
CELLS TO BE PLACED FOR 1"=50' MAPS

BORDER

TITLE SHEET

00-0 ADJACENT MAP #

00-0

DECO. CONDUIT UGD
OAKLD CO. 0 50' TROY TWP.

XXX 000-0

LEGEND

Lights

DTE Poles

Foreign Poles

UG Transformers

OH Transformers

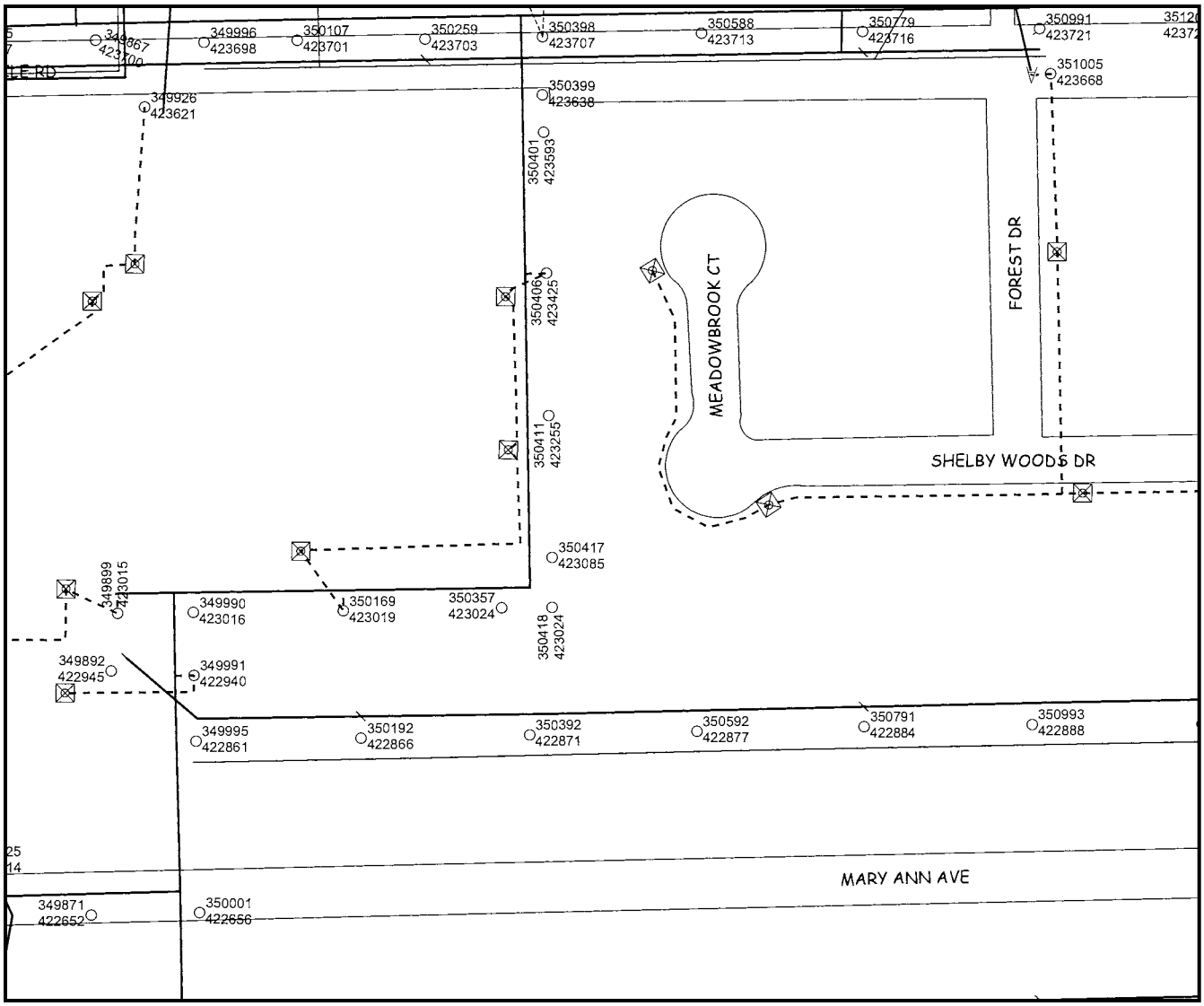
Overhead Lines

Underground Lines

Coordinate System for Poles 329081 411668

Pedestals

SAMPLE OF OUTSIDE SALES MAP



Please note:

All documentation to be reviewed at the Utility Coordination Meeting must be received at least 10 business days prior to the meeting date: Send all information to the Regional Planning Office where your project is located. **See Planning and Design Service Area Map.**

For all future correspondence on this request, please contact the Regional Planning Office for your project.

To help facilitate timely electric utility coordination, please note the following:

Provide conflict list and associated drawings.
Specifically identify conflicts and provide locations of conflicts.
Poles and/or wire conflicts.
Street lighting posts and/or underground cable.
Underground facilities, i.e. cable, conduit, manholes and ground mounted equipment.
Send documents to the Regional Planning Office.
Documents must be received no less than 10 days before the Utility Coordination Meeting.

Requesting Company / Owner Agency to conduct Utility Coordination Meeting

The purpose of this meeting is to confirm design conflicts and discuss design options and/or relocation options.
Meeting should occur as soon as possible, but after the following have been completed.
Utilities have been plotted on Requesting Company / Owner Agency's design documents.
Conflicts have been identified by Requesting Company / Owner Agency.
Conflict list has been created by Requesting Company / Owner Agency.

Requesting Company / Owner Agency to conduct Pre-Construction Meeting

The purpose of this meeting is to confirm or coordinate the resolution of conflicts/relocations identified at the Utility Coordination Meeting.
Conflict information must be communicated prior to the Utility Coordination Meeting. Failure to do so will likely prevent DTE from meeting the project's utility relocation time line.

Things to Remember

Designers should be instructed to make every effort to avoid utility relocations.
Underground relocations can take up to 18 months or longer.
Overhead relocations can take 6 months or longer depending on the facilities involved.

Vaughan, Rachel

From: Rachel Blink <rlblink@gmail.com>
Sent: Friday, June 24, 2022 1:23 PM
To: Vaughan, Rachel/DET
Subject: [EXTERNAL] Fwd: Design Ticket MI2022061701421
Attachments: image001.png; W Washington Ave Everstream.jpg

---------- Forwarded message ---------
From: **Sara Morlan** <SaraM@westerntel-com.com>
Date: Fri, Jun 24, 2022, 12:59 PM
Subject: Design Ticket MI2022061701421
To: RLBLINK@GMAIL.COM <RLBLINK@gmail.com>

Hello,

In regards to design ticket MI2022061701421 Everstream has underground fiber on the north side of W Washington St within the proposed work area.

I have attached a Google Earth image for your review. The underground fiber is represented by the green line in the image.

Please let me know if you have any further questions.

Thank you,

SARA MORLAN

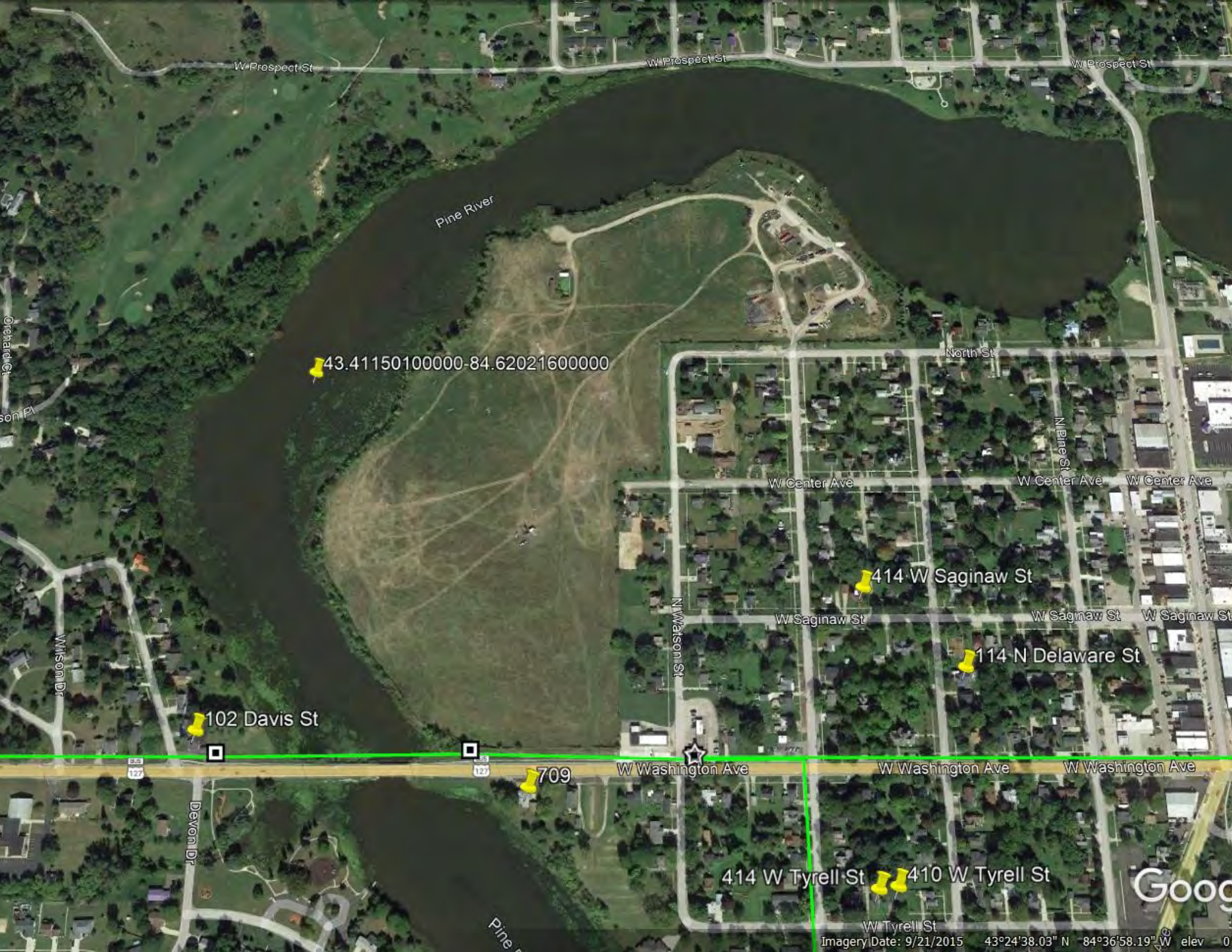
CABLE PROTECTION

4273 58TH ST.

HOLLAND, MI 49423

OFFICE: 616-393-0138 EXT 114

EMAIL: SARAM@WESTERNTEL-COM.COM


W Prospect St
W Prospect St
W Prospect St
Pine River
43.41150100000-84.62021600000
North St
N Pine St
W Center Ave
W Center Ave
W Center Ave
414 W Saginaw St
W Saginaw St
W Saginaw St
W Saginaw St
114 N Delaware St
N Watson St
Wilson Dr
102 Davis St
US 127
US 127
709
W Washington Ave
W Washington Ave
W Washington Ave
Devon Dr
414 W Tyrell St
410 W Tyrell St
W Tyrell St
Pine
Imagery Date: 9/21/2015 43°24'38.03" N 84°36'58.19" W elev 0

Vaughan, Rachel

From: Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Sent: Thursday, April 13, 2023 6:46 AM
To: Vaughan, Rachel
Cc: Andrae, Bill; Irish, Marissa (MDOT)
Subject: [EXTERNAL] RE: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

Good morning Rachel,

We did hear back from our Lansing staff. Being the proposed sheet piling will be approximately 80 ft away from the bridge at the closest, it doesn't appear likely that the proposed sheet piling will affect the bridge. If the distance of the sheet piling changes and gets closer than approximately 80 ft from the bridge, please let Marissa and myself know and we'll do further follow up with our Lansing staff.

Thank you for reaching out.
Brian

From: Irish, Marissa (MDOT) <IrishM1@michigan.gov>
Sent: Monday, April 3, 2023 3:06 PM
To: Vaughan, Rachel <Rachel.Vaughan@jacobs.com>; Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Cc: Andrae, Bill <William.Andrae@jacobs.com>
Subject: RE: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

It's currently in review by geotechnical. (I apologize; I should've sent it on to both groups and did not.) Indication I heard last week was they were looking for soil boring information that wasn't readily available in our bridge files. I'll follow up with them to see if they've had any luck.

The short answer is that we will require monitoring of the bridge, however I'm trying to get the extent of concern identified.

Thanks for checking in.
Marissa

From: Vaughan, Rachel <Rachel.Vaughan@jacobs.com>
Sent: Monday, April 3, 2023 2:32 PM
To: Irish, Marissa (MDOT) <IrishM1@michigan.gov>; Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Cc: Andrae, Bill <William.Andrae@jacobs.com>
Subject: RE: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

CAUTION: This is an External email. Please send suspicious emails to abuse@michigan.gov

Hi Marissa,

We're just following up again – any luck finding somebody in the Lansing office to review the drawings we sent?

Thanks!

Rachel

Rachel Vaughan | Jacobs | Environmental Engineer
O:248.412.7568 | M:906.281.3539 | rachel.vaughan@jacobs.com

From: Irish, Marissa (MDOT) <IrishM1@michigan.gov>
Sent: Wednesday, March 22, 2023 1:50 PM
To: Vaughan, Rachel <Rachel.Vaughan@jacobs.com>; Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Cc: Andrae, Bill <William.Andrae@jacobs.com>
Subject: [EXTERNAL] RE: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

Good afternoon –
I sent the information to our Lansing bridge staff for comment. I believe they've been short staffed w/ conferences the last couple weeks. I'll check back w/ them to see if they've had a chance to review.

Thank you for reaching back out.
Marissa

From: Vaughan, Rachel <Rachel.Vaughan@jacobs.com>
Sent: Wednesday, March 22, 2023 12:40 PM
To: Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>; Irish, Marissa (MDOT) <IrishM1@michigan.gov>
Cc: Andrae, Bill <William.Andrae@jacobs.com>
Subject: RE: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

CAUTION: This is an External email. Please send suspicious emails to abuse@michigan.gov

Hi, I was wondering if you've had a chance to review the sheet pile wall alignment we sent you and if you had any thoughts regarding the need to monitor the bridge along M-46 during construction? Please let me know if you have questions or want to discuss the work in more detail. We'll be finalizing our design in the next month or so and would like to include details regarding bridge monitoring in the design if it is needed.

Thanks!
Rachel

Rachel Vaughan | Jacobs | Environmental Engineer
O:248.412.7568 | M:906.281.3539 | rachel.vaughan@jacobs.com

From: Vaughan, Rachel
Sent: Monday, March 6, 2023 4:08 PM
To: Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>; Irish, Marissa (MDOT) <IrishM1@michigan.gov>
Cc: Andrae, Bill <William.Andrae@jacobs.com>
Subject: Velsicol Chemical Superfund Site Sheet Pile Wall, St. Louis, Michigan

Hi Brian and Marissa,

Our preliminary drawings showing the sheet pile wall alignment are attached. Drawing S-201 shows the alignment of the wall near the M-46 bridge. As I mentioned on the phone, we have been contracted by the EPA to design this sheet pile wall to contain the contaminants present at the Velsicol Chemical Corporation Superfund Site, so the alignment is based on the site/contaminant boundaries. Please let us know if you have questions or would like to discuss the work in more detail on a conference call.

Thanks!
Rachel

Rachel Vaughan | Jacobs | Environmental Engineer
O:248.412.7568 | M:906.281.3539 | rachel.vaughan@jacobs.com

From: Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Sent: Monday, March 6, 2023 3:59 PM
To: Vaughan, Rachel <Rachel.Vaughan@jacobs.com>
Cc: Irish, Marissa (MDOT) <IrishM1@michigan.gov>
Subject: [EXTERNAL] RE: Please call: St Louis Project at the Pine River

Hello Rachel,

Per our phone discussion this afternoon, please email any plans that you have that show the sheet piling location near the M-46 bridge, that would be appreciated. The work will occur outside the MDOT ROW in this area, but in the vicinity of the M-46 bridge over the Pine River.

I've included the Bay Region Bridge Engineer, Marissa Irish, in this email and she can provide any comments/issues she sees with the planned work in relation to the bridge.

Thank you,
Brian

Brian Atkinson
Operations Engineer
MDOT Mt. Pleasant TSC
1212 Corporate Dr.
Mt. Pleasant, MI 48858

989-621-0192 (Cell)
989-773-7756 (Office)
Email: atkinsonb@michigan.gov

From: Whitman, Tammy (MDOT) <WhitmanT@michigan.gov>
Sent: Wednesday, March 1, 2023 12:54 PM
To: Hofweber, Jack (MDOT) <HofweberJ@michigan.gov>; Atkinson, Brian (MDOT) <AtkinsonB@michigan.gov>
Cc: Potts, Jason (MDOT) <PottsJ@michigan.gov>; Bates, Shaun (MDOT) <BatesS2@michigan.gov>
Subject: Please call

Good afternoon,

I just received a call from Rachael from Jacobs Engineering out of Bingham Farms, MI. Rachael stated that they will be handling part of an EPA clean up project in St. Louis at the former feed plant, possibly late this year. The company plans on driving large sheet piling about 50 to 75 feet away from the bridge on M-46, which could cause significant vibration. She wanted to speak to someone to see if there is anything she needs to do on her end with MDOT. I didn't know if this would be in our right of way and require a permit, or where she was measuring from?

I wasn't sure who would handle this type of question? Please call Rachael to get further information, 906-281-3539.

Thank you,

Tammy Whitman

Mt. Pleasant TSC Secretary
1212 Corporate Drive
Mt. Pleasant, MI. 48858
Cell: (989) 423-8601
Fax: (989) 775-6329

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Appendix F
Engineered Cap Assumptions Technical Memorandum

Memorandum

CH2M HILL, Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

Subject:	**Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design**
Project Name:	Velsicol Chemical Corporation Superfund Site
Contract Info:	Great Lakes Architect and Engineering Services II Contract (GLAES), Contract Number 68HE0519D0007, Task Order Number 68HE0521F0106
Attention:	Tom Alcamo/U.S. Environmental Protection Agency (EPA), Region 5
From:	CH2M HILL, Inc. (CH2M)[1]
Date:	June 30, 2023
DCN:	GLAES-R5-21F0106-02017

CH2M prepared this technical memorandum for EPA to obtain EPA and Michigan Department of Environment, Great Lakes and Energy (EGLE) concurrence on the design assumptions for the future engineered cap that will be installed over the Former Plant Site (FPS) of Pine River at the Velsicol Chemical Corporation Superfund Site (site). Although the engineered cap remedial design (RD) has not been awarded, the engineered cap design will impact the in-progress downgradient vertical barrier wall (DGVBW) RD. The preliminary DGVBW design assumes the top elevation of the DGVBW will be 723 feet above mean sea level (amsl), consistent with what the feasibility study (FS; Weston, 2011) presented. However, if CH2M constructs the engineered cap as described in the FS (Weston, 2011) and incorporated in the Record of Decision (ROD; EPA, 2012), more than 7 feet of cap material will be constructed on top of the existing grade, and a top elevation of 723 feet amsl will not be sufficient along some areas of the DGVBW. CH2M recommends constructing an engineered cap using a geosynthetic clay liner (GCL) and 18- to 36-inch root zone layer in lieu of the 36-inch natural compacted clay soil layer and 42-inch root zone layer of the proposed engineered cap construction described in the FS and ROD. This reduced cap profile would require less sheet pile to construct the DGVBW and less fill material than the engineered cap profile proposed in the FS and ROD. The following subsections include supporting information for the recommended engineered cap construction. CH2M is performing this work under Great Lakes Architect and Engineering Services (GLAES) II Contract 68HE0519D0007, Task Order Number 68HE0521F0106.

1. Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses approximately 100 acres in St. Louis, Michigan, and includes the FPS and a residential area referenced as the adjacent or nearby properties (ANP). The lead agency for the remedial investigation (RI)/FS was the EGLE. EPA is the lead agency for the ongoing RD and remedial action (RA).

[1] CH2M HILL, Inc. is a wholly owned subsidiary of Jacobs Engineering Group Inc.

A chemical manufacturing plant formerly occupied the FPS from the mid-1930s until it was demolished in 1978. Industrial operations at the plant, which included manufacturing of pesticides and fire retardants, resulted in widespread contamination on the FPS. In 1982, the Velsicol Chemical Corporation entered into an administrative order of consent with the United States and the State of Michigan. Pursuant to the administrative order on consent, the Velsicol Chemical Corporation constructed a containment system for the FPS, which included the installation of a low-permeability cap and a 2-foot-thick, low-permeability slurry wall around the entire 52-acre FPS.

The FPS is fenced and is bordered on the south and east by the ANP, with Washington Avenue (M-46) along the southern edge. Watson Street and North Street mark the eastern edge, and Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the FPS boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The site consists of the following four operable units (OUs), as shown on Figure 1:

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which a ROD was published in October 2022 (EPA 2022)
- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of Pine, Chippewa, and Tittabawassee Rivers, for which RI activities are ongoing

The DGVBW is a component of the OU1 remedy and will be installed within Pine River near the shoreline of the FPS to decrease the potential for contaminants present in the shallow unit of the FPS to directly discharge to Pine River.

2. Containment System Description

As described in the ROD, the FPS containment system will consist of a vertical barrier, perimeter drain system, and a sitewide engineered cap (EPA, 2012). The vertical barrier will extend from the till unit to above the existing ground surface to allow connection with and construction of the new engineered cap. The vertical barrier is divided into two sections: a downgradient section, which runs along the perimeter of the FPS bounded by Pine River, and an upgradient section, which runs along the perimeter of the FPS not bounded by Pine River. CH2M expects to finalize the in-progress DGVBW RD in summer 2023. RD activities for the upgradient vertical barrier wall have not begun; however, predesign investigation activities are currently underway and are expected to be complete in 2023.

The ROD states that a perimeter drain system along the vertical barrier alignment (upgradient and downgradient) will be installed to maintain an inward gradient toward the FPS and to prevent the outward flow of groundwater from the site (EPA, 2012). The perimeter drain system will also lower the groundwater elevation of the shallow unit within the barrier boundary, potentially resulting in a decrease in hydraulic pressure on the lower hydrogeologic units and reduction of vertical migration of site-related contaminants of concern. The perimeter drain system will be installed inside the existing slurry wall. Perimeter drain RD investigation activities were completed in summer 2022. The perimeter drain RD has not been awarded; therefore, RD activities have not begun.

The third component of the FPS containment system is an engineered cap, which will meet the requirements of Part 111 of the *Natural Resources and Environmental Protection Act* (Act 451 of 1994), as required in the ROD. The purpose of the engineered cap is to reduce infiltration of surface water into the underlying units. Before placing the cap materials, the entire FPS will need to be re-graded for stormwater management.

3. Conceptual Containment System Design

The FS describes the conceptual containment system design (Weston, 2011), and the ROD reflects its description (EPA, 2012). The conceptual vertical barrier wall design consists of a sealed sheet pile wall around the perimeter of the FPS. The FS envisioned the DGVBW being installed at the toe of the river (estimated approximately 75 feet from the existing shoreline) and set approximately 10 feet into the till unit, with a top elevation of 723 feet amsl. In accordance with the FS, this would result in sheet pile heights ranging from 23 to 33 feet, depending on the depth to till.

CH2M anticipates that the perimeter drain system will consist of a series of groundwater collection trenches, collection sumps, and pumps, which would be constructed inside of the existing slurry wall. The conceptual design described in the FS assumes that 6-inch, high-density polyethylene, perforated pipe will be placed along the bottom of the trenches to collect and transmit groundwater with collection sumps placed approximately every 500 feet. Pumps capable of pumping a mixture of groundwater and nonaqueous phase liquid (if present) would be installed in the sumps. Based on available data at the time of FS development, it was estimated that the perimeter drain system could contribute a flow of up to approximately 15 gallons per minute to the wastewater treatment plant that will be constructed as part of the OU1 remedy.

Because the existing cap at the FPS does not meet the performance standard of Part 111 of the *Natural Resources and Environmental Protection Act* (Act 451 of 1994) required in the ROD, a new engineered cap will be designed and constructed. The FS and ROD assumed an approximately 7-foot-thick cap construction, as illustrated on Figure 2.

Based on the bathymetric survey results from the April 2022 survey, the toe of the riverbank slope extends over 100 feet from the existing shoreline in some locations. To reduce the amount of imported fill that needs to be placed between the existing shoreline and the DGVBW and to avoid taking a significant area of the existing river footprint, EPA directed CH2M to relocate the DGVBW alignment closer to the shoreline (that is, to a maximum distance of 50 feet from the existing shoreline). This revised alignment will require steeper slopes to meet the 723-foot-amsl top elevation of the DGVBW based on the rough grading plan presented in the FS because there is less distance to slope the engineered cap material between the existing shoreline and the DGVBW. Based on the existing ground elevations, CH2M estimates the DGVBW would have to be constructed at a minimum elevation of 728 feet amsl, assuming a 25% slope along some areas of the DGVBW, or 737 feet amsl, assuming a 4% slope, to mitigate the steep elevations. Figures 3A, 3B, and 3C show the sloping requirements along the DGVBW based on existing ground surface elevations and adding 7 feet of engineered cap material.

To maintain a lower top elevation for the DGVBW, and subsequently less sheet piling, CH2M is proposing a revised conceptual engineered cap design, with an approximately 3.5-foot profile, as illustrated on Figures 2, 3A, 3B, and 3C. This proposed engineered cap will be functionally equivalent to the 7-foot profile engineered cap described in the FS and ROD but will allow the DGVBW to be constructed to a top elevation of 723 feet amsl, therefore reducing the overall square footage of sheet pile required to construct it. With a top elevation of 723 feet amsl, the slope of the proposed engineered cap would vary along the DGVBW but would be between 4% and 25%.

The imported fill volume is another important consideration for the construction of the overall containment system. Both conceptual engineered cap designs will require similar imported fill volumes for the topsoil and lateral drainage layers. However, there is a significant difference in the depth of the root zone and clay layers. The root zone layer will be constructed with existing onsite material to the extent possible. Based on the as-builts for the existing clay cap, the cap varies in thickness between 28 inches and 46 inches across the 52-acre FPS. It will likely be necessary to import some fill for the root zone layer for both conceptual engineered cap designs. There is a larger difference in fill volumes between the two conceptual designs for the clay layer. The FS and ROD design requires a 36-inch clay cap, where the proposed engineered cap design uses a GCL in lieu of the 36 inches of clay. Not only does the GCL require less imported material, but GCLs typically achieve better hydraulic performance than compacted clay. A fully hydrated GCL has a permeability of 5×10^{-9} centimeter per second (Minerals Technologies, Inc., n.d.). GCLs are also less likely to be impacted by freeze-thaw or desiccation-rewetting cycles. Additionally, GCLs typically do not require as much root zone depth, so that layer can be reduced to as little as ±18 inches. However, for conservative estimates and comparisons, this technical memorandum assumes a 36-inch root zone will be constructed for the proposed engineered cap design. Table 1 provides a comparison of the estimated fill volumes for the two conceptual engineered cap designs.

4. Recommendations

The preliminary RD for the DGVBW is in progress. Defining the top elevation of the DGVBW is a critical element for completing the design because it will impact whether an anchoring system will be required along the DGVBW, where the anchoring system will be installed, and what type of anchoring system is installed, as well as construction sequencing of the DGVBW (that is, whether dewatering activities can occur before backfilling activities or whether dewatering activities and backfilling activities must occur concurrently).

The conceptual engineered cap design, as described in the FS and ROD would require a DGVBW top elevation greater than 723 feet amsl, which is the current top elevation of the DGVBW. Therefore, CH2M recommends that the DGVBW design proceeds under the assumption that the future engineered cap will be designed and constructed following the proposed profile illustrated on Figure 2 and described in this technical memorandum with a GCL in lieu of 36 inches of natural compacted clay soil and a reduced root zone layer thickness. The proposed engineered cap design is projected to reduce the overall DGVBW construction costs. Because of the significant reduction in the volume of cap materials that must imported to the site and through the surrounding community, it will be easier to construct the revised cap with fewer impacts to residents that surround the site. Although the RD for the engineered cap has not been awarded, the design assumptions for it have a significant impact on the RD of the DGVBW, which is in progress. Therefore, concurrence from EPA and EGLE regarding this assumption is needed to complete the DGVBW design.

5. Agency Concurrence with Proposed Engineered Cap Design

Both EPA and EGLE are in agreement that a GCL can be used in lieu of the 36 inches of natural compacted clay soil and a reduced root zone layer. EPA provided their concurrence with this construction approach during their review of the preliminary DGVBW design, to which this technical memorandum was attached. EGLE provided comments to this technical memorandum that will need to be addressed during the engineered cap design; the purpose of this technical memorandum was only to provide a proposed alternative to the future engineered cap design. However, EGLE was in agreement that the GCL system is an acceptable alternative to the compact clay liner system described in the FS and ROD and will satisfy the requirements of Part 111. EGLE's comments are included in Attachment 1 of this technical memorandum.

6. References

Minerals Technologies, Inc. n.d. *Geosynthetic Clay Liners: From the World's Leading Supplier of GCLs*. Accessed October 31, 2022. https://www.mineralstech.com/business-segments/performance-materials/cetco/environmental-products/products/gcl.

U.S. Environmental Protection Agency (EPA). 2012. *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan.* June 19.

U.S. Environmental Protection Agency (EPA). 2022. *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Operable Unit 3, St. Louis, Michigan.* October.

Weston Solutions of Michigan, Inc. (Weston). 2011. *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Table

Table 1. Conceptual Engineered Cap Comparison

Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan

	Engineered Cap Described in FS and ROD	**Proposed Engineered Cap**
Profile Thickness (Approximate)	>7 feet	>3.5 feet
Square Footage of Sheet Pile (Estimated)	160,000	140,000
Volume of Imported Fill Assuming Onsite Material Can Be Reused (Estimated)[a]	380,000 to 490,000 yd^3	80,000 to 140,000 yd^3
6-inch Topsoil Layer	40,000 yd^3	40,000 yd^3
Root Zone Layer[b]	40,000 to 150,000 yd^3	0 to 60,000 yd^3
48 inches for FS/ROD Cap		
36 inches for Proposed Cap		
Lateral Drainage Layer (Assumed 6 inches thick)	40,000 yd^3	40,000 yd^3
Clay Layer (10^{-7} cm/sec Hydraulic Conductivity)	260,000 yd^3	Negligible
36 inches for FS/ROD Cap		
GCL for Proposed Cap		
Volume of Imported Fill Assuming Onsite Material Cannot be Reused (Estimated)[c]	640,000 yd^3	340,000 yd^3
Truck Trips for Imported Material (Estimated)[d]	17,000 to 22,000	4,000 to 6,000
Other Considerations	DGVBW will either need to be constructed further into river or higher than proposed engineered cap design, requiring more sheet pile and potentially a more robust anchoring system, increasing construction costs of the DGVBW.	DGVBW can be constructed to lower elevation and closer to existing shoreline to support this engineered cap, requiring less sheet pile and likely not as much anchoring, resulting in reduced construction costs for the DGVBW.

[a] Volumes assume an expanded FPS area of 53 acres to account for the additional area between the existing shoreline and DGVBW.

[b] Volume range assumes existing clay cap thickness is 46 inches across the entire existing 52-acre FPS (low end) and that the existing clay cap thickness is 28 inches across the entire existing 52-acre FPS (high end).

[c] Volume estimate assumes no existing FPS material can be reused and all engineered cap material must be imported, and includes volumes for topsoil, root zone layer, lateral drainage layer, and clay layer.

[d] Totals assume a 22-yd^3 truck; the truck trips were calculated for the volume ranges assuming onsite material can be reused.

> = greater than

cm/sec = centimeter(s) per second

DGVBW = downgradient vertical barrier wall

FPS = Former Plant Site

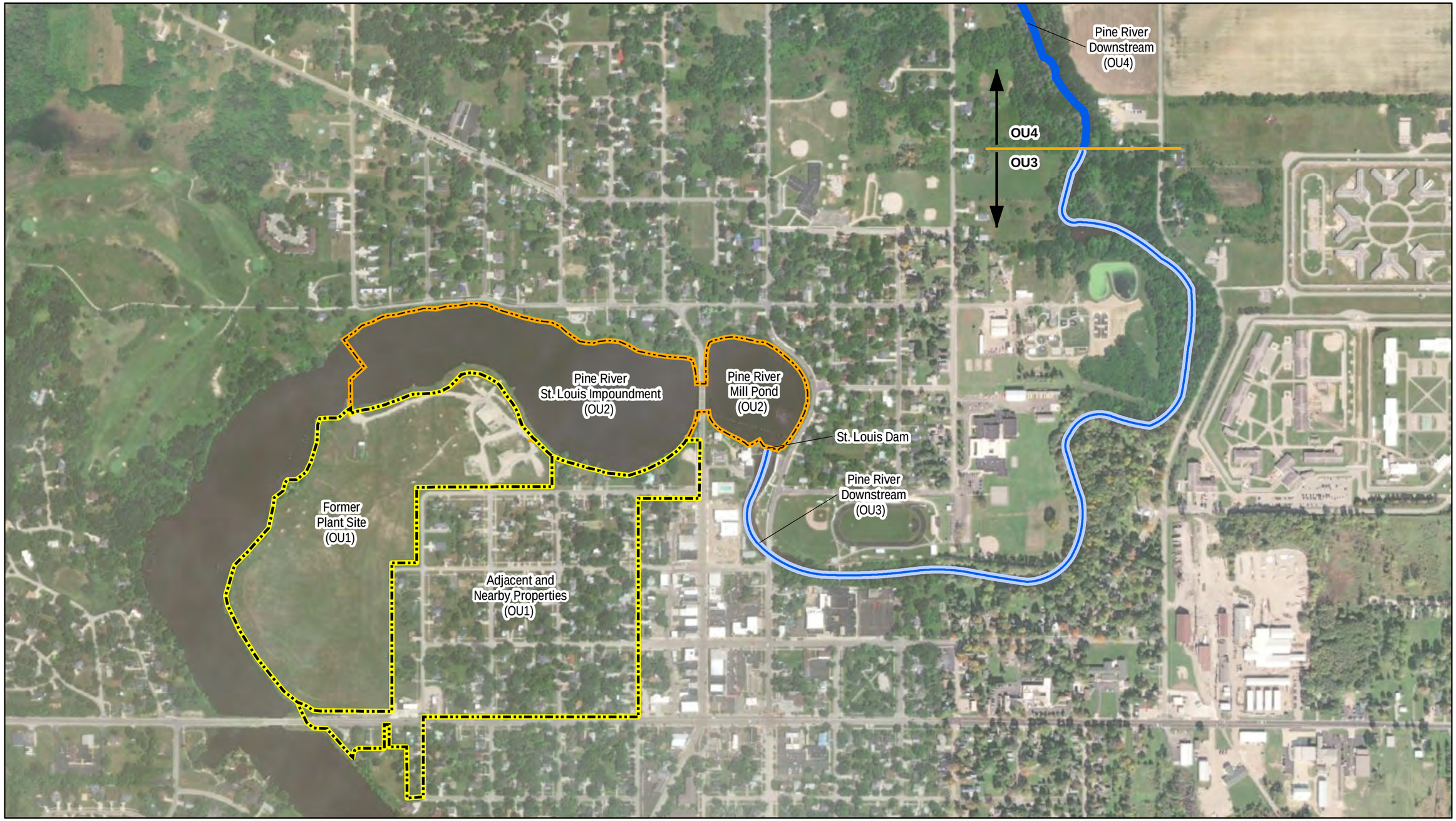
FS = Feasibility Study (Weston, 2011)

GCL = geosynthetic clay liner

ROD = Record of Decision (EPA, 2012)

yd^3 = cubic yard(s)

Figures



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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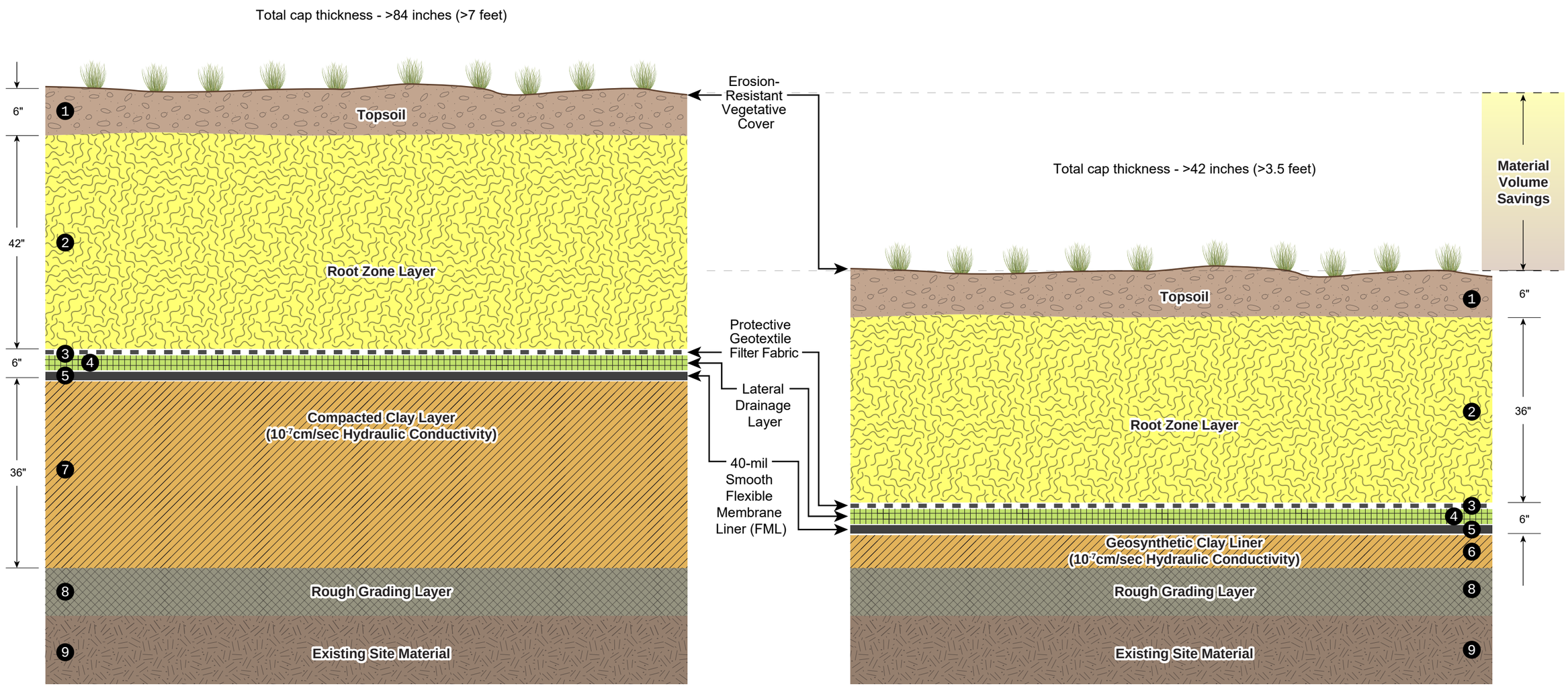

ENGINEERED CAP AS DESCRIBED IN THE FEASIBILITY STUDY AND RECORD OF DECISION
NOT TO SCALE

PROPOSED ENGINEERED CAP
NOT TO SCALE

Layer Descriptions:

1. **Topsoil** likely consists of clean, imported material. This layer will allow vegetation to develop, reducing potential for erosion and protecting the underlying cap components.
2. **Root zone layer** likely consists of existing clay cap material if it can be reused, and clean imported material. This layer will support vegetation growth and minimize frost and root penetration into the barrier layers.
3. **Protective geotextile filter fabric** filters precipitation and prevents overlying soil particles from obstructing the flow of water through the lateral drainage layer.
4. **Lateral drainage layer** consists of either clean, imported sand or a geocomposite material. This layer will remove water infiltrating the topsoil and root zone layers to reduce the hydraulic head over the FML, reducing the potential for sloughing and instability of the overlying soil layers.The thickness of this layer was not specified in the FS. For evaluation purposes, it was assumed to be 6 inches.
5. **40-mil smooth flexible membrane layer** consists of HDPE. This layer will provide the primary low hydraulic conductivity barrier against stormwater percolation and protect the below layers from root penetration, burrowing animals, and potential degradation as a result of freeze/thaw cycles.
6. **Geosynthetic clay liner** achieves a hydraulic conductivity of $1x10^{-7}$ cm/sec. This layer will provide a secondary low hydraulic conductivity barrier against water percolation and limit the possibility of VOC migration upwards. Geosynthetic clay liners typically achieve better hydraulic performance than compacted clay.
7. **Compacted clay layer** consists of clean, imported material that achieves a hydraulic conductivity of $1x10^{-7}$ cm/sec. This layer will provide a secondary low hydraulic conductivity barrier against water percolation and limit the possibility of VOC migration upwards.
8. **Rough grading layer** consists of existing FPS topsoil and clay cap material. This layer will prepare a suitable base to construct the cover over and create necessary grades required for effective drainage.
9. **Existing site material** will provide a base for the engineered cap.

Figure 2
Engineered Cap Profile Schematic
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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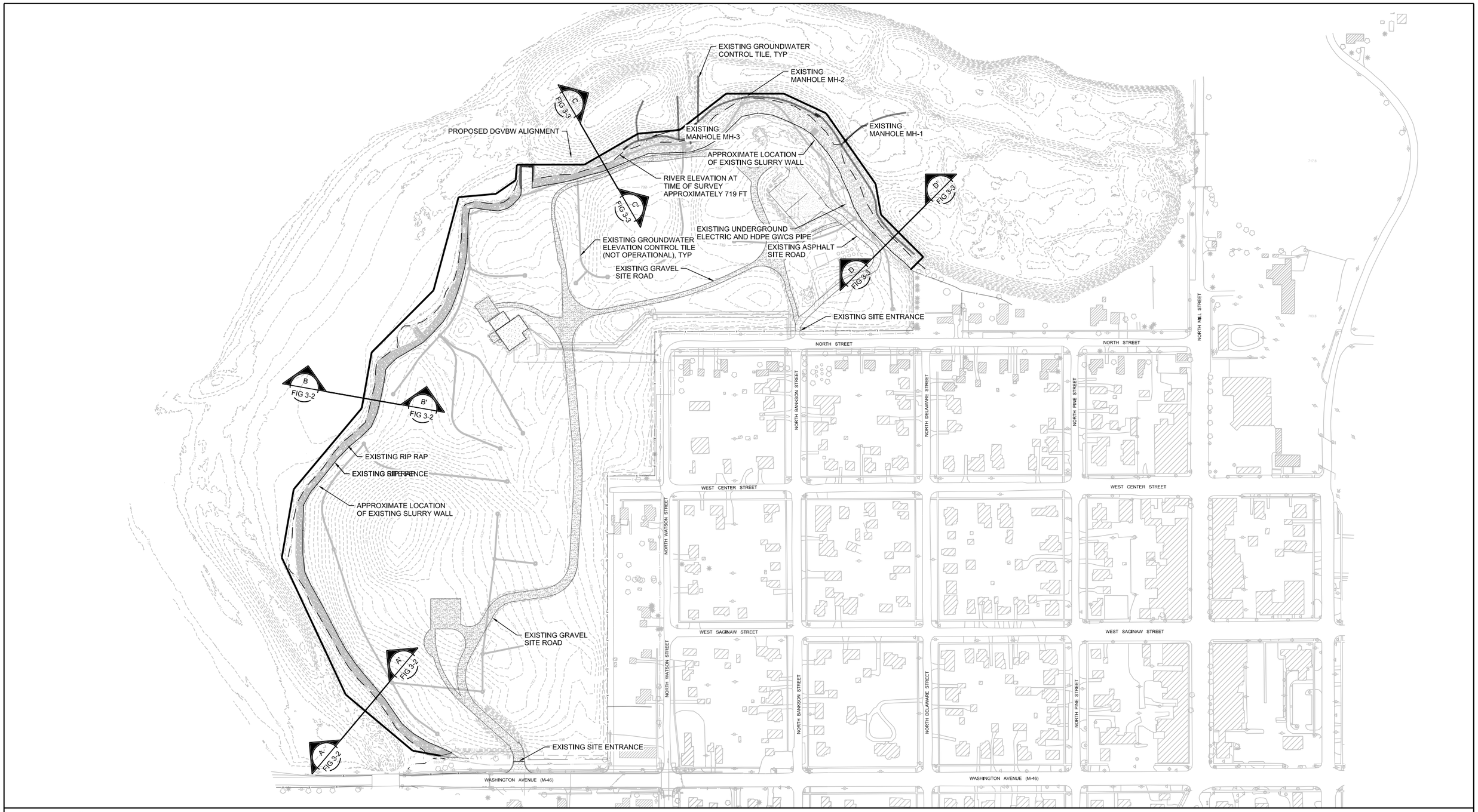

N

0 150 300 450
Scale In Feet

FIGURE 3A: PLAN VIEW
Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design
Velsicol Chemical Corporation Superfund Site
St. Louis, Michgian

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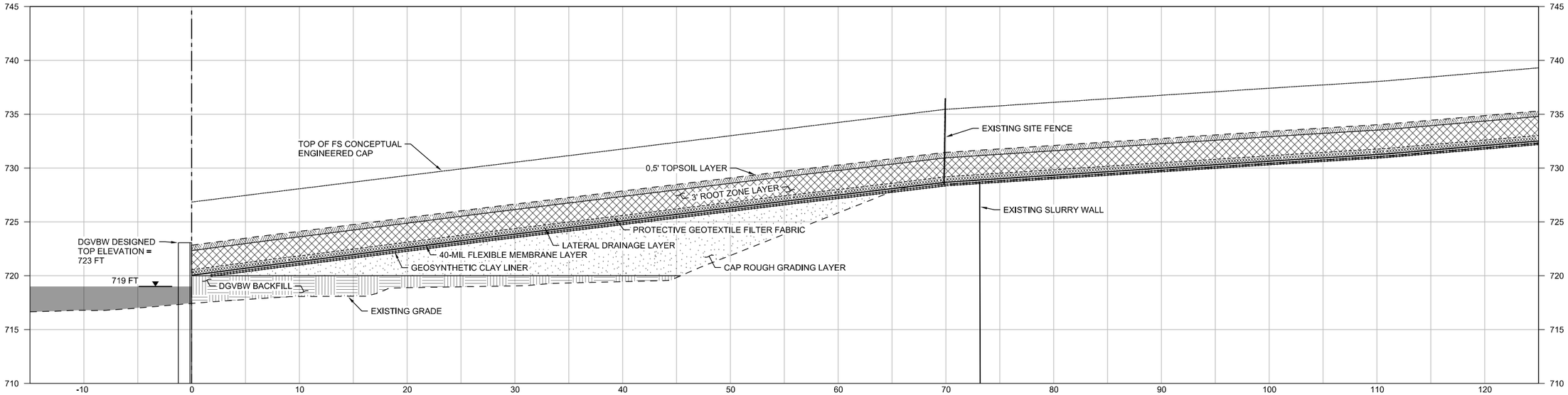
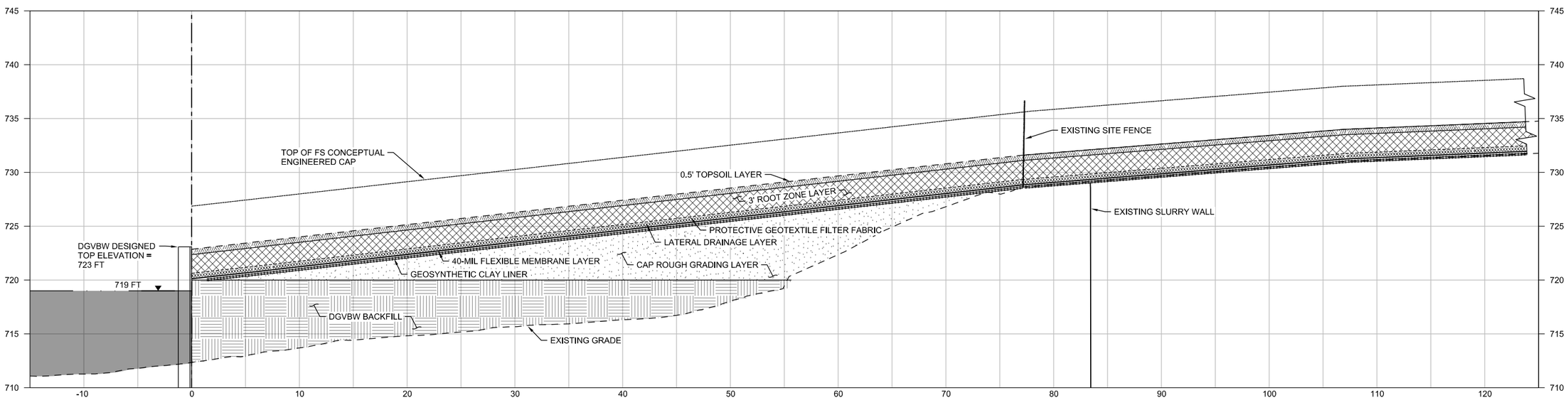


B SECTION B-B'
1"=1"
FIGURE 3-1



A SECTION A-A'
1"=1"
FIGURE 3-1

FIGURE 3B: CROSS SECTIONS A-A' AND B-B'
Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design

Velsicol Chemical Corporation Superfund Site
St. Louis, Michgian

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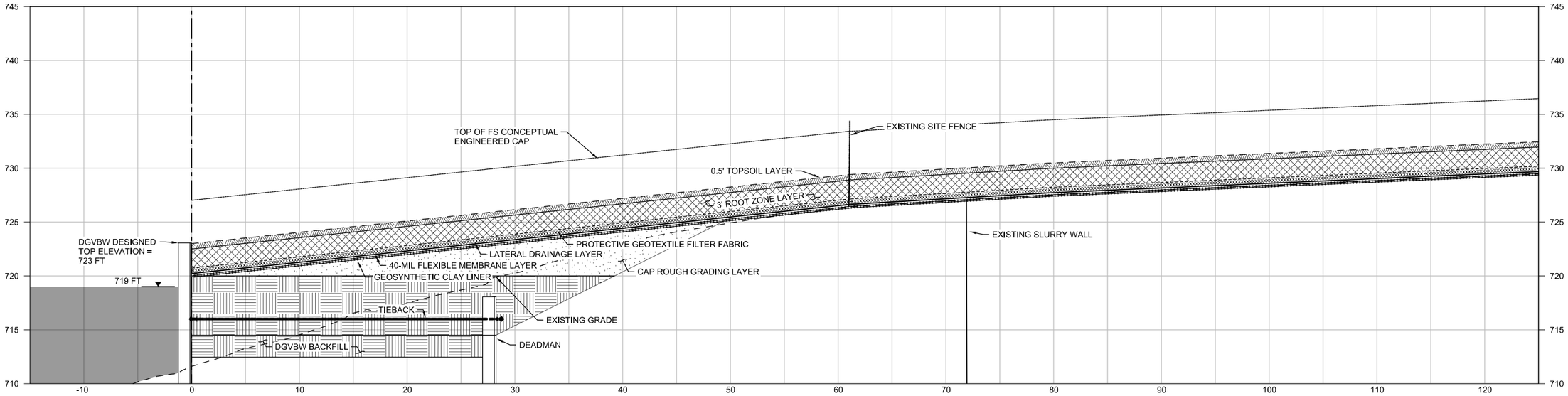
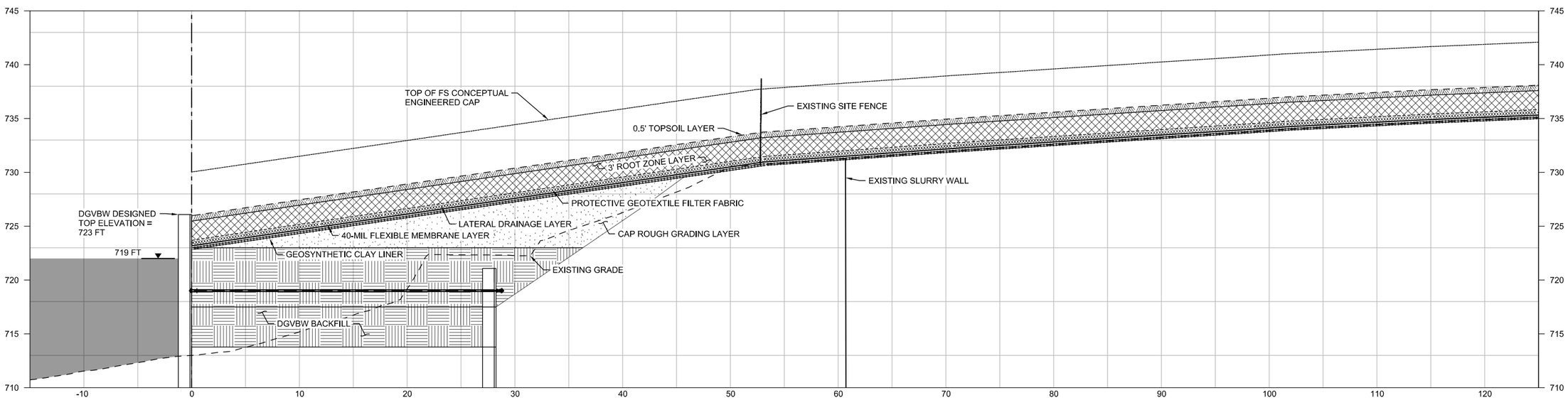


D SECTION D-D'
1"=1"
FIGURE 3-1



C SECTION C-C'
1"=1"
FIGURE 3-1

FIGURE 3C: CROSS SECTIONS C-C' AND D-D'
Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design

Velsicol Chemical Corporation Superfund Site
St. Louis, Michgian

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Attachment 1
Michigan Department of Environment, Great Lakes, and Energy Comments for Future Engineered Cap Design

Vaughan, Rachel

From: Alcamo, Thomas <alcamo.thomas@epa.gov>
Sent: Friday, March 24, 2023 1:48 PM
To: Pratt, Scott; Vaughan, Rachel; Andrae, Bill
Subject: [EXTERNAL] FW: Velsicol Chemical Landfill Cap Review (EGLE Comments)

From: Martinson, Erik (EGLE) <MartinsonE@michigan.gov>
Sent: Friday, March 24, 2023 11:15 AM
To: Alcamo, Thomas <alcamo.thomas@epa.gov>
Cc: Baltusis, Matt (DEQ) <BALTUSISM@michigan.gov>
Subject: Velsicol Chemical Landfill Cap Review (EGLE Comments)

Tom,

Below are comments from EGLE's landfill engineer in our Materials Management Division (MMD) regarding EPA's proposal for a modification to the engineered cap at the Velsicol Chemical Superfund Site.

Thank you.

The draft memorandum: Draft Future Engineered Cap Design Assumptions for Downgradient Vertical Barrier Wall Remedial Design (Memo) submitted by CH2M Hill, Inc. on December 21, 2022, has been reviewed pursuant to the final cover requirements of Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and its administrative rules. Per RRD's request, this review was restricted to the modification to replace the approved compact clay liner (CCL) system to a geosynthetic clay liner (GCL) system. Based on this review, the MMD finds the Memo technically deficient. A list of deficiencies is below.

1. *Rough Grading Layer*
    a. *The Memo did not include or reference any specific information regarding the material that will be used for the grading layer or subgrade layer. Materials that provide a stable base and will not affect the integrity of the GCL need to be used.*

2. *Flexible Membrane Liner (FML)*
    a. *The Memo did not include or reference a technical demonstration that smooth FML is still appropriate versus a textured FML with the modification, especially in areas with a steeper slope.*

3. *Geosynthetic Clay Liner (GCL)*
    a. *The Memo did not include or reference an analysis of the GCL system in terms of settlement calculations. Typically, GCL panels overlap 6 inches on the side and 12 inches end to end. An analysis of the settlement calculations needs to be performed to ensure that when differential settling happens, the GCL panels are not pulled apart.*
    b. *The Memo did not include or reference an analysis of the GCL system in terms of side slope stability. It is possible for GCL panels to slide on the subgrade, especially in areas with a steeper slope.*
    c. *The Memo did not include or reference how the GCL panels will be anchored or if any tie-ins are necessary. This information needs to be included.*
    d. *The Memo did not include or reference any material specifications, material QA/QC reports, how will the material be stored, or transported around on site.*

4. *The Memo did not to include or reference an approved Construction Quality Assurance (CQA) Plan. An approved CQA Plan that details the storage, transportation, installation, contingencies, material specifications, material testing procedures, and material testing criteria needs to be done. The actual construction of the of the final cover system is critical to its efficacy and long-lasting integrity.*

5. *Within the last paragraph on page 2, the Memo states "The perimeter drain will be installed inside the existing slurry wall." The Memo is unclear if this perimeter drain will impact the final cover in any way. From the cross-sections, it is clear that the final cover would extend over the existing slurry wall. Would this perimeter drain need to be placed through the final cover? If so, a technical description, engineering drawings, and installation procedures should be included.*

6. *Figure 3A identifies several existing structures within the boundary of the "Former Plant Site" such as underground utilities, gravel roads, groundwater control tiles, and manholes. The Memo gives the impression that the final cover would be placed over top of them. The Memo fails to specify if and/or how these structures will impact the final cover. If so, the same information specified in #5 should be included.*

7. *The same information specified in Comment #5 should also be included if any wells (e.g., gas collection or piezometer) are needed.*

8. *The Memo did not include or reference how stormwater will be managed. The cross-sections in Figures 3B and 3C make it look like that there will be ponding at the base of the landfill and the down gradient vertical barrier wall will be restricting water flow off of the cell.*

9. *The Memo did not include or reference any information regarding maintenance or repairs to the GCL if needed. If a future operations happen to penetrate through the GCL, how will it be repaired?*

10. *The Memo did not include or reference adequate engineering drawings of the final cover system.*
    a. *Drawings with the final grades, elevations, boundaries, and all structures need to be included.*
    b. *Drawings of all details such as, anchor trenches, tie-ins, and penetration points need to be included.*
    c. *Drawings should also include adequate cross-sections.*

If the above deficiencies were addressed and found to be technically adequate, the MMD would agree that the GCL system is equivalent to the CCL system and satisfies the requirements of Part 111. Ultimately, if the GCL's integrity is compromised, then the GCL system will not be equivalent to the approved CCL system.

Erik Martinson
Project Manager
Site Assessment and Site Management Unit
Superfund Section
Remediation and Redevelopment Division
Michigan Department of Environment, Great Lakes, and Energy
517-285-3978 | martinsone@michigan.gov

Appendix G
Hydrographic and Topographic Survey Results Summary Technical Memorandum

CH2M HILL, Inc.
9191 S. Jamaica Street
Englewood, CO 80112-5946

Subject:	**Hydrographic and Topographic Survey Results Summary**
Project Name:	Velsicol Chemical Corporation/Pine River Superfund Site
Attention:	Tom Alcamo/U.S. Environmental Protection Agency (EPA)
From:	CH2M HILL, Inc. (CH2M)
Date:	September 13, 2022
DCN:	GLAES-R5-21F0106-02004

CH2M has prepared this technical memorandum for the Environmental Protection Agency (EPA) to summarize the field activities and findings from the topographic and hydrographic survey performed along and within the Pine River at the Velsicol Chemical Corporation/Pine River Superfund Site (site). The bathymetric survey was performed to support remedial design (RD) of the downgradient vertical barrier as described in the June 22, 2012, Record of Decision (ROD). This work is being performed under Great Lakes Architect and Engineering Services II Contract 68HE0519D0007, Task Order Number 68HE0521F0106.

1. Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses approximately 100 acres in St. Louis, Michigan, and includes the Former Plant Site (FPS) and a residential area referenced as the adjacent or nearby properties (ANP). The lead agency for the remedial investigation (RI)/feasibility study (FS) was the Michigan Department of Environment, Great Lakes, and Energy (EGLE). EPA is the lead agency for the ongoing RD and remedial action (RA) efforts for the site.

A chemical manufacturing plant previously occupied the FPS from the mid-1930s until it was demolished in 1978. Industrial operations at the plant, which included manufacturing of pesticides and fire retardants, resulted in widespread contamination on the FPS. In 1982, the Velsicol Chemical Corporation entered into an administrative order on consent with the United States and the State of Michigan. Pursuant to the administrative order on consent, the Velsicol Chemical Corporation constructed a containment system for the FPS, which included the installation of a low-permeability cap and a 2-foot-thick low-permeability slurry wall around the entire 52-acre FPS.

The FPS is fenced and is bordered on the south and east by the ANP, with Washington Avenue (M-46) along the southern edge. Watson Street and North Street mark the eastern edge, and the Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the former plant boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The site consists of four operable units (OUs), as shown on Figure 1. The OUs are described as follows:

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which RI activities are ongoing
- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee rivers, for which RI activities are ongoing

The survey activities described in this technical memorandum occurred along and within the Pine River, and the results will be used for remedial component design for OU1.

2. Investigation Objectives

As described in the ROD, a vertical barrier will be installed around the entire perimeter of the FPS as part of the overall site remedy to decrease the potential for dissolved-phase contaminants in the Shallow Unit to discharge to the Pine River. A conceptual alignment of the downgradient portion of the vertical barrier was illustrated in the FS (Weston, 2011) and shows construction of the vertical barrier downgradient of the existing site slurry wall, within the Pine River. As described in the FS, fill will be placed in the area between the existing ground surface and downgradient vertical barrier and overlain with an engineered cap. The purpose of the topographic and bathymetric surveys is to provide documentation of these features to support future RDs.

3. Field Activities

Bathymetric survey field activities were performed by Seaworks Group, LLC (Seaworks) of Benton Harbor, Michigan April 4 through 9, 2022. CH2M performed full-time oversight of the field event.

The survey area included the stretch of the Pine River from the M-46 bridge crossing downstream to the Mill Street bridge crossing and the adjacent riverbank area located along the FPS (Figure 2). Boat access to this stretch of river is limited by low vertical clearance imposed by Pine River bridges at M-46 and Mill Street. The subcontractor used a drone vessel (Z-Boat 1800-RP) and small jon boat to complete the hydrographic survey due to the limited boat access for this stretch of the river. The drone was controlled remotely by a crew who followed and monitored the vessel from the jon boat. Both vessels were launched from Leppien Park just south of the M-46 bridge, as the vertical clearance at this location was sufficient to allow passage of both vessels into the survey area.

The following subsections provide a brief summary of the field activities that were performed. Additional detail can be found in the *Final Report for: Velsicol Superfund Site, Pine River, St. Louis, MI Bathymetric and Topographic Investigation* (Seaworks 2022), provided in Attachment 1.

3.1 Survey Control and Equipment Calibration

Control surveys were performed by the hydrographic and topographic survey crews prior to commencing data collection. Control Points CP1105004 and CP105005 were used to perform the control surveys. Control surveys were performed using a Trimble RTK GPS Rover in Observed Control Point mode.

As detailed in Seaworks' final survey report, a sound velocity profile was measured immediately prior to multibeam, single-beam, and side-scan surveys using a Digibar Pro. The Digibar cast recorded velocities throughout the water column at 1-foot increments, which were applied to sonar data during collection and processing. Additionally, sound velocity at the sonar head was measured and applied in real-time using the head-mounted AML MicroX probe. A new Digibar cast was performed approximately every two hours, or any time the vessel moved to a new survey area.

In addition, pre- and post-survey water level checks were performed by comparing the elevation outputs from the bathymetric survey positioning system (Applanix POS MV 120 Position and Orientation System) data to the elevation outputs from the GPS (Trimble R8) used to perform the control surveys.

Bar checks were performed regularly to confirm the sonar head draft value and to document a physical check against Seaworks' electric soundings. The bar checks were completed by confirming returns measured off an aluminum plate held at a known depth below the sonar head.

Multibeam patch tests were performed regularly to measure and confirm sensor mounting offsets. To perform this check, survey lines were run in a predetermined pattern over a recognizable object, such as a slope or pipeline, and then the data was processed using a software routine to compute the pitch, roll, and heading angular offsets.

3.2 Multibeam Bathymetric Survey and High-resolution Side-Scan Imaging

Seaworks completed the multibeam bathymetric survey April 8 and 9, 2022. Figure 2 shows the survey area. Survey line spacing for the multibeam survey ranged between 10 and 30 feet, depending on water depth. Data was collected using a R2Sonic 2020 multibeam sonar system within 10 to 20 feet of the riverbank. Shallow areas closer to the riverbank were surveyed using a single-beam Z-Boat drone.

The side-scan survey was performed April 7-8, 2022. An Edgetech 4125 side-scan sonar system was used to perform the side-scan imaging. Survey line spacing for the side-scan sonar survey was 40 feet, minimum. Due to the shallow water depths within the survey area, the side-scan sonar was hung directly over the side of the jon boat rather than towed behind it.

3.3 Underwater Magnetometer Survey

The magnetometer survey was performed April 4 through April 7, 2022. The survey area is shown in Figure 2. A Geometrics G-882 Cesium Vapor Marine Magnetometer was used to complete the survey. The survey line spacing was 25 feet to maximize coverage and minimize the chance of missing small targets between the lines. Due to the shallow water depths, Seaworks attached the magnetometer to foam floats and towed it behind the jon boat.

3.4 Topographic Survey

The topographic survey was performed concurrently with the hydrographic survey on April 8 and 9, 2022. The topographic survey area is shown on Figure 2, from as close to the hydrographic survey limits as possible, up to the fence line. Topographic data was collected using a Trimble RTK GPS rover. The data was collected on approximately 50-foot spaced transects to capture top and toe of slope and significant slope breaks. Site features of interest were also mapped.

3.5 Decontamination Activities

The Z-Boat, jon boat, and survey equipment were all decontaminated prior to demobilization. Decontamination activities were performed on the existing process pad.

4. Data Processing

After data collection, Seaworks processed the survey data using multiple software packages. Multibeam and topographic survey data was processed using the Hypack/Hysweep 2020 software package. Data was exported in a non-reduced point cloud XYZ format, as well as 1-foot by 1-foot XYZ grid files reduced using average sounding selection. The XYZ grid was used in Hypack's TIN utility to generate contour and GeoTIFF files for inclusion in bathymetric plots.

Side scan data was reviewed in Chesapeake Technology SonarWiz. Items of interest were manually identified and measured, and a target database was generated.

Magnetometer data was processed using Hypack 2020 Single-Beam editor. Data was converted to XYGamma format and processed in the TIN utility to generate a contour drawing showing deviations from background gamma values. Debris objects were identified and cross-referenced with side-scan data to assist with target identification.

More details on the data processing performed by Seaworks is included in the *Final Report for: Velsicol Superfund Site, Pine River, St. Louis, MI Bathymetric and Topographic Investigation* (Seaworks 2022), provided in Attachment 1.

5. Survey Results

The survey results are summarized in the following sections. Results are further detailed in the *Final Report for: Velsicol Superfund Site, Pine River, St. Louis, MI Bathymetric and Topographic Investigation* (Seaworks 2022), provided in Attachment 1.

5.1 Bathymetric Survey Results

The multibeam bathymetric survey resulted in a digital terrain model illustrating current sediment elevations. Figure 3 shows the results of the multibeam bathymetric survey. Sediment elevations from the Mill Street Bridge to approximately 2,300 feet upriver range from approximately 699 feet above mean sea level (AMSL) in the deepest section of the river (water depth of approximately 20 feet) to 717 feet AMSL along the northern riverbank. This area of the river was remediated as part of the OU2 RA, and the lower sediment elevations in this section of the river reflect the sediment removal activities that were performed during the RA. The areas where sediment elevations are higher are the historic locations where temporary sheet piles were installed to support the OU2 RA. All sheet piles associated with OU2 RA were removed in the fall of 2014.

The remainder of the survey area was not affected by historic OU2 RA activities. Sediment elevations from 2,300 feet upriver from the Mill Street Bridge to the M-46 Bridge range from 706 feet AMSL to 717 feet AMSL. The main river channel in this section of the river appears to range between 6 and 12 feet deep with shallower, flat benches along either side. Based on the side-scan survey results (further detailed in Section 5.2), it appears that subaqueous vegetation is present within the shallow benches. Some vegetation was observed in the main river channel in this area, as well. The bathymetric survey results represent the acoustic bottom, and due to the vegetation in this area, it is likely that the sediment surface is actually a few inches deeper than the acoustic bottom.

5.2 Side-Scan and Magnetometer Surveys

The side-scan and magnetometer surveys revealed numerous debris and utility-type features, including:

- A 12-foot by 6-foot rectangular shaped object, likely composed of some ferrous metal. This object was observed approximately 1,500 feet upriver of the Mill Street Bridge.
- A linear feature approximately 60 feet in length was observed within the river sediments. Based on the strong magnetometer returns, this object is likely ferrous in nature. This feature was identified approximately 2,400 feet upriver from the Mill Street Bridge.
- A potential utility crossing approximately 2,700 feet upriver from the Mill Street Bridge. This feature was identified only by the magnetometer, indicating it is buried under the sediment.
- A potential utility crossing approximately 800 feet downriver from the M-46 Bridge.

The side-scan imagery is illustrated in Figure 4. The magnetometer data is presented with the side-scan data in two figures: Figure 5 shows the magnetic contours in 75 nanotesla (nT) increments, which is useful for identifying weaker returns. Figure 6 shows the magnetic contours in 200 nT increments, for viewing strong return objects.

5.3 Topographic Survey

The topographic survey resulted in a digital terrain model of the south and east riverbanks within the survey area, located along the FPS. The results of the topographic survey are depicted in Figure 7.

6. Utility Inquiry

Based on the observations of side-scan and magnetometer surveys, a utility inquiry was requested from the Michigan Utility Notification Center on June 17, 2022, ticket number 2022061701421, for the horizontal location of water lines, sewer lines, gas lines, electric lines, and fiber optic lines in the proposed project area. Notifications were sent to thirteen utility owners: Charter Communications Cable TV, Charter Communications Fiber Optics, Consumers Energy Electric, Consumers Energy Gas, DTE Energy Electric, Everstream Fiber Optics, Frontier/Verizon Telephone, Gratiot County Drain Commission, Pine River Township Sanitary Sewer, St. Louis City Electric, St. Louis City Potable Water, St. Louis City Sanitary Sewer, and St. Louis City Storm Sewer.

Responses were received from five utility owners:

- Consumers Energy responded on June 29, 2022, stating that there are no electric distribution underground facilities mapped for the area of the proposed project area. Consumers noted this did not include underground electric service lines that may be present.
- Everstream responded on June 24, 2022, stating that they had an underground fiber line on the north side of West Washington Street within the proposed project area.
- The City of St. Louis responded on June 22, 2022, stating there are water, sanitary sewer, and storm sewer lines that border the Pine River, and therefore in the project area. There are water and storm were lines within the alignment of West Washington Avenue where it crosses the Pine River. These lines may directly impact the project area.

Utilities that provided written response to the inquiry confirmed the absence of infrastructure which crossed the survey area below the water surface and none of the responses indicated infrastructure present

in the locations of potential utility-type features identified during the side-scan and magnetometer surveys.

7. Conclusions

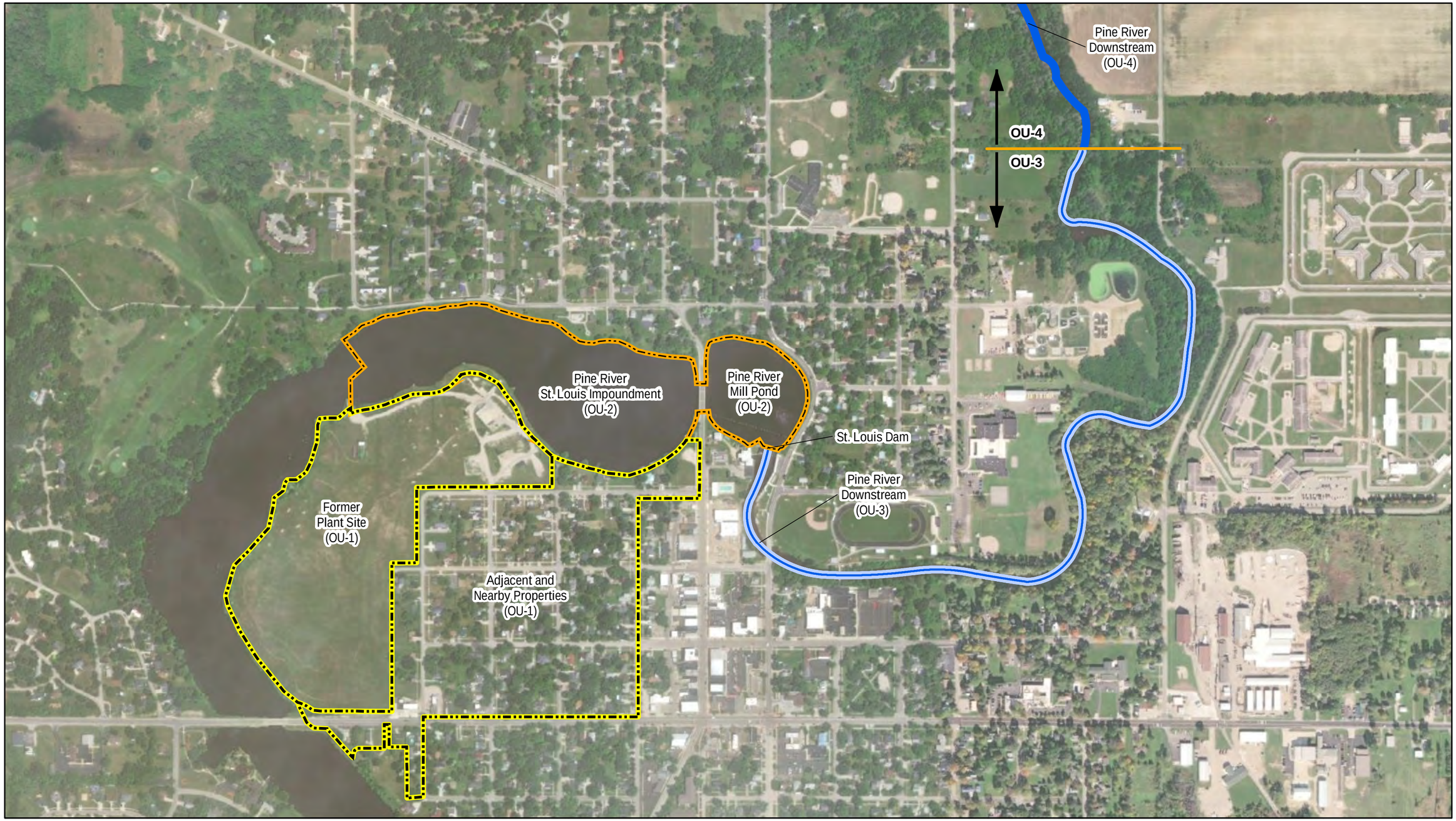
The primary objective of the hydrographic and topographic survey activities described in this TM was to define the surface elevations of the riverbank and riverbed and to assess the potential presence of metallic debris within the riverbed which may influence the downgradient vertical barrier design. The data collected during these surveys is sufficient to support the downgradient vertical barrier wall design and to provide fill volume estimates. The debris features observed from the side-scan and magnetometer surveys will be considered during future RD efforts. In addition, based on the results of this utility inquiry made through the Michigan Utility Notification Center, additional inquiries will be made, in writing, directly to utility providers in the project area to ensure the RD of the downgradient vertical barrier wall adequately addresses this issue.

8. References

Seaworks Group, LLC. 2022. *Final Report for: Velsicol Superfund Site, Pine River, St. Louis, MI Bathymetric and Topographic Investigation*. April.

Weston Solutions of Michigan, Inc. (Weston). 2011. *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Figures



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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Document Path - MKE - \\Hercules: \\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\Reports\2021\QAPP\MapFiles\Figure01_Study Areas and Operable Units.mxd User Name: mpetersh Date: 8/27/2021 Time: 3:47:13 PM

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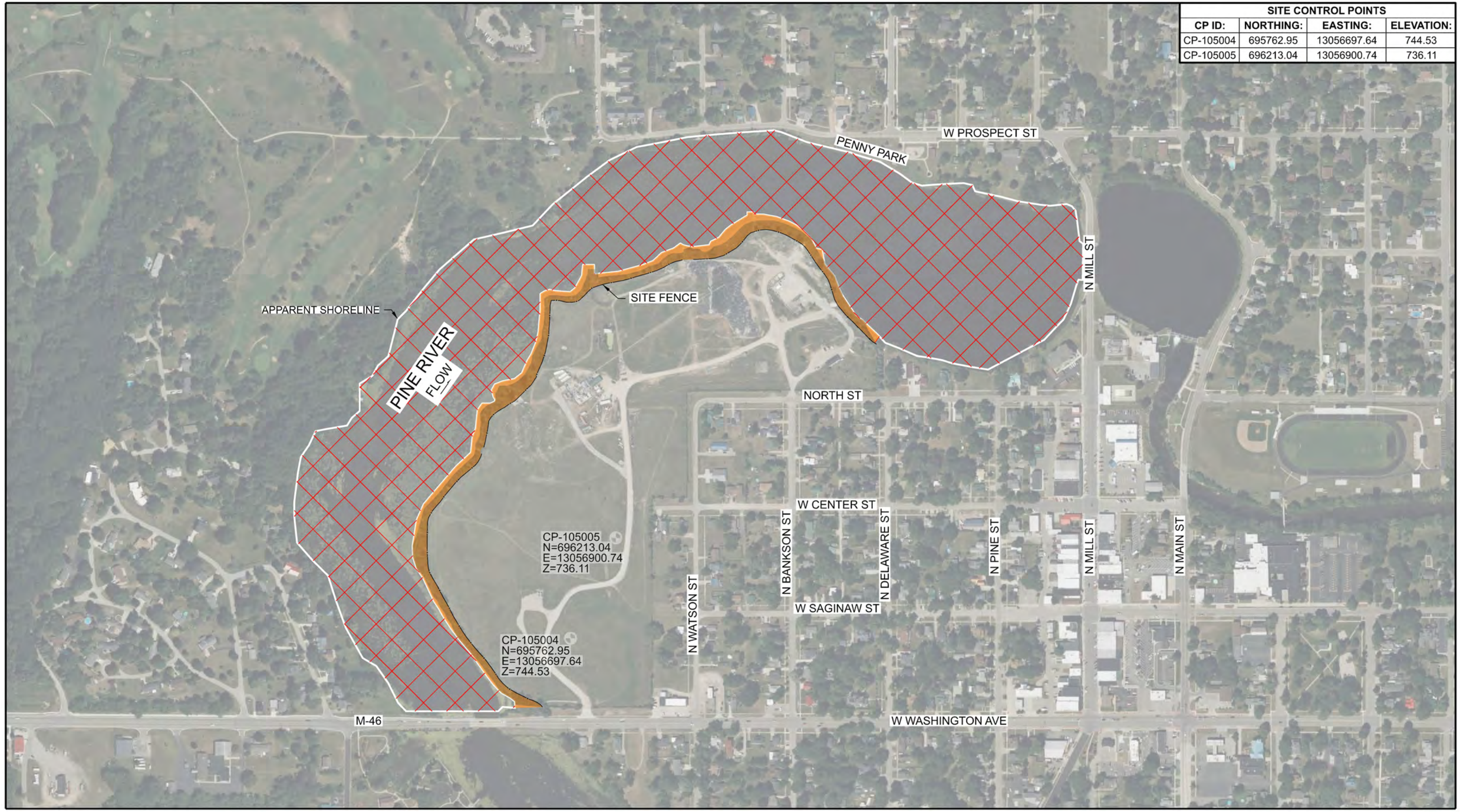
CP-105005	696213.04	13056900.74	736.11



Legend:

- Control Point
- Bathymetric Survey Area
- Topographic Survey Area Between Shoreline and Existing FPS Fence

N

0 200 400 600
Scale In Feet

Figure 2. Topographic and Hydrographic Survey Area
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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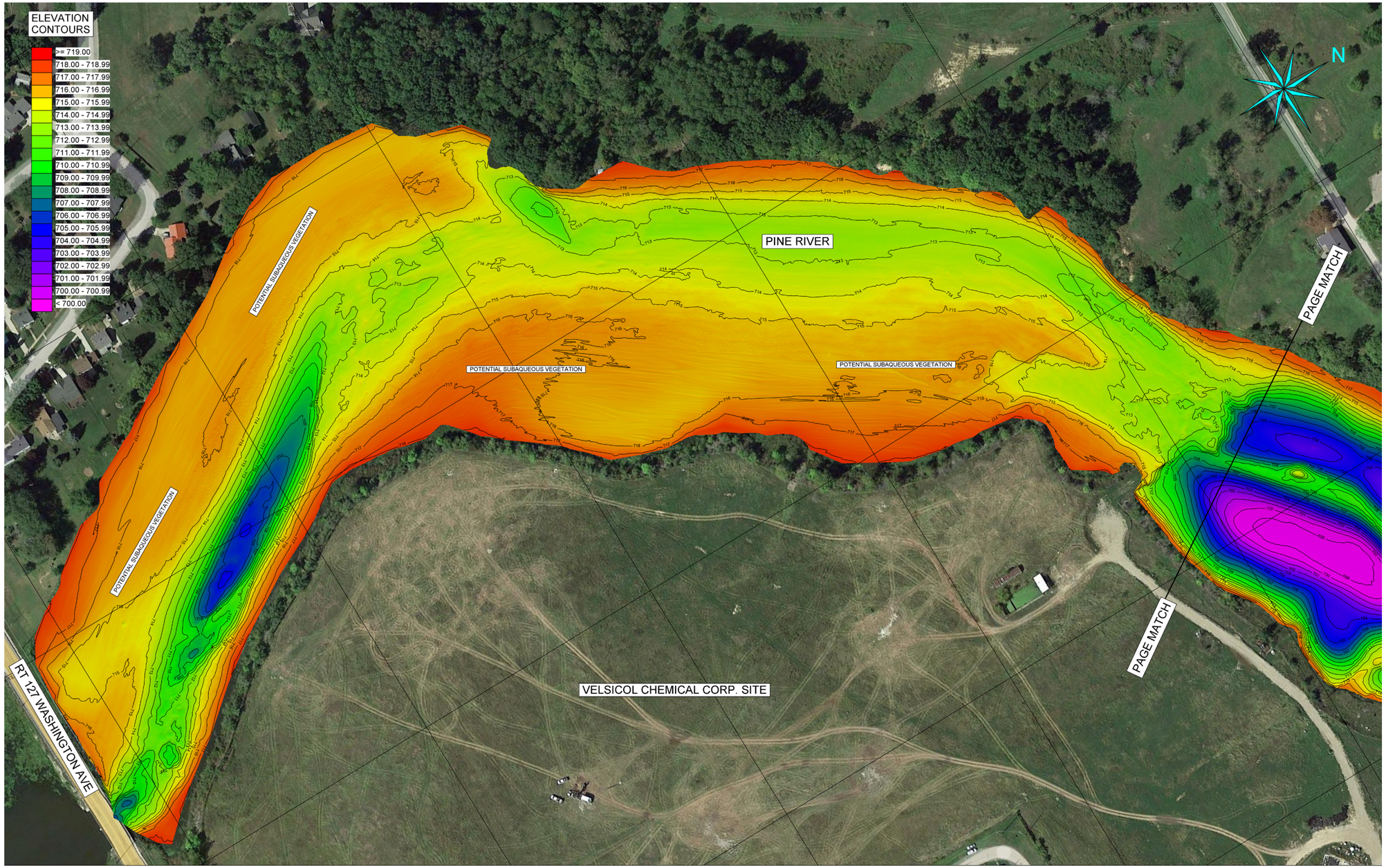

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6. AVERAGE WATER SURFACE ELEVATION DURING SURVEY WAS: 719.35'

100 200 400 600 800 Feet

Figure 3
Multibeam Survey Results
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)

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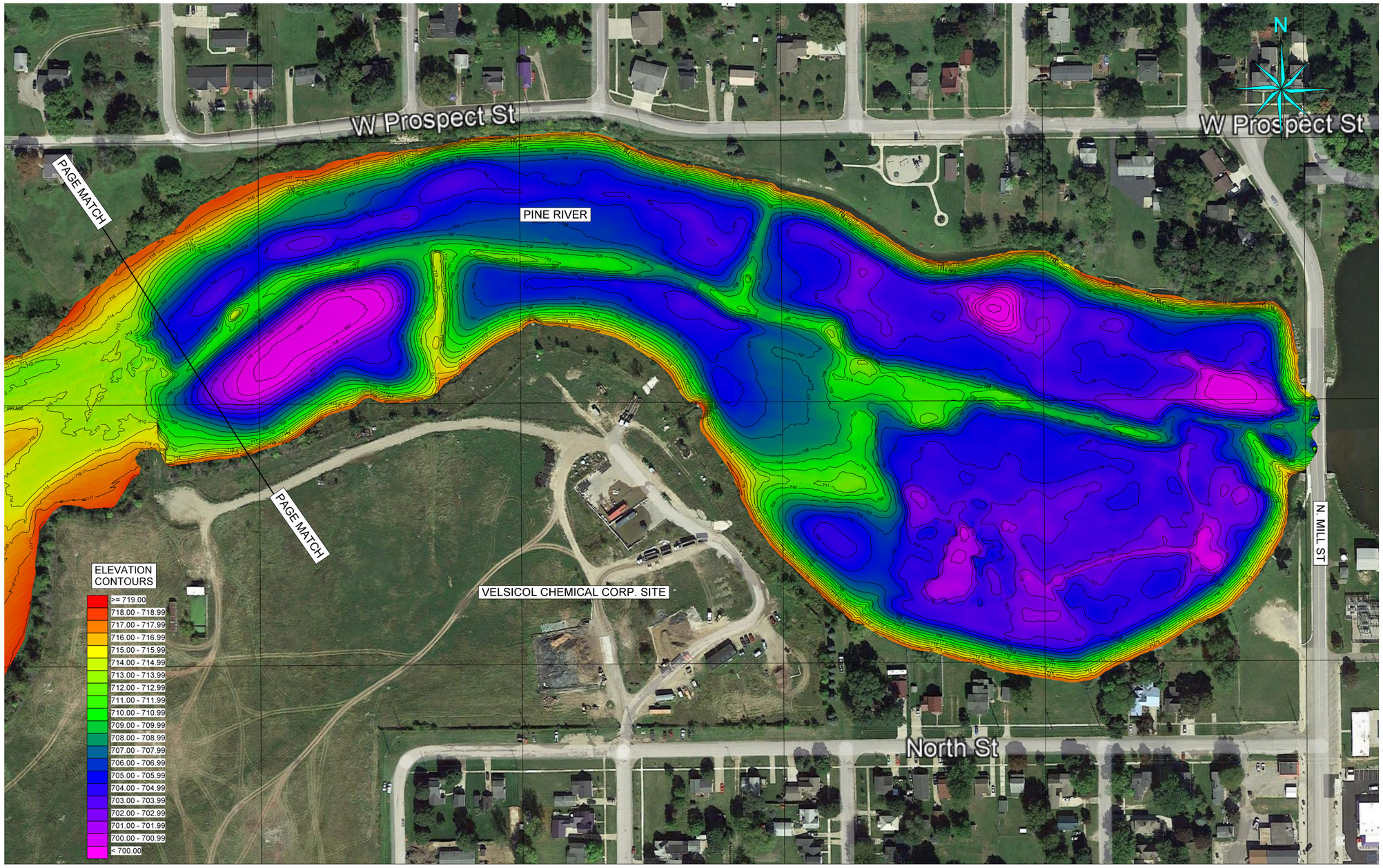

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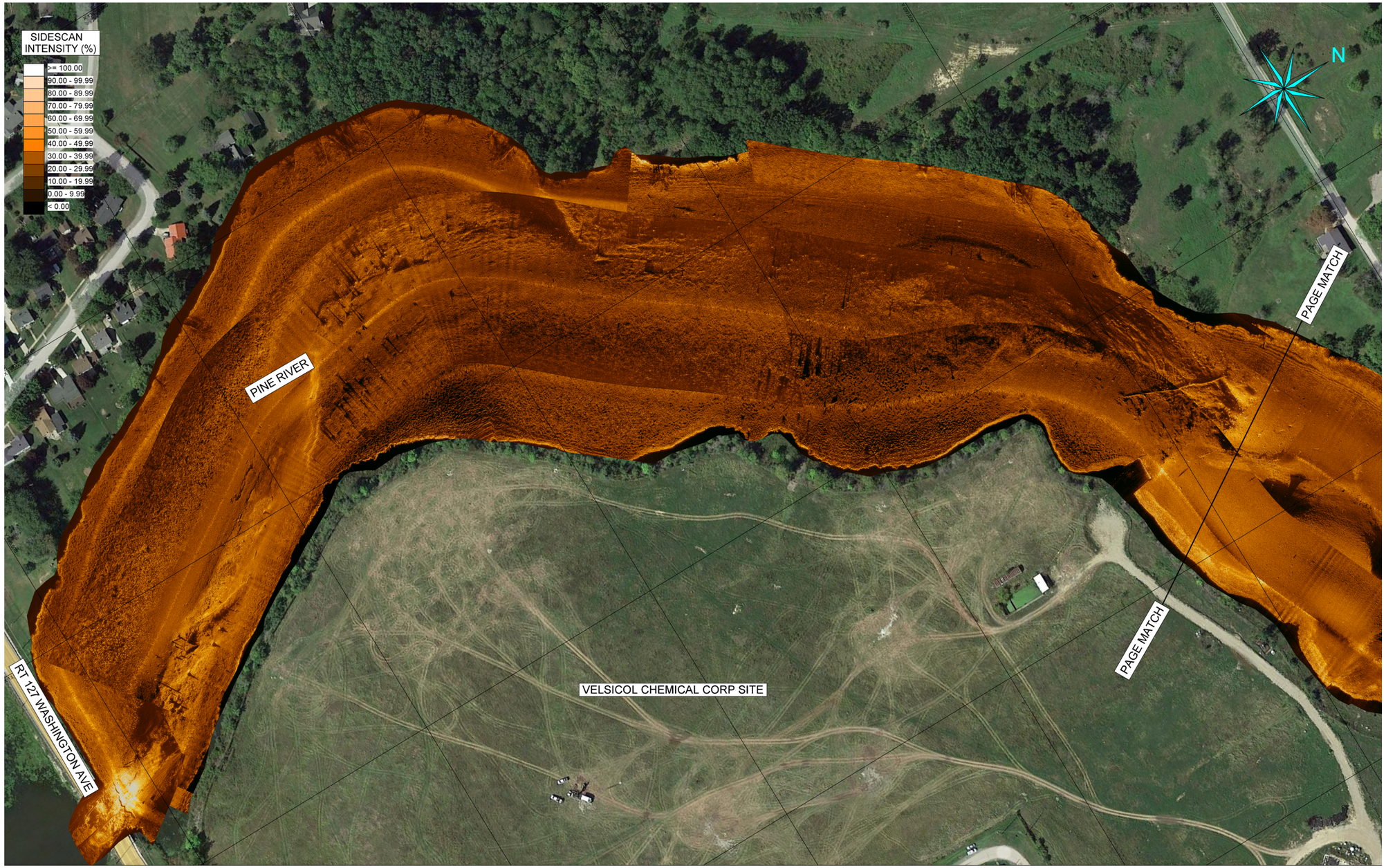

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2. SIDESCAN MOSAIC WAS GENERATED USING .1FT x .1FT RESOLUTION AND COVERUP OVERLAY METHOD.

100 200 400 600 800 Feet

Figure 4
Side-Scan Survey Results
Velsicol Chemical Corporation Superfund Site
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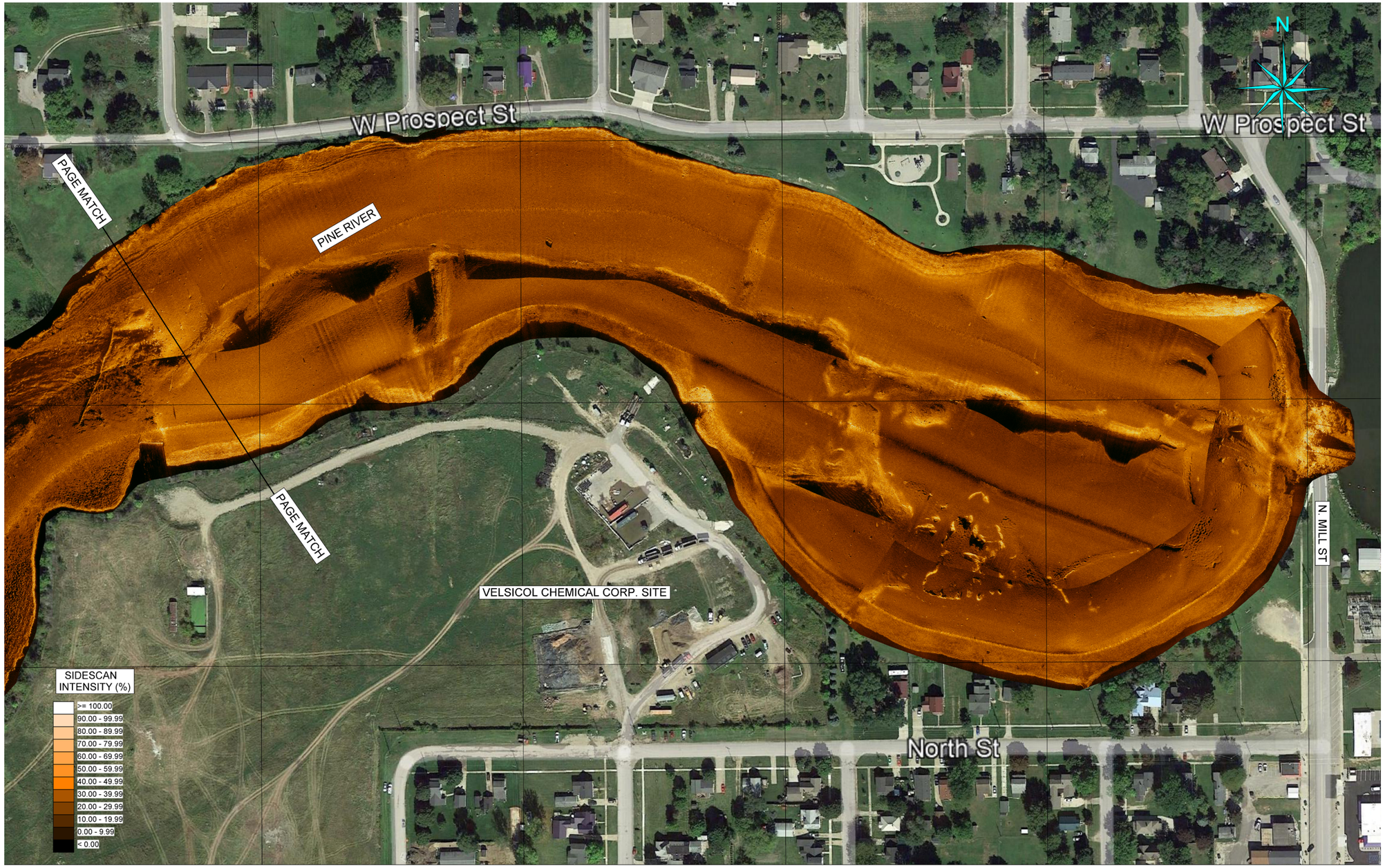

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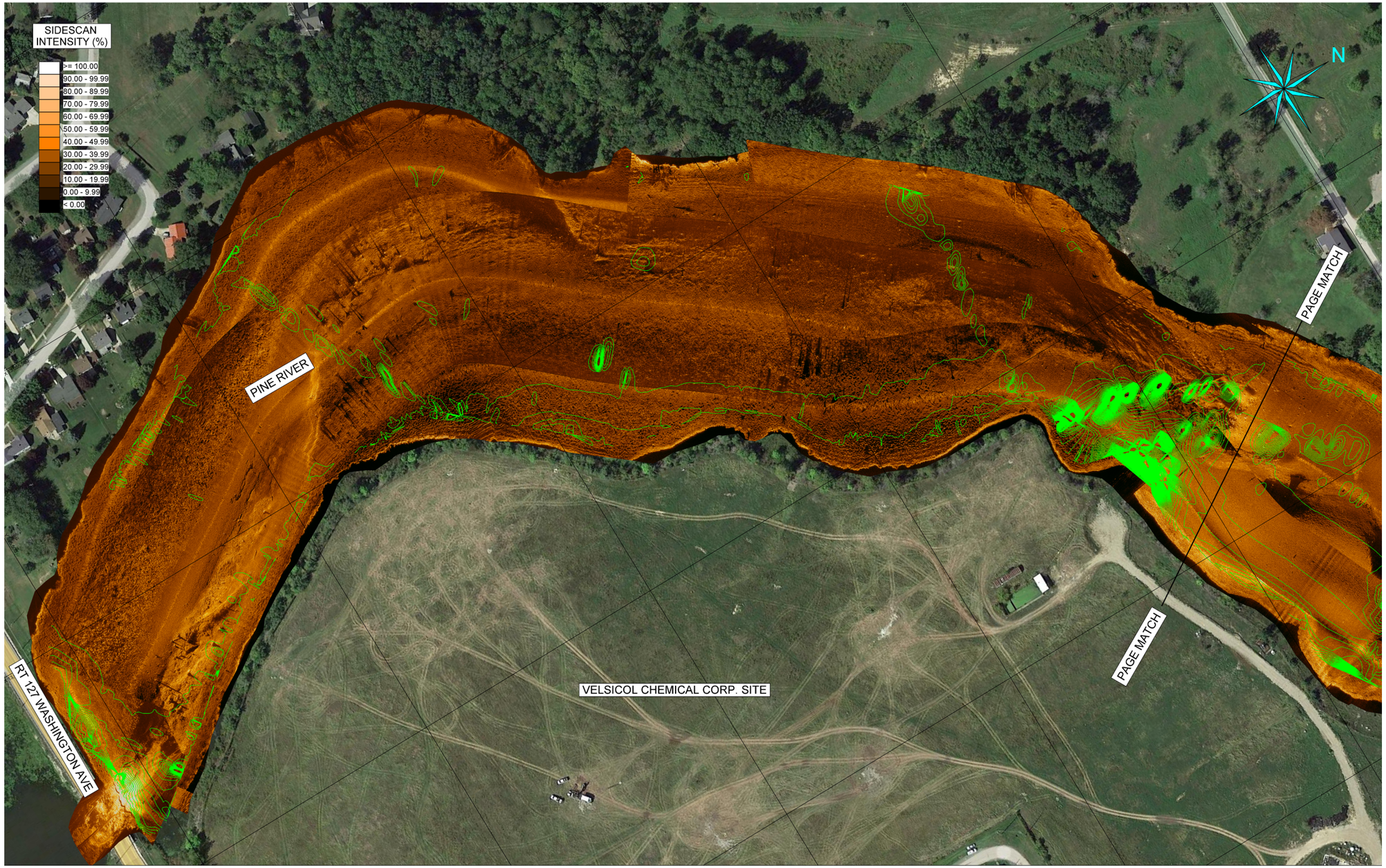

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3. GREEN CONTOURS INDICATE RELATIVE MAGNETOMETER GAMMA VALUES IN 75nT INCREMENTS.

100 200 400 600 800 Feet

Figure 5
Magnetometer Survey Results (75 nT increments)
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)

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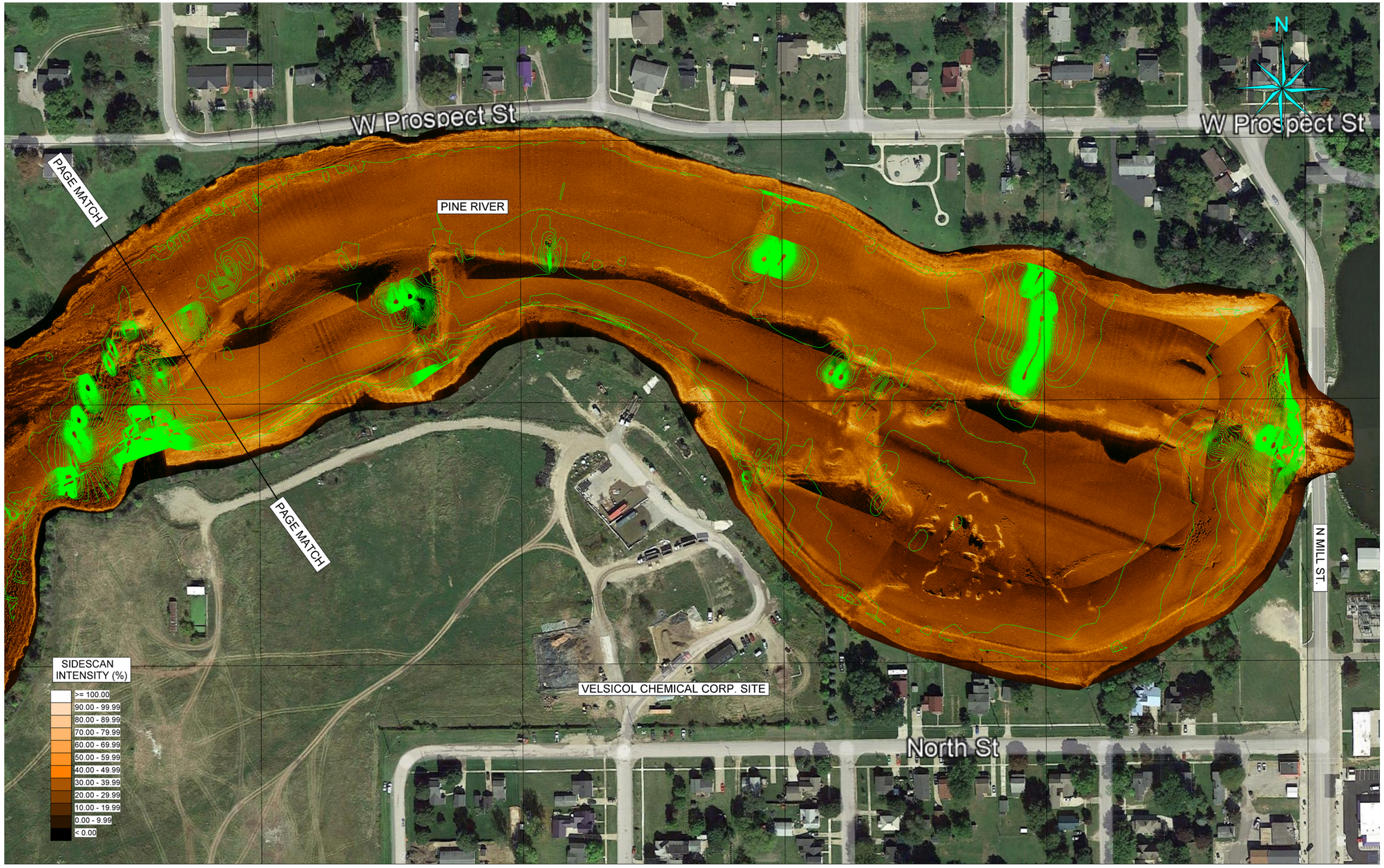

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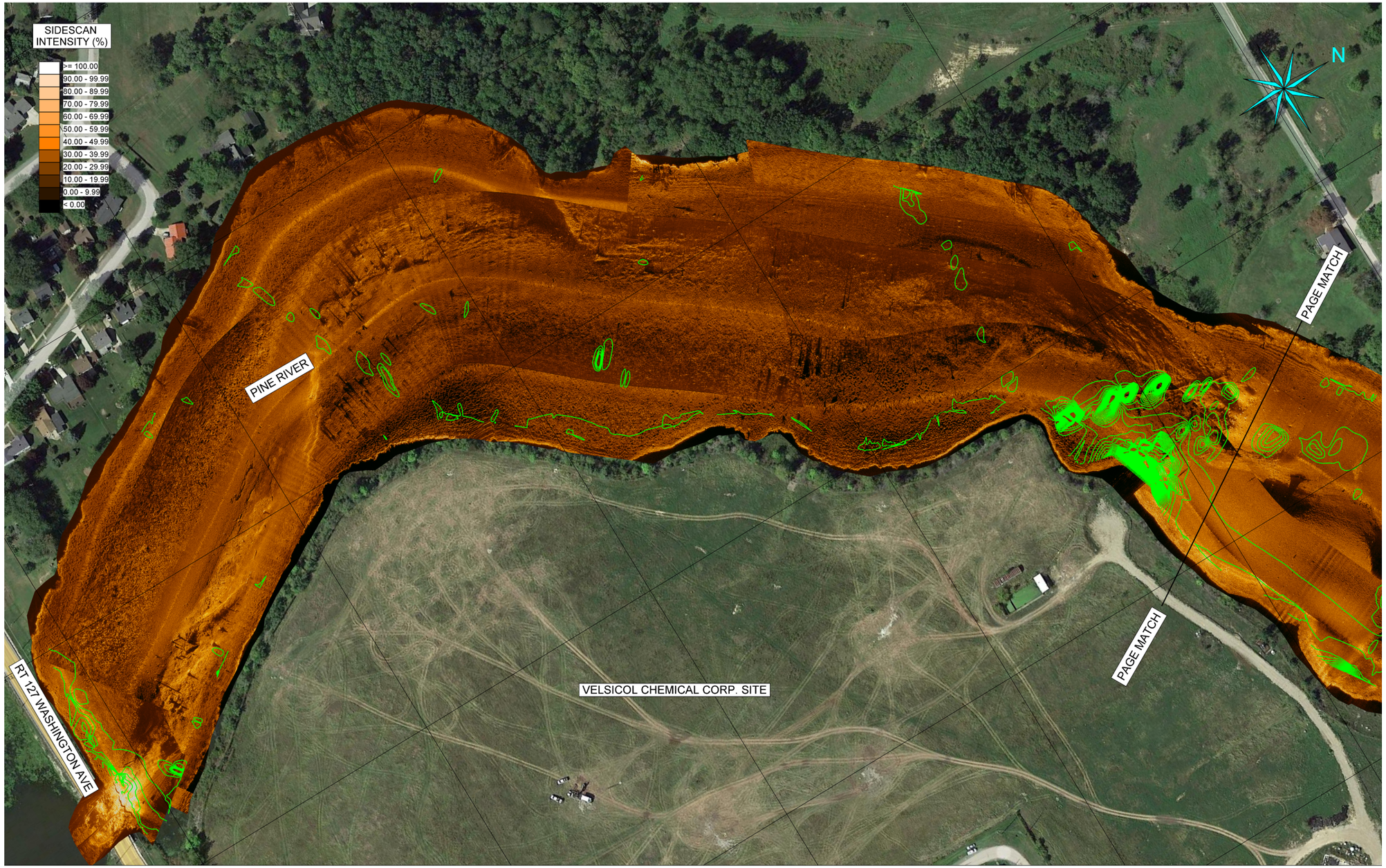

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Figure 6
Magnetometer Survey Results (200 nT increments)
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)

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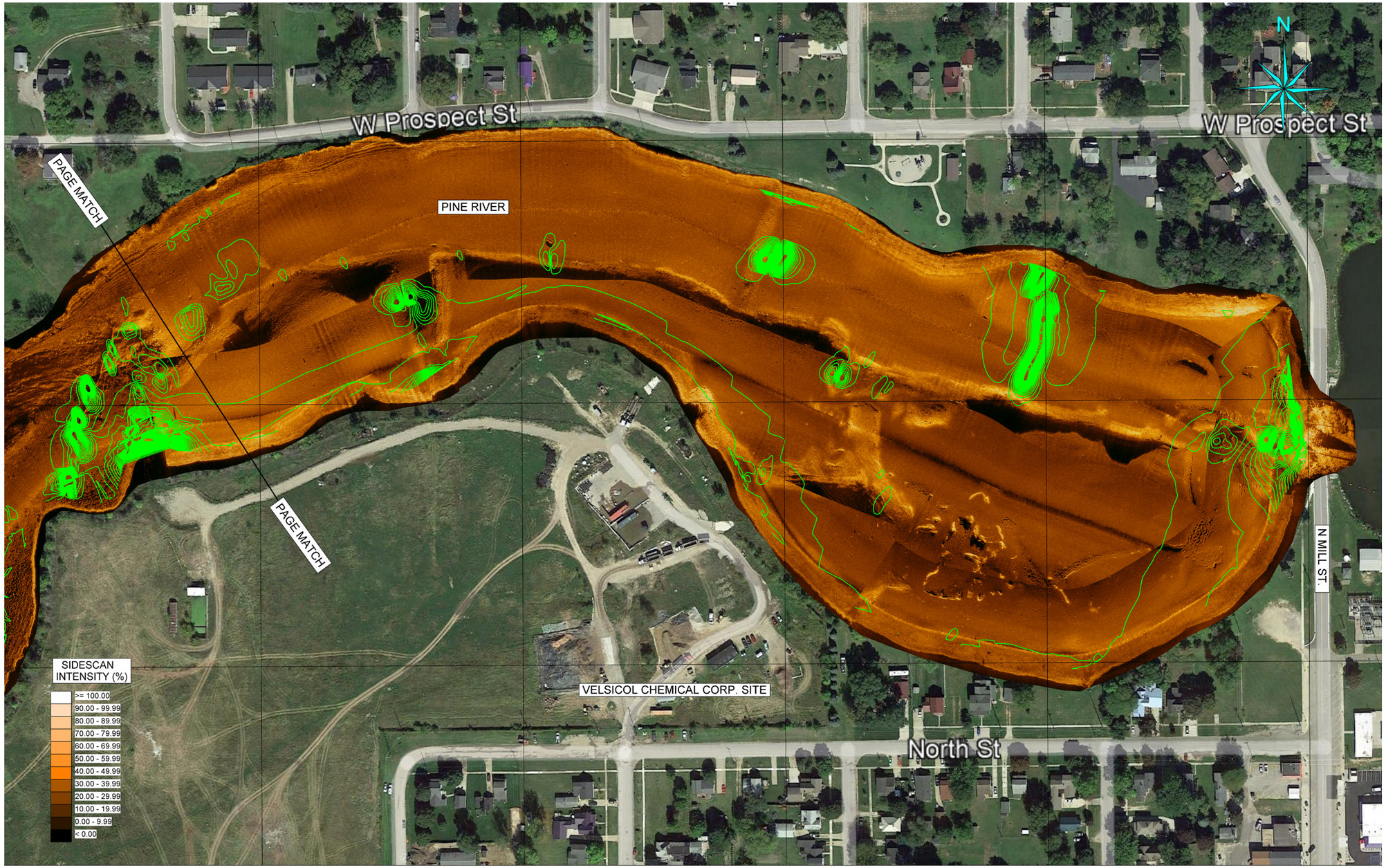

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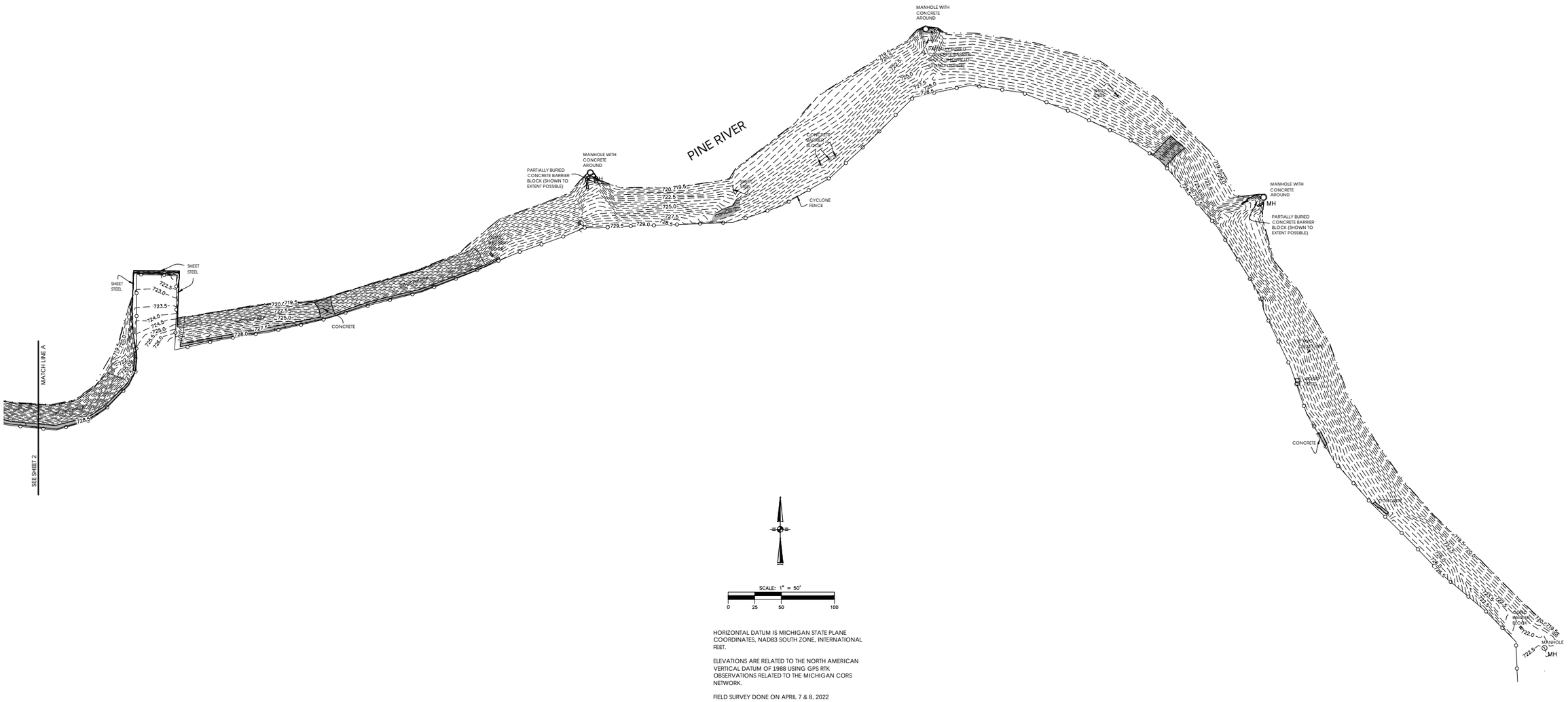
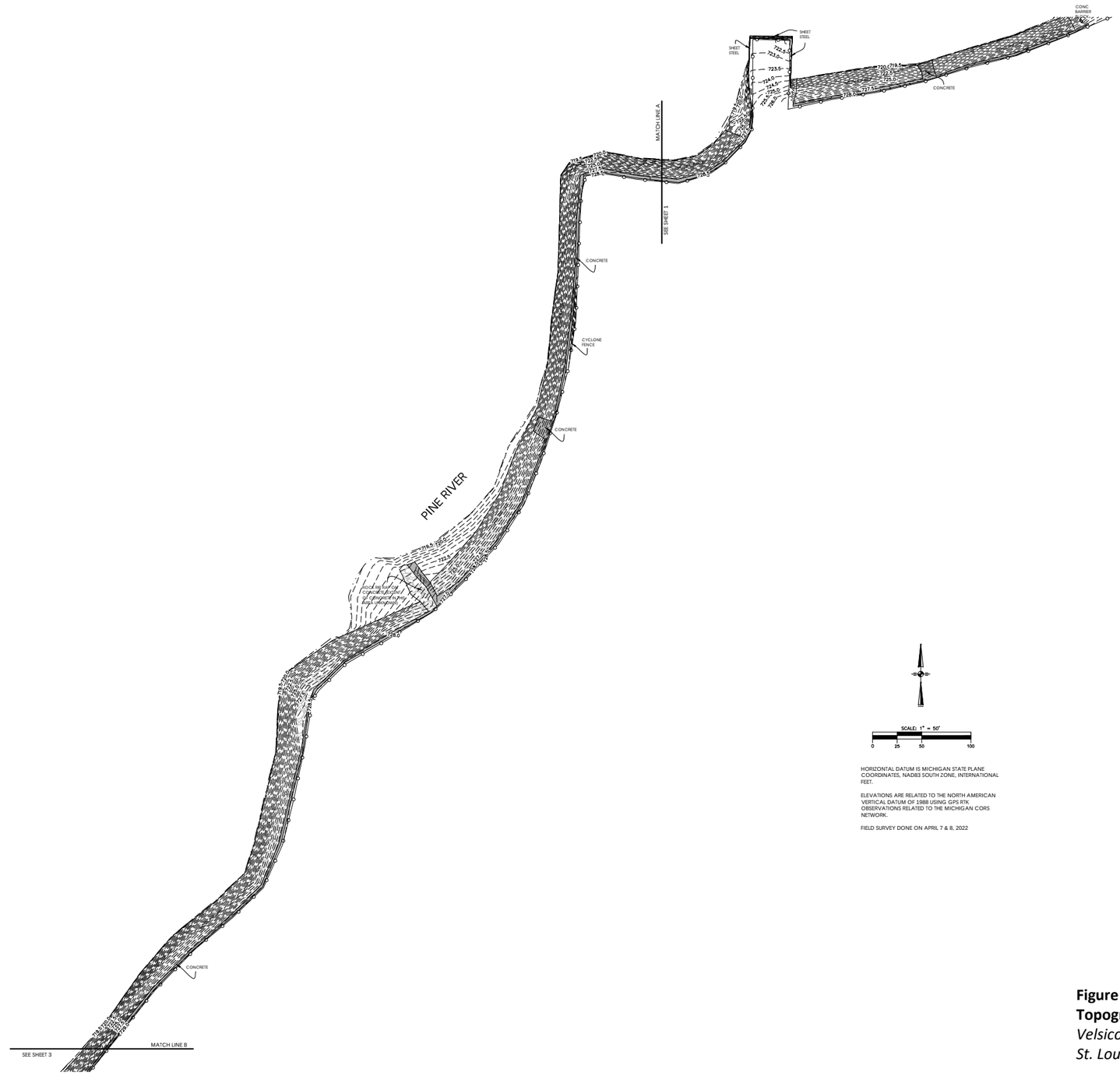


Figure 7
Topographic Survey Results
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)



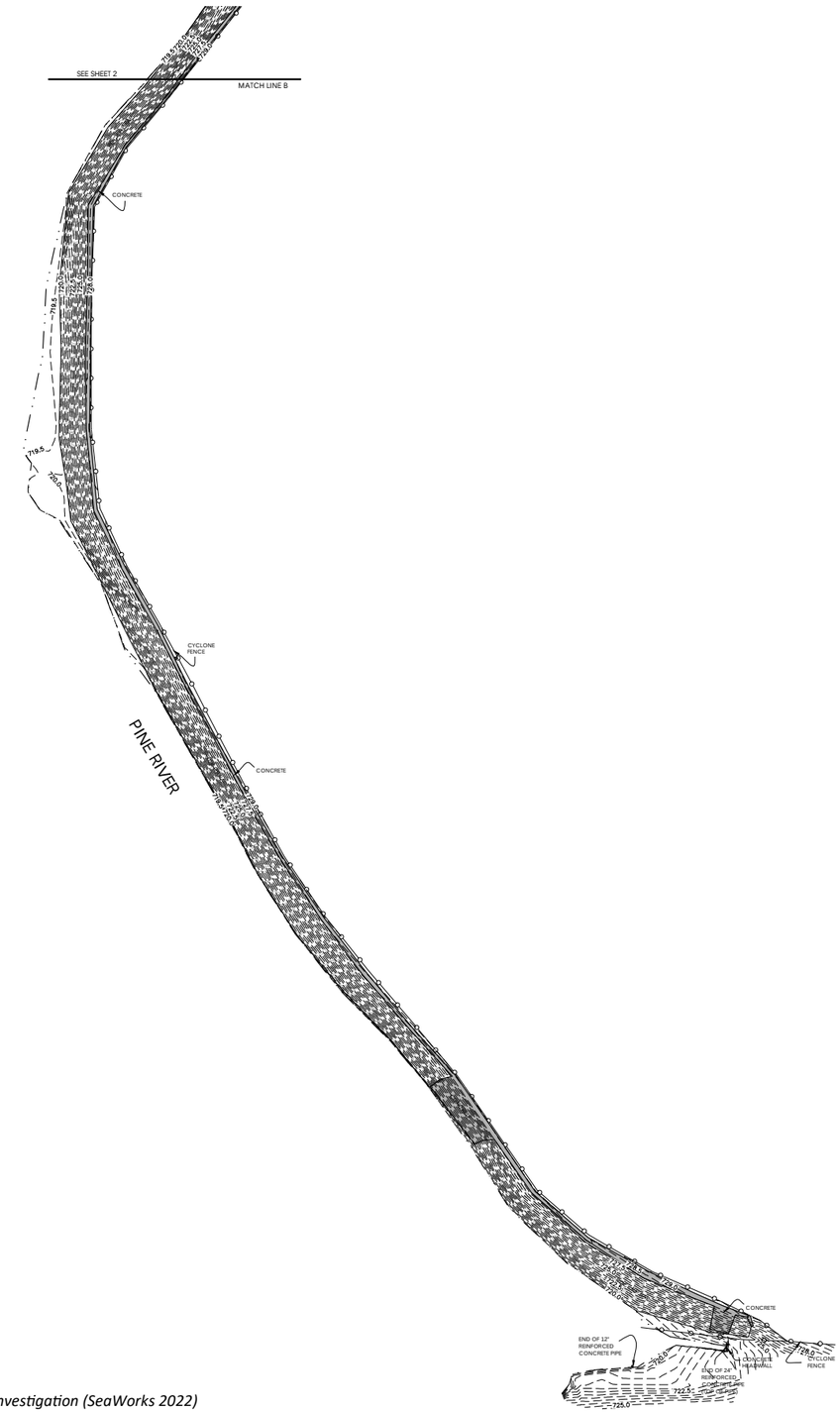
HORIZONTAL DATUM IS MICHIGAN STATE PLANE COORDINATES, NAD83 SOUTH ZONE, INTERNATIONAL FEET.

ELEVATIONS ARE RELATED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 USING GPS RTK OBSERVATIONS RELATED TO THE MICHIGAN CORS NETWORK.

FIELD SURVEY DONE ON APRIL 7 & 8, 2022

Figure 7
Topographic Survey Results
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)



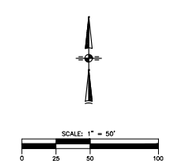


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Figure 7
Topographic Survey Results
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St. Louis, Michigan

Source: Final Report for Velsicol Superfund Site Bathymetric & Topographic Investigation (SeaWorks 2022)

Attachment 1
Seaworks Final Report

Final Report for:

Velsicol Superfund Site
Pine River, St. Louis, MI
BATHYMETRIC & TOPOGRAPHIC INVESTIGATION

Prepared for:

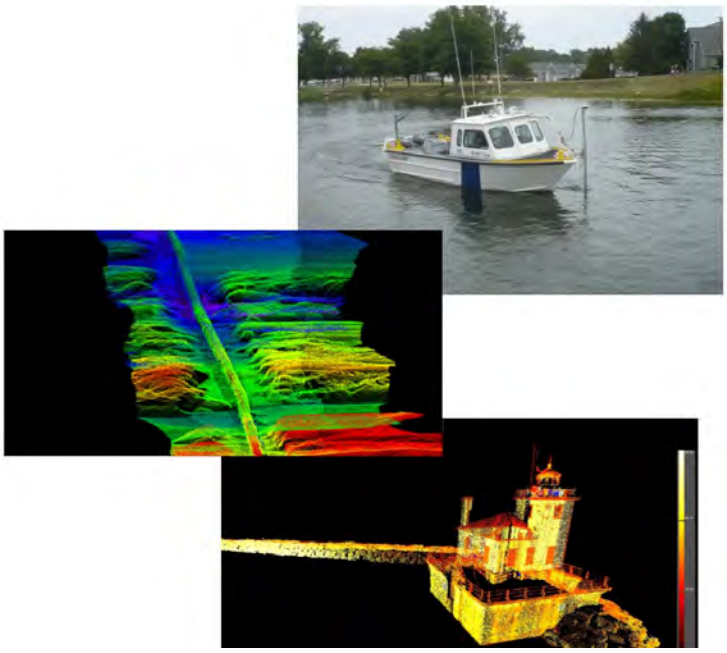
JACOBS

1999 Bryan St., Suite 1200
Dallas, TX 75201

Prepared By:

SEAWORKS GROUP, LLC

185 E. Main St., Suite 414, Benton Harbor, MI 49022 269-277-3005



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7.0 ATTACHMENTS

PLAN VIEW PLOTS
.XYZ FORMAT HYDROGRAPHIC DATA (ELECTRONIC FILES)
SIDESCAN SONAR GEOTIFF FILES (ELECTRONIC FILES)

1.0 Introduction

1.1 Project Overview

Seaworks was tasked with performing a hydrographic investigation along the Pine River in St. Louis, MI. This survey area was adjacent to the Velsicol Chemical Plant Superfund Site . The purpose of the survey was to assess site conditions to assist in the design of a vertical barrier. This investigation included a multibeam bathymetric survey, magnetometer survey, high resolution side scan sonar, and shoreside topographic survey. Single-beam data was also collected in limited areas of shallow water.

The survey encompassed the outlined river area from the M-46 overpass to the N. Mill St. bridge. Project water depths varied between approximately 2' to 20' in this section of the river. Survey data was collected by Seaworks between April 4th and April 9th 2022.

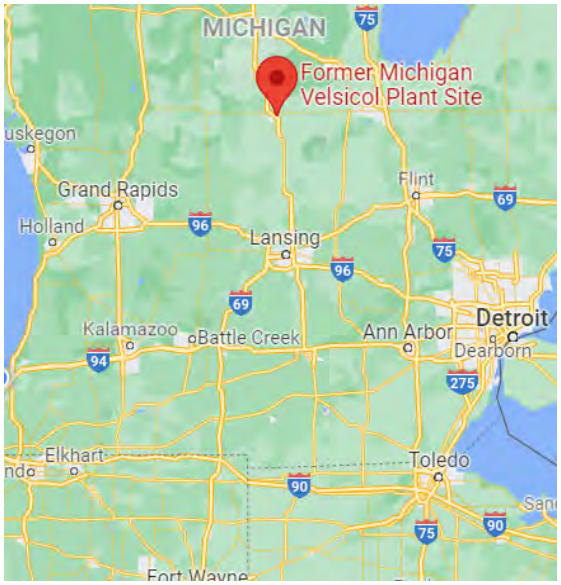

Figure 1.1 – Project Location

Figure 1.2 – Survey Area (Green)

2.0 Datums & Control

2.1 Project Datums

Horizontal

Datum: Michigan State Plane Coordinate System, South Zone (2113), 1983 North American Datum
Units: International Ft.

Vertical

Datum: North American Vertical Datum of 1988
Units: International Ft.
Geoid: Continental US (CONUS) 2018

2.2 Survey Control

Prior to the survey, several checks were performed on the site control by both the hydrographic and topographic survey crews, obtaining similar results. Checks were performed using RTK GNSS technology with corrections from the MDOT VRS Network. A Trimble R8 rover was utilized in Observed Control Point mode.

Provided				Observed (MI CORS)		
PID	E	N	Elv.	E	N	NAVD88 Elv.
CP105004	13,056,697.64	695,762.95	744.53	13,056,697.66	695,762.95	744.75
CP105005	13,056,900.74	696,213.04	736.11	13,056,900.74	696,213.02	736.26
CP105003	13,056,319.27	696,597.33	728.86	Not found		
CP101	13,057,263.43	696,831.30	727.10	Not found		

All survey work was performed using the MDOT VRS Network and is currently in the NAVD88 vertical datum. However an adjustment based on site control could be performed if needed.

3.0 Equipment

3.1 Survey Vessels

Z-Boat 1800-RP

The Z-Boat 1800-RP is a small, remote-controlled, "drone" survey vessel that can be equipped with most of the same survey technologies as Seaworks' large survey vessels. It's portability and compact size make it ideal for shallow-water surveying, difficult to access areas, and protected waters of any depth. Seaworks' boat has a "ruggedized package" upgrade which features a single lifting eye, a dual- GPS/GNSS antenna mount frame, and an interchangeable sensor mount well.

Figure 3.1 – Z-Boat

Specifications

- Length: 6'
- Width: 3'
- Height: 3'
- Survey/max speed: 3/8kts
- Boat weight: 85lbs
- Payload capacity: 65lbs

3.2 Multibeam Sonar

R2Sonic 2020

The R2Sonic 2020 multibeam sonar system scans underwater features using a high-resolution swath of 256 beams with beam widths of 2° across-track and 2° along-track (2° x 2° system). The system can be operated in either equidistant or equal-angle operating modes, with a swath coverage angle of up to 130°. The sonar operates at user-selectable frequencies between 200kHz and 450kHz.

Figure 3.2 – R2Sonic 2020

A continuous sound velocity profile is normally measured by velocity probe casts and then corrected for within the processing software.

Sonar Equipment & Accessories

- Multibeam Echosounder: R2Sonic 2020
- SV Profiler: Teledyne Odom Digibar Pro

3.3 Sidescan Sonar

Edgetech 4125

The Edgetech 4125 side-scan sonar is a 600/1,600Khz dual simultaneous frequency system designed for high-resolution search and mapping applications. The dual frequencies provide a combination of long range search capability and ultra high resolution images for detail and detection of very small objects.

The 4125 system utilizes Edgetech's Full Spectrum CHIRP technology, which provides higher resolution imagery at ranges up to 50% greater than comparable systems. The system has an operating ranges of 120m @ 600Khz and 35m @ 1,600Khz. It has a horizontal beam width of 0.20° and an across-track resolution of 0.6cm.

Figure 3.3 – Edgetech 4125

The sonar towfish is typically towed behind the survey vessel at an optimal altitude above the bottom to maximize detection and image quality. In shallow waters it is deployed from the side of the vessel using an outrigger davit.

3.4 Positioning & Orientation System

Applanix POS MV 120

Horizontal and vertical positioning will be accomplished using an Applanix POS MV 120 Position & Orientation system. The POS MV 120 package uses RTK (Real Time Kinematic) GPS technology which is capable of receiving both L1 & L2 frequencies as well as the GLONASS satellites. Equipment is capable of achieving positioning accuracies of up to +/-0.10', both horizontally and vertically. The RTK positioning

equipment is be capable of rapid update rates >5Hz, allowing it to be used for real-time heave compensation.

Figure 3.4 – POS MV 120

A two-antenna "moving baseline RTK" system is used by the POS to provide high-accuracy heading in addition to vessel position. Heading sensing equipment is capable of maintaining at least +/-0.10° heading accuracy under most conditions.

The final component of the system is a precision motion sensor which is used for vessel pitch and roll corrections. The sensor was calibrated/zeroed with the vessel at rest, and then mounting offsets were determined by a patch test performed prior to mobilization. Motion sensing equipment is capable of angular measurement accuracy of at least +/-0.04°.

3.5 Magnetometer Equipment

Geometrics G-882

The Geometrics G-882 Cesium Vapor Marine Magnetometer is used to locate ferrous objects by detecting distortions they create in the earth's magnetic field. The magnetometer's sensitivity is better than 1.0 gamma and sampling intervals are as low as 1hz. This translates to detection capabilities varying from >30m for 1 ton of steel to 10m for 30lb of steel.

Figure 3.5 – Geometrics G-882

The magnetometer is typically towed behind the survey vessel at a distance where readings are not affected by metal on the vessel itself. In deeper water it is towed beneath the surface, in shallower water it is towed on the surface by attaching it to floats.

4.0 Personnel

Chris Ebner, P.E. (MI & IL) was the Project Manager and Lead Hydrographer for the operation. Chris is a Hydrographer certified by the Hydrographic Society of America and the National Society of Professional Surveyors (THSOA/NSPS) with 15 years of experience in hydrographic surveying.

Wade Whitfield and Ed Lopez were the Project Surveyors for field data collection and processing. Wade and Ed have relevant education backgrounds, work experience, and extensive hands-on experience using the hydrographic systems described above.

5.0 Procedures

5.1 Mobilization & Launch

The Z-boat was transported to site by trailer along with the Jon boat. Both of these were deployed from Leppien Park just south of M-46 bridge. Both of these vessels had sufficient vertical clearance to pass under this bridge.

5.2 Calibrations & Checks

Immediately prior to multibeam, single-beam, and side-scan surveys, a sound velocity profile was measured using the Digibar Pro. The Digibar cast recorded velocities throughout the water column at 1' increments, which were applied to sonar data during collection and processing. Additionally, sound velocity at the sonar head was measured and applied in real-time using the head-mounted AML MicroX probe. A new Digibar cast was performed approximately every two hours, or any time the vessel moved to a new survey area.

Pre and post-survey water level checks were performed by comparing RTK GPS elevation outputs from the POS MV to water level shots from the Trimble RTK GPS Rover.

Bar checks for the Survey Vessel were performed regularly, by measuring returns off an aluminum plate held at a known depth below the sonar head. This is done to confirm the sonar head draft value as well as provide a documented physical check against Seaworks' electronic soundings.

Multibeam patch tests for the Survey Vessel were performed regularly in order to measure and confirm sensor mounting offsets. This is done by running survey lines in a predetermined pattern over a recognizable object such as a slope or pipeline. The data is then processed using a software routine to compute the pitch, roll, and heading angular offsets.

5.3 Field Procedures

<u>Topographic River Bank Survey</u>
After QC points were verified with the RTK GNSS rover, topographic data was collected on approximate 50' spaced transects. These transects captured top and toe of slope along with significant slope breaks. This procedure was used along the designated riverbank area. Data was collected from as close to the hydrographic survey limits as possible, up the bank to the existing fence line. Site features of interest were also mapped.

Multibeam Hydrographic Survey

After initial checks and calibrations, bathymetry lines were run parallel to the river centerline at line spacings of 10' - 30'. Survey line spacing was selected in order to provide complete bottom coverage by the multibeam swath at varying water depths. 100% overlap (200% coverage) was desired between passes in order to maximize density and provide redundant data for QC purposes. However this was not possible in shallow conditions due to narrow swath width.

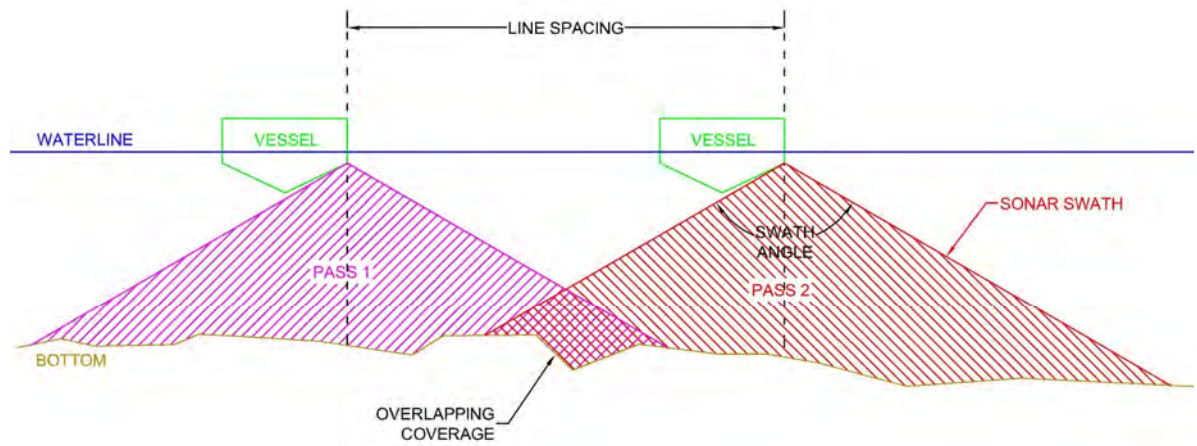

Figure 5.1 – Multibeam Swath Diagram (General)

Multibeam data was generally collected to water depths of as little as 3-4' and within 10-20' of banks. Additional coverage in very shallow water was achieved using a single-beam Z-Boat drone. The Z-Boat can generally collect data in 1.5-2' depths. From the extents of the Z-boat to fence line, topographic pole shots were used to complete bank/upland survey.

Sonar operating parameters - Bathymetry

- Sonar Frequency: 400Khz
- Swath Angle: 120°, increased to 130° in shallow water
- Sonar Mode
    - Equi-Distant Beams
    - Down/Bathy/Normal
- Survey Speed: 3.5-4.0Kts

Side-Scan Sonar Survey

Due to shallow water depths throughout the site, the side-scan sonar was hung directly over the side of the Jon Boat rather than towed below the surface. Optimal coverage obtaining 200% overlap was achieved using a minimum line spacing of 40'. This ensured there was redundant data for QC purposes, and that no objects of interest was lost within the nadir gap directly beneath the towfish. Survey line orientation was parallel to the river centerline. A minimal survey speed was used for optimal data density and resolution.

Side-scan sonar operating parameters:

- Sonar Frequency: 600/1,600Khz
- Coverage Width: 50/25m
- Survey Speed: 3.0Kts
- Tow Cable Length: 0 (hung directly from vessel)
- Average Altitude: 2-6m

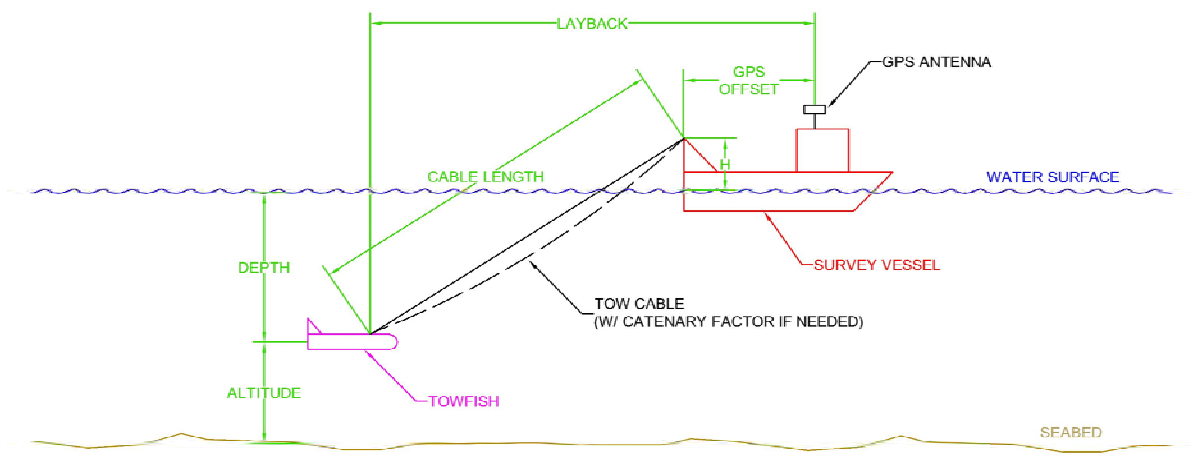

Figure 5.2 – Towed Sonar Layback

Magnetometer Survey

During the magnetometer phase, the magnetometer was towed approximately 30' behind the survey vessel. This distance was selected to minimize interference from the vessel itself, while still maintaining control to maneuver the vessel along banks and obstacles. Due to shallow depths, the magnetometer was towed at the surface by attaching it to foam floats. Survey line orientation was parallel to the river centerline with line spacing of no greater than 25'. The line spacing was selected to maximize coverage and minimize any chance of missing small targets between lines. (Same line spacing as specified in SOW)

Magnetometer operating parameters:

- Line Spacing: 25'
- Survey Speed: 3.5Kts
- Tow Cable Length: 30' (will be adjusted as-needed to maintain altitude)
- Average Altitude: 6-18'

Figure 5.3 –25' Transect Magnetometer Survey Lines

5.4 Processing & Deliverables

Following data collection, survey data was processed using the Hypack/Hysweep 2020 software package. Raw data was pre-filtered, then manually cleaned of unsuitable data and sonar noise. Positioning and motion sensing corrections was applied, then data was saved in Hypack Edited Data format for additional post-processing.

Data was exported in a non-reduced point cloud .XYZ format, as well as 1'x1' XYZ grid files reduced using Average sounding selection. The XYZ grid was used in Hypack's TIN utility to generate contour and geotiff files for inclusion in bathymetric plots.

Side scan data was reviewed in Chesapeake Technology SonarWiz. The water column was digitized and positioning and heading smoothing was applied. Time Varied Gain (TVG) values was adjusted as needed for the best visual appearance. Items of interest were manually identified and measured, and a target database was generated. Finally, individual side-scan passes were georeferenced and mosaicked into a 0.1' resolution Geotiff image, using Overlay and Average filter methods.

Magnetometer data was processed using Hypack 2020 Single-Beam editor. Data was converted to XYGamma format and processed in the TIN utility to generate a contour drawing showing deviations from background gamma values. Debris objects were identified and cross-referenced with side-scan data to assist with target identification.

6.0 Results and Discussion

Bathymetric Survey

The entire survey area was well covered using the above-mentioned technologies. The northeast, downriver portion of the site from the Mill St. Bridge to 2,300' upriver contains the deepest water, up to approximately 20'. This section is characterized by a system of submerged dikes and/or ponds that have a man-made appearance. The southwest, upriver remainder of the site is shallower, consisting of a 6-12' deep main channel, with shallower flat benches along either side.

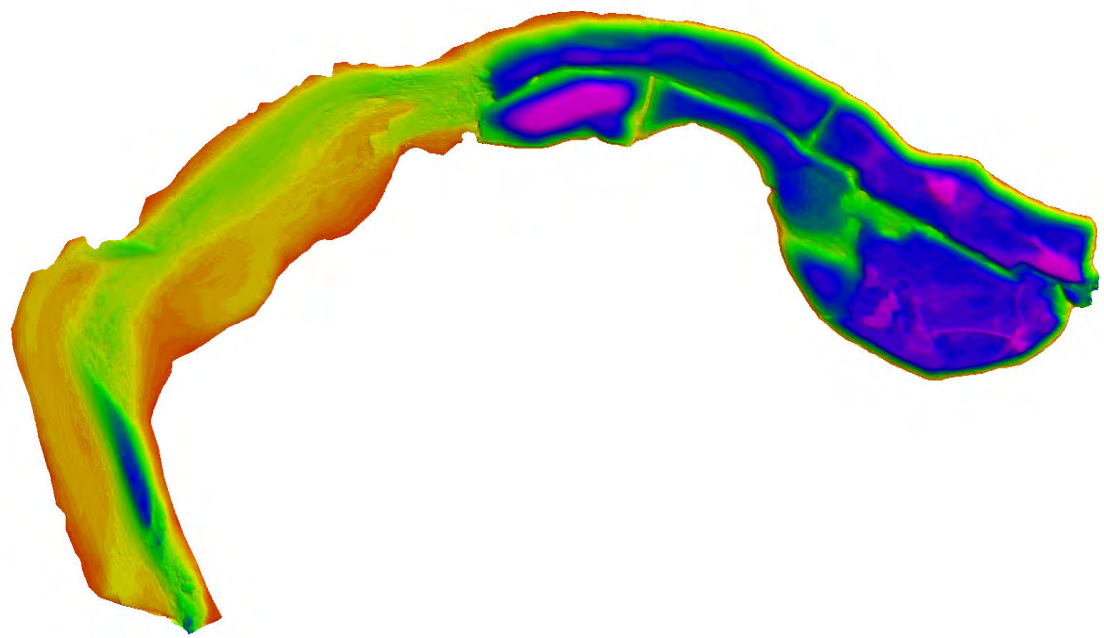

Figure 6.1 – 3-D Bathymetric Model of Site

Bathymetric data consists primarily of multibeam sonar, however single-beam sonar deployed from the Z-Boat was used in two sections of very shallow water at the southern, upriver portion of the site.

Beginning approximately 2,500' upriver of the Mill St. Bridge and continuing upriver to the Washington Ave. bridge, it appears that subaqueous vegetation is present. This is particularly found in the shallower benches along the river banks, but some is potentially present near the

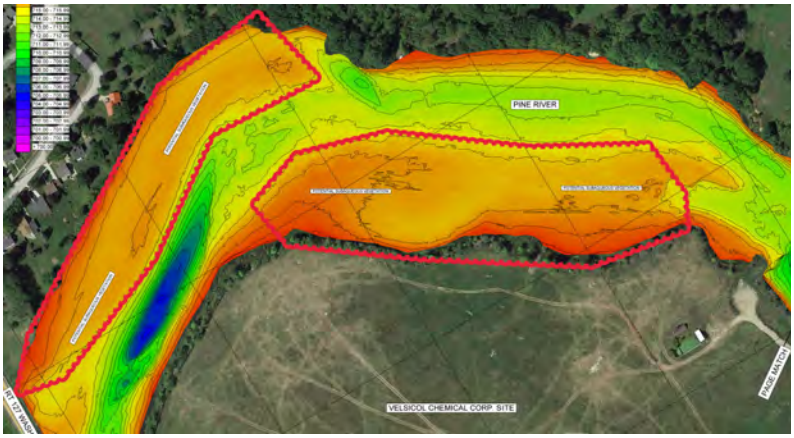

Figure 6.2 – Approximate extents of single-beam coverage (red)

main channel as well. The vegetation can be observed in the sidescan data and gives the bottom a "rough" appearance.

In early spring conditions, the vegetation typically lies flat and forms a "mat" along the bottom. Therefore the bathymetric data represents the acoustic bottom, however experience has shown that the sediment surface is typically a few inches deeper than the acoustic bottom in these conditions. The contours give a good representation of the river bed, however if the sediment surface is needed for volume computations an extensive grid of pole or leadline soundings may be recommended. Sections of the most obvious subaqueous vegetation are noted on the attached drawings.

Sidescan & Magnetometer Survey

Magnetometer data has been presented in two contour plots, showing magnetic contours in both 75nT and 200nT increments. The 75nT plot is useful for identifying weaker returns, while the 200nT is useful for viewing strong return objects without being covered up.

The sidescan sonar and magnetometer revealed numerous debris and utility-type reatures. The first debris item of note is a 12' by 6' rectangular shaped object, located approximately 1,500' upriver from the Mill St. bridge near the center of the river. It appears to be the shape of a small boat or car based the rounded end. (Figure 6.3). There are strong magnetometer returns around the object, so it is likely composed of some ferrous metal.

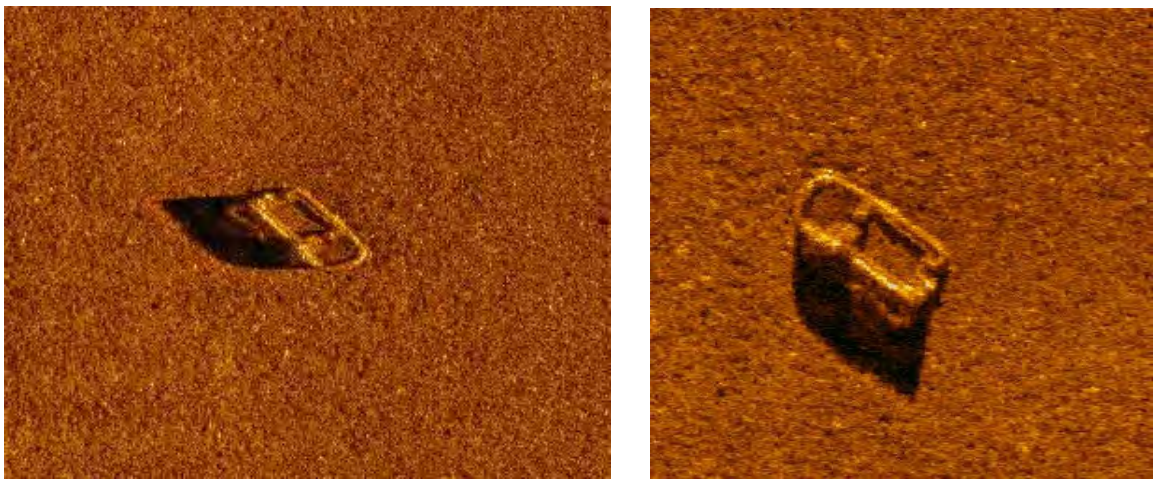

Figure 6.3 – Possible Small Boat/Car Debris

Approximately 2,400' upriver from the Mill St. bridge, an object with the appearance of an exposed pipe was located, roughly 60' in length. The object also appears to be ferrous in nature based upon strong magnetometer returns. The object has an approximate North to South orientation and crosses the river diagonally (Figure 6.4).

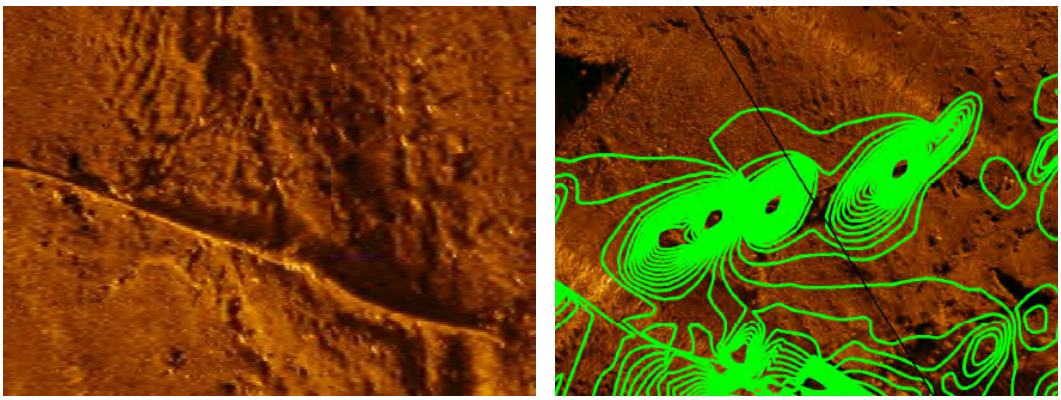

Figure 6.4 – Pipe Shaped Debris & Magnetometer Returns

In the

Another potential utility crossing was identified about 2,700' upriver from the Mill St. bridge. This was located by the magnetometer only, indicating that it is buried under the sediment. This crossing is oriented approximately west to east and crosses the river diagonally. (Figure 6.5)

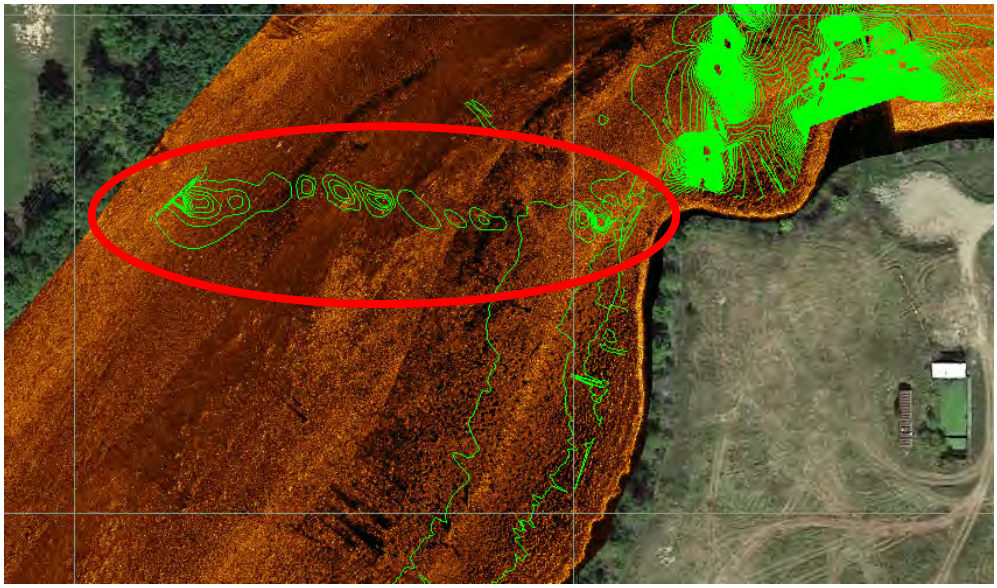

Figure 6.5 – Potential Buried Utility Crossing

In the upriver portion of the river another potential utility crossing was discovered based on magnetometer and sidescan data. This item is located approximately 800' downriver from the Washington Ave. bridge, also running approximately West to East. A portion of the utility is uncovered and can be seen on the river bottom. (Figure 6.6). It has the appearance of a thick cable or narrow pipe.

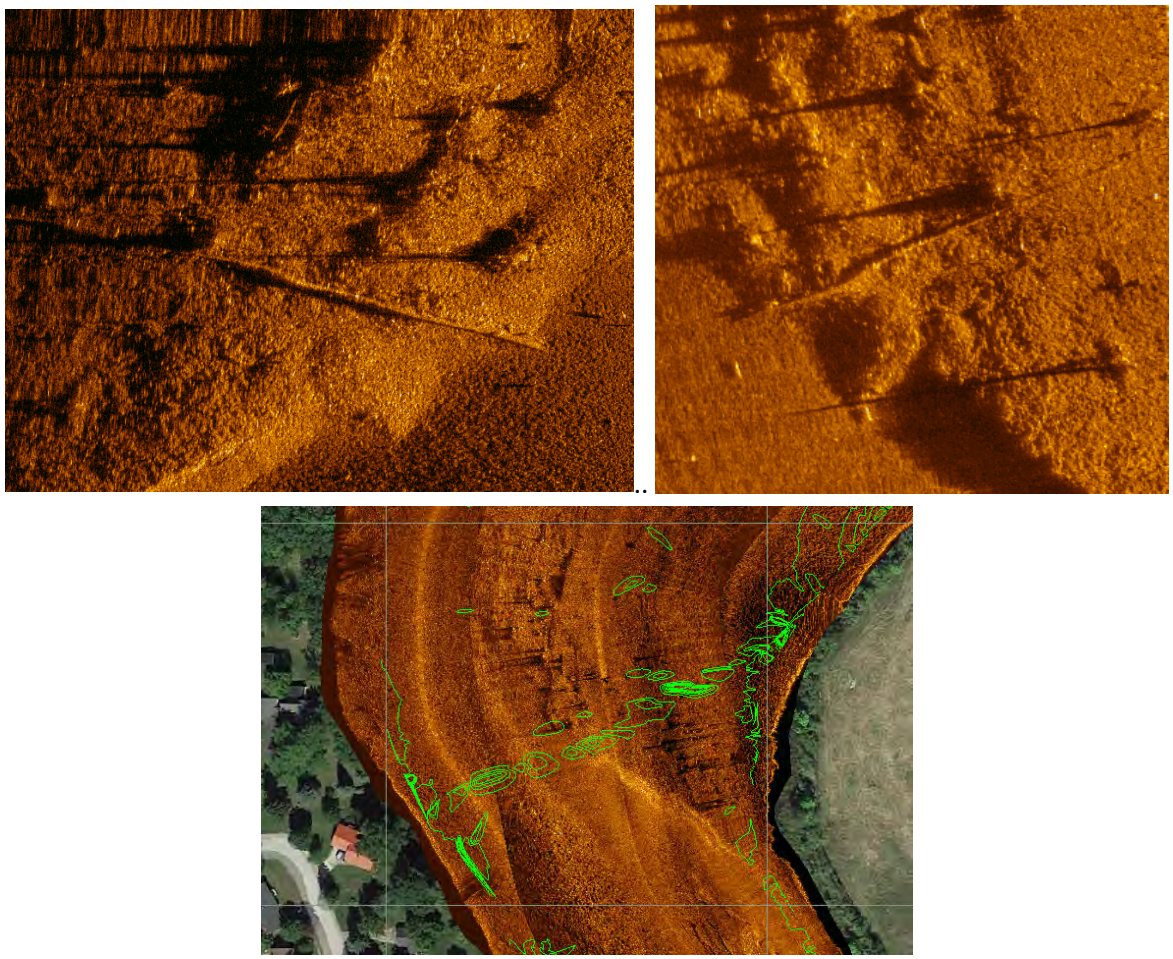

Figure 6.3 – Cable/Narrow Pipe Utility Crossing

Overall, the survey revealed a multitude of debris objects, both man-made and natural. Only the key items of interest have been described above. Data and plots should be carefully reviewed before any further design or construction activities take place.

Appendix H
Final Perimeter Drain and Geotechnical Investigation Data Evaluation

Memorandum

CH2M HILL, Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

Subject:	**Perimeter Drain and Geotechnical Predesign Investigation**
Project Name:	Velsicol Chemical Corporation Superfund Site Remedial Design
Contract Info:	Design and Engineering Services (DES), Contract Line Item Number 2 (CLIN 2) Contract Number 68HE0519D0007, Task Order Number 68HE0521F0106
Attention:	Tom Alcamo, U.S. Environmental Protection Agency (EPA), Region 5
From:	CH2M HILL, Inc. (CH2M)[1]
Date:	March 1, 2023
DCN:	GLAES-R5-21F0106-02008

CH2M prepared this Technical Memorandum (TM) for the EPA to describe the methods, procedures, and results of the perimeter drain and geotechnical predesign investigation at the Velsicol Chemical Corporation Superfund Site (site) located in St. Louis, Michigan. As described in the accepted technical proposal, *Technical Proposal – Velsicol Chemical Superfund Site, St. Louis, Michigan, Remedial Design* (Jacobs, 2021), additional data collection is required to design the remedial components described in the June 22, 2012, Record of Decision (EPA 2012). The data collected during this predesign investigation will assist in the completion of the perimeter drain and downgradient vertical barrier wall remedial designs (RDs). CH2M performed this work under Great Lakes Architect Engineer Services (GLAES) II Contract 68HE0519D0007, Task Order 68HE0521F0106.

1. Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses approximately 100 acres in St. Louis, Michigan, and includes the Former Plant Site (FPS) and a residential area referenced as the adjacent or nearby properties (ANP). The lead agency for the remedial investigation/feasibility study was the Michigan Department of Environment, Great Lakes, and Energy. EPA is the lead agency for the RD and remedial action (RA).

A chemical manufacturing plant formerly occupied the FPS from the mid-1930s until it was demolished in 1978. Industrial operations at the plant, which included manufacturing of pesticides and fire retardants, resulted in widespread contamination on the FPS. In 1982, the Velsicol Chemical Corporation entered into an administrative order of consent with the United States and the State of Michigan. Pursuant to the administrative order of consent, the Velsicol Chemical Corporation constructed a containment system for the FPS, which included the installation of a low-permeability cap and a 2-foot-thick, low-permeability slurry wall around the entire 52-acre FPS.

[1] CH2M HILL, Inc. is a wholly owned subsidiary of Jacobs Engineering Group Inc.

The FPS is fenced and is bordered on the south and east by the ANP, with Washington Avenue (M-46) along the southern edge. Watson and North Street mark the eastern edge, and the Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the FPS boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The site consists of the following four operational units (OUs):

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which a Proposed Plan was completed in August 2022
- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee Rivers, for which remedial investigation activities are ongoing

This TM presents the investigation activities completed in OU1 within the FPS (Figure 1).

2. Previous Investigations

The following documents summarize previous investigations completed on the FPS, and CH2M consulted these documents throughout the perimeter drain predesign investigation activities, as needed:

- *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2011)
- *Remedial Investigation Addendum Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2009)
- *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* (Weston, 2006)
- *Source Migration Investigation Report, Velsicol Chemical/Pine River Site, OU1, St. Louis, Michigan* (CH2M, 2005)

3. Objectives

The perimeter drain and geotechnical predesign investigation was performed to support the downgradient vertical barrier wall RD, which is included in the current task order. Data collected through the investigation will also be used to support the perimeter drain RD, which will be completed under a future task order. The following outlines the specific objectives for each part of the investigation:

- **The perimeter drain predesign investigation** was completed to evaluate the possible alignment of the perimeter drain, to provide additional till depth information, and to provide data to determine disposal requirement assumptions for soils that will be excavated and disposed offsite during perimeter drain construction.
- **The geotechnical predesign investigation** was performed to close multiple data gaps that CH2M identified during review of the historical boring logs near the proximity of the downgradient vertical barrier wall alignment during development of the Investigation Work Plan (CH2M, 2022b).

The objective of the geotechnical predesign investigation was to acquire the geotechnical data necessary to complete the downgradient vertical barrier wall RD.

4. Predesign Investigation Field Activities

CH2M conducted the perimeter drain predesign investigation field activities on June 15 and 16, 2022, and the geotechnical predesign investigation field activities between July 6 and 14, 2022.

Figure 2 shows the investigation area. To the extent possible, CH2M used soil borings along the downgradient portion of the FPS for both the perimeter drain and geotechnical portions of the predesign investigation. Investigation activities are detailed in the following subsections.

4.1 Perimeter Drain Drilling Investigation

To support the design elements and future waste management decisions for the site perimeter drain, CH2M evaluated the subsurface conditions from the ground surface to the underlying glacial till layer along the FPS perimeter. CH2M used a Geoprobe 7822 to advance a total of 20 soil borings to the top of the underlying till unit. Figure 2 shows the locations of the completed borings at select locations just inside the FPS slurry wall along the entire site perimeter. The soil borings were advanced using direct-push technology to depths ranging from approximately 14 to 20 feet below ground surface (bgs). CH2M selected the soil boring locations to provide sufficient spatial coverage for collecting soil samples representative of future materials to be disposed of offsite. Although previously completed soil borings provided sufficient till elevation data for the RD, CH2M logged soil borings and documented till elevations to supplement existing data.

The CH2M geologist logged soil from each boring in accordance with the Unified Soil Classification System (USCS) and recorded the information on field soil boring logs following procedures outlined in the Field Operating Procedure (FOP) *Soil Boring Logging* included in the *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site Remedial Design* (CH2M, 2022b). The logs note soil attributes such as color, particle size, consistency, moisture content, structure, plasticity, odor (if obvious), organic content (if visible), and depth to till. Attachment 1 contains the soil boring logs. The CH2M geologist also recorded significant observations in the fieldbook. In addition to USCS logging procedures, soil was continuously screened for organic vapors using a photoionization detector (PID) and selectively photographed at the discretion of the field geologist. The soil boring logs contain documentation of PID screening results.

4.1.1 In Situ Soil Waste Characterization Sample Collection

CH2M collected one in situ soil waste characterization sample from each perimeter drain soil boring. Each soil sample collected was biased toward the most impacted material as determined by visual and olfactory observation and PID measurements. Samples were analyzed for Toxicity Characteristic Leaching Procedure (TCLP) volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), TCLP pesticides, TCLP herbicides, TCLP metals, pH, and flashpoint.

4.2 Geotechnical Drilling Investigation

Historical site investigations were limited in geotechnical sample collection and testing for engineering properties that would support a barrier wall design. Therefore, CH2M performed a geotechnical-specific investigation to collect sufficient data to develop the downgradient vertical barrier wall RD.

The geotechnical investigation involved drilling and collecting samples from the shallow unit and the till unit, where the vertical barrier wall will be embedded, for geotechnical testing.

Figure 2 shows the locations of the seven geotechnical soil borings that were advanced from ground surface to up to 20 feet into the till unit at the locations. The till unit was generally encountered 20 feet bgs. The borings were drilled using a track-mounted Diedrich D-120 mud rotary drill rig. A CH2M geologist supervised the drilling work, logged the borings, and collected soil samples.

Standard Penetration Testing (SPT) was performed for all borings at 2.5-foot intervals from ground surface to 15 feet bgs, using a standard automatic and above-the-hole hammer for four consecutive 6-inch penetrations. The SPT facilitated estimation of in-place density and sample collection. After 15 feet bgs, CH2M collected samples at 5-foot intervals, depending on the subsurface soil conditions. Relatively undisturbed pitcher tube samples were taken within the till layer to characterize the in situ properties of soil, such as shear strength, to determine engineering soil parameters for the downgradient vertical barrier wall design. SPT samples and pitcher tube samples were collected in succeeding 5-foot intervals, with an SPT sample and test performed following the recovery of the pitcher tube without the need for interval drilling or reaming because of the larger diameter of the pitcher tube sample (approximately 3 inches) compared to the SPT sample (approximately 2 inches).

CH2M performed in-field pocket penetrometer tests on cohesive soil samples to measure the compressive strength of the soil and in-field Torvane tests on the tip of each pitcher tube sample to determine shear strength of the soil. The soil boring logs provided in Attachment 1 show the pocket penetrometer and Torvane test results.

The CH2M geologist logged soil from each boring in accordance with the USCS and recorded on the field soil boring logs following procedures outlined in the FOP *Soil Boring Logging,* included in the *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site Remedial Design* (CH2M, 2022b). The logs noted soil attributes such as color, particle size, consistency, moisture content, structure, plasticity, odor (if obvious), and organic content (if visible). Attachment 1 includes the geotechnical soil boring logs. The CH2M geologist also recorded significant observations in the fieldbook. Geotechnical boring logs also included the boring number, depth of drilling, sampling interval, sample type, and in situ testing results. Soil was continuously screened for organic vapors using a PID and selectively photographed at the discretion of the CH2M geologist.

4.2.1 Geotechnical Soil Sample Collection

SPT samples were collected every 2.5 feet to 15 feet and every 5 feet thereafter. Typically, at approximately 20 feet bgs, relatively fine-grained till material was encountered, in which case a pitcher sampler was recovered every 5 feet, with an SPT sample immediately following. CH2M collected, logged, and placed the SPT samples in clear jars. The pitcher sample tubes were observed, and the end tip soil was logged for classification and tested (pocket pen or Torvane) and sealed with end caps to prepare for transport for laboratory testing.

The following criteria were used to select geotechnical samples for laboratory analysis:

- An adequate sample volume in each Shelby tube was present for testing assignment.
- Soil samples collected within the shallow unit were selected for grain size, Atterberg limits, and moisture content testing based on the following:
  - The physical location of borings along the river (to provide adequate spacing along the downgradient site perimeter)

  - Depth intervals that corresponded to the estimated sediment layer elevations in the river. Estimated glacial till and river sediment elevations came from historical borings and current bathymetry results
- Soil and Shelby tube samples collected within the till unit were selected for grain size, Atterberg limits, moisture content, and triaxial shear testing based on the following:
  - The physical location of borings along the river to provide adequate spacing along the downgradient site perimeter)
  - The sample's elevation relative to the estimated till surface elevation in the river
  - Elevated SPT results, indicative of glacial till

Grain size, Atterberg limits, and moisture content tests were performed to confirm soil classifications, estimate hydraulic conductivity, and obtain information regarding general engineering properties. Triaxial tests were performed to obtain drained soil parameters from within the glacial till unit.

Based on these criteria, CH2M identified the following geotechnical samples for laboratory testing:

- Sixteen samples were collected and submitted for grain-size analyses (washed sieves) testing. Testing was performed on both shallow unit and till unit materials.
- Eleven samples were collected and submitted for Atterberg limits testing. Testing was performed on till unit material only.
- Nineteen samples were collected and submitted for moisture content testing. Testing was performed on both shallow unit and till unit materials.
- Four pitcher tube samples were submitted for consolidated undrained triaxial shear testing (three points each). Testing was performed on till unit material only.

4.3 Post-drilling Activities

Upon completion of core logging and sampling operations, soil cuttings from each boring, as well as drilling mud from the geotechnical borings, were drummed and handled in accordance with the FOP *IDW Handling and Disposal,* included in the *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site Remedial Design* (CH2M, 2022b). Soil borings were backfilled with hydrated bentonite and marked with a stake labeled with the boring number so that each location could be identified and surveyed. The drill rig, all nondisposable sampling equipment, and personnel were properly decontaminated following the FOP *Field Equipment Cleaning and Decontamination Procedures,* included in the *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site Remedial Design* (CH2M, 2022b).

4.4 Quality Assurance/Quality Control Samples

The CH2M *Final Uniform Federal Policy Quality Assurance Project Plan, Revision 2, Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan, Operable Unit 1—Remedial Design* (CH2M, 2022a) did not require field duplicate, matrix spike/matrix spike duplicate, field blank, and equipment blank samples for the in situ soil waste characterization samples or the geotechnical samples collected as part of this predesign investigation. Trip blanks and temperature blanks, however, were required and were included with waste characterization sample shipments.

4.5 Air Monitoring

The potential presence of VOCs within the FPS requires air monitoring using a PID to monitor the breathing zone near the drill rig, near the soil sample processing and sample collection table, and at the exclusion zone boundary. CH2M performed air monitoring in accordance with the *Health and Safety Plan, Velsicol Chemical Corporation Superfund Site, Former Plant Site Remedial Design, St. Louis, Michigan* (CH2M, 2021) during drilling and sampling activities. CH2M calibrated the PIDs (MiniRAE unit and MultiRAE unit) daily using compressed gas cylinders according to manufacturer instructions. No action level exceedances were observed during the field investigation.

5. Investigation-derived Waste

CH2M placed soil boring cuttings, personal protective equipment (PPE), and drilling mud from the mud rotary drill rig generated during predesign investigation activities in Department of Transportation-approved, 55-gallon drums.

CH2M labeled the drums with the site name, media (for example, soil, PPE, drilling mud), date generated, generator contact information, and drum number. CH2M inspected the drums weekly and documented the information on the Waste Inventory Log.

Seventeen drums were generated during the investigation of soil, drill cuttings, and drilling mud. Because CH2M took investigation-derived waste (IDW) samples from each of the perimeter drain locations, which corresponded with geotechnical boring locations, no additional soil IDW samples were collected. CH2M collected one IDW sample from the drum with the highest PID readings (PD010) to characterize the drilling mud. Samples were analyzed for TCLP VOCs, TCLP SVOCs, PCBs, TCLP pesticides, TCLP herbicides, TCLP metals, pH, and flashpoint. All waste was characterized as nonhazardous.

6. Field Equipment Decontamination

CH2M decontaminated nondisposable sampling equipment (drill rigs, drill tools, and associated equipment) with a water and Alconox mixture before commencing intrusive activities at each boring. CH2M provided access to a potable water source for drilling and decontamination activities at the site.

Final decontamination of the drill rig, rods, bits, and tools consisted of high-pressure, low-volume steam cleaning. Final decontamination activities occurred on the secondary containment pad located in the northeastern area of the site. CH2M transferred all decontamination water to the onsite 21,000-gallon storage tank located within the secondary containment pad. The 21,000-gallon storage tank stores water pumped from the dense nonaqueous phase liquid/groundwater collection system; CH2M pumps this tank for offsite disposal of its contents on a weekly basis. The decontamination liquid was disposed offsite with the dense nonaqueous phase liquid/groundwater collection system wastewater. US Ecology transported the waste to its facility in Detroit, Michigan.

7. Surveying

Spice Group Inc., a subcontracted Michigan-licensed surveyor, completed surveying activities on September 28, 2022, after completion of the investigation field activities. The survey consisted of collecting geospatial data for the soil borings. The survey results are included in Table 1 and were incorporated into Figure 2.

8. Deviations from the Investigation Work Plan

There were no deviations during the perimeter drain predesign investigation from the Investigation Work Plan (CH2M, 2022b). For the geotechnical investigation, CH2M reduced the number of soil borings from eight to seven because of field schedule constraints. Additionally, the number of geotechnical tests varied from what was listed in the Investigation Work Plan (CH2M, 2022b). The geotechnical tests that were chosen and performed were based on geotechnical engineer review of the soil boring logs and results of the in-field pocket penetrometer and Torvane tests.

9. Perimeter Drain Predesign Investigation Results

Attachment 2 includes the perimeter drain predesign investigation data and the *Analytical Data Summary of the Perimeter Drain Sampling at the Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan* (CH2M 2023). The waste characterization information collected is sufficient to support the perimeter drain RD. Based on review of the data, it can be assumed that the waste for the perimeter drain RA will be nonhazardous. The RD and supporting engineer's cost estimate should reflect this assumption; however, depending on the length of time between this field investigation and the perimeter drain RA, additional waste characterization sampling and analyses may be required during the RA.

10. Geotechnical Predesign Investigation Results

Attachment 3 tabulates the geotechnical test results. The geotechnical data were reviewed by a CH2M geotechnical engineer for quality, completeness, and applicability. Therefore, the geotechnical data were deemed sufficient for supporting the downgradient vertical barrier wall design, for which the preliminary design has been submitted.

11. Conclusion

The primary objective of the field activities and geotechnical investigation described in this TM was to provide sufficient waste characterization data and geotechnical data to be used in the perimeter drain and downgradient vertical barrier wall designs, respectively. The data collected during this investigation are sufficient to support these designs.

12. References

CH2M HILL, Inc. (CH2M). 2005. *Source Migration Investigation Report, Velsicol Chemical/Pine River Site, OU1, St. Louis, Michigan*.

CH2M HILL, Inc. (CH2M). 2021. *Health and Safety Plan, Velsicol Chemical Corporation Superfund Site, Former Plant Site Remedial Design, St. Louis, Michigan.* September.

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CH2M HILL, Inc. (CH2M). 2022b. *Perimeter Drain and Geotechnical Predesign Investigation Work Plan, Velsicol Chemical Corporation Superfund Site Remedial Design*. June.

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U.S. Environmental Protection Agency (EPA). 2012. *Record of Decision – Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan.* June.

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Weston Solutions of Michigan, Inc. (Weston). 2009. *Remedial Investigation Addendum Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. January.

Weston Solutions of Michigan, Inc. (Weston). 2011. *Feasibility Study Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Tables

Table 1. Survey Point Summary

Perimeter Drain and Geotechnical Predesign Investigation Technical Memorandum

Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan

Location ID	Northing	Easting	Ground Elevation (feet amsl)
PD001*	697485.946	13057449.791	729.666
PD002*	697372.984	13057019.021	727.089
PD003*	697256.452	13056729.117	729.469
PD004	697062.739	13056607.906	728.936
PD005	696840.021	13056491.412	727.704
PD006*	696553.777	13056309.635	729.035
PD007	696257.158	13056073.018	729.303
PD008*	696008.234	13056106.439	729.481
PD009*	695788.937	13056235.962	730.731
PD010*	695601.708	13056400.465	729.625
PD011	695488.064	13056608.416	731.602
PD012	695471.272	13056991.198	735.650
PD013	695576.594	13057047.129	735.611
PD014	695856.762	13057039.675	734.782
PD015	696051.090	13057041.602	732.867
PD016	696408.926	13057054.202	730.850
PD017	696612.145	13057201.543	727.696
PD018	696887.716	13057252.608	730.218
PD019	696889.238	13057582.115	730.338
PD020	696975.233	13058056.308	728.773

* Locations that had both IDW and geotechnical borings

Notes:

All coordinates for this project are established on the State Plane Coordinate System, Michigan South Zone based on the North American Datum of 1983 (2011), International Feet.

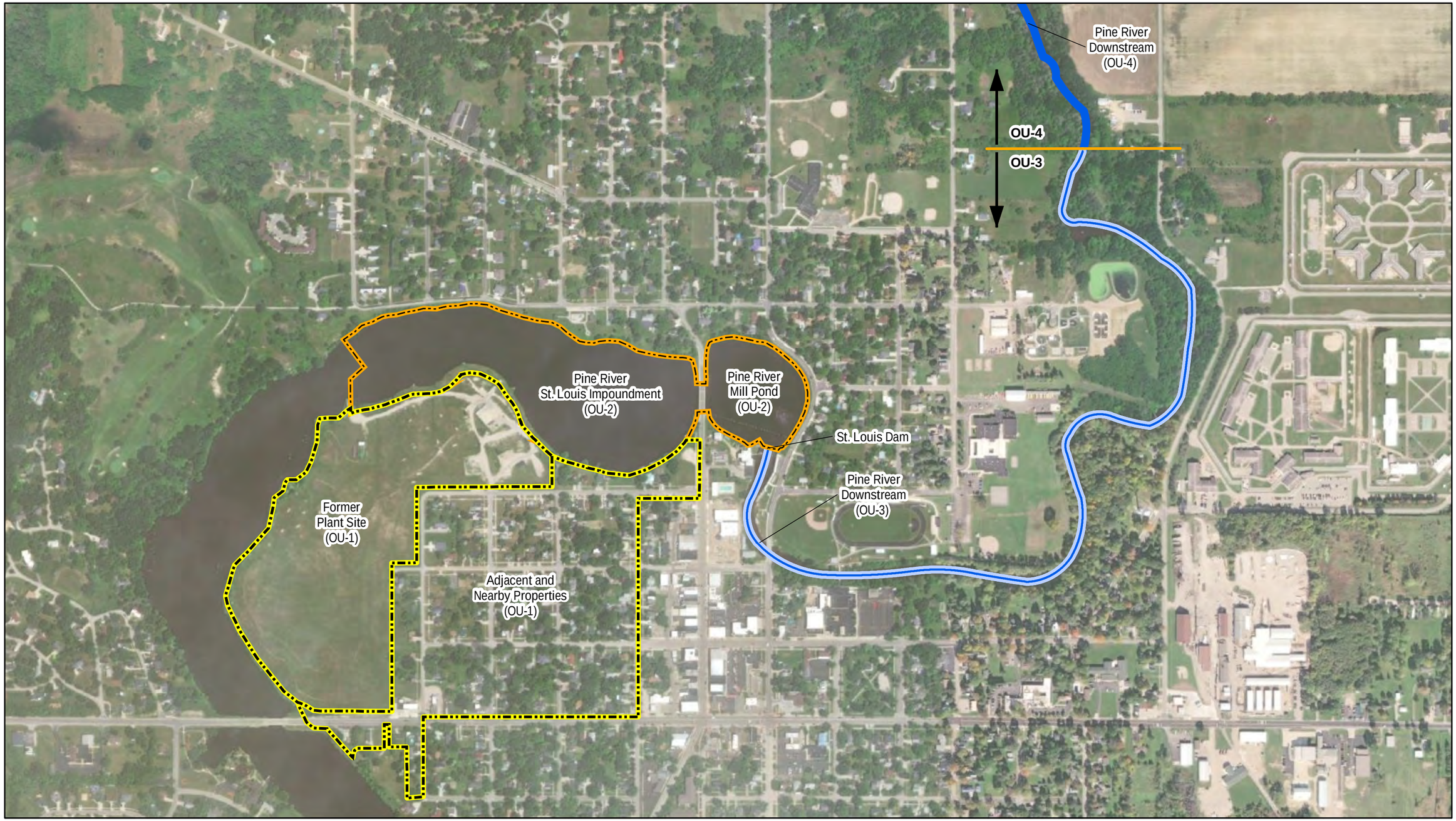
Survey Date: September 28, 2022

amsl = Above mean sea level

ID = identification

IDW = investigation-derived waste

Figures



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

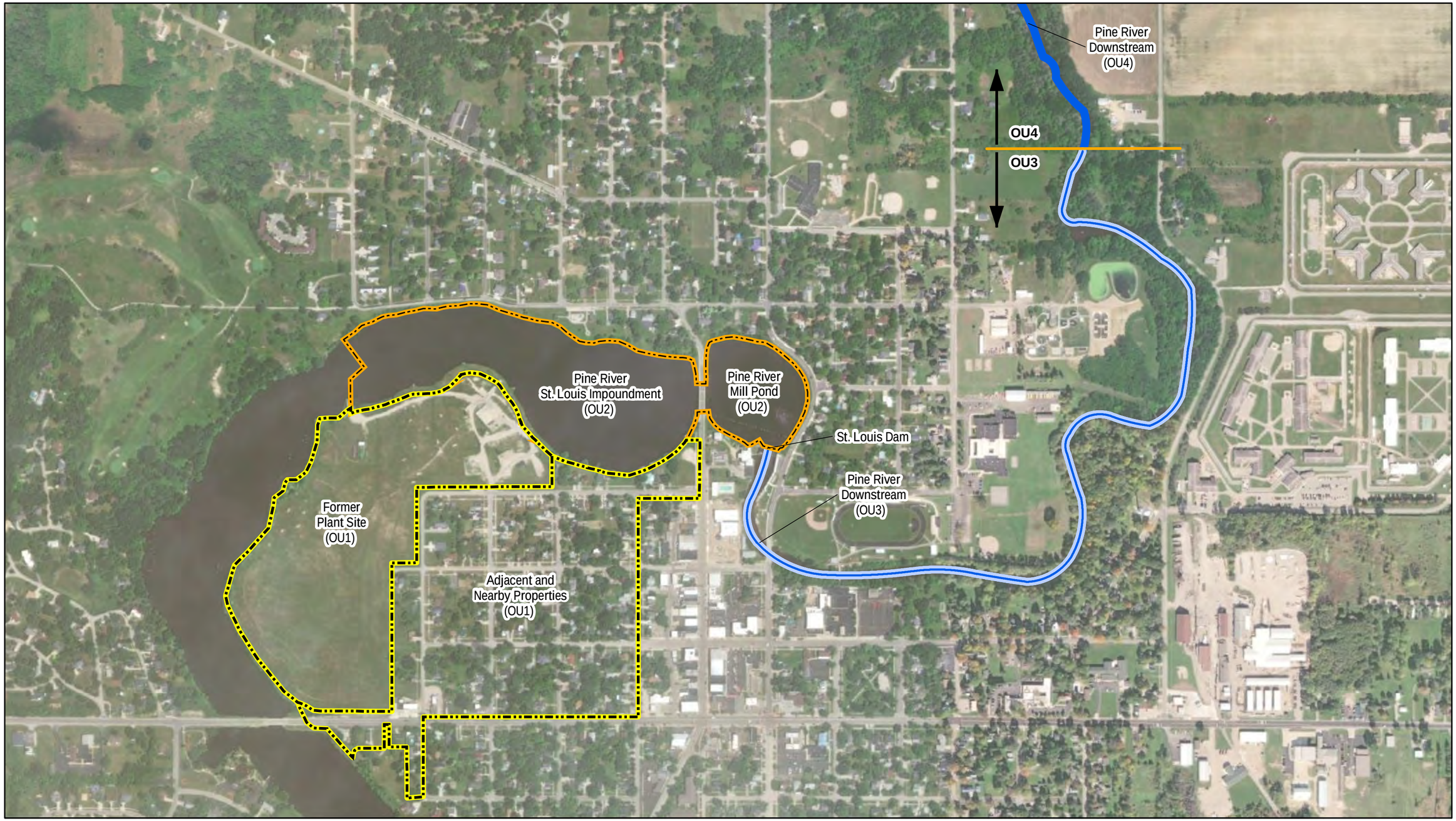
N

0 600 1,200
Feet

FIGURE 1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

ch2m

Document Path - MKE - \\Hercules: \\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\Reports\2021\QAPP\MapFiles\Figure01_Study Areas and Operable Units.mxd User Name: mpetersh Date: 8/27/2021 Time: 3:47:13 PM



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1-1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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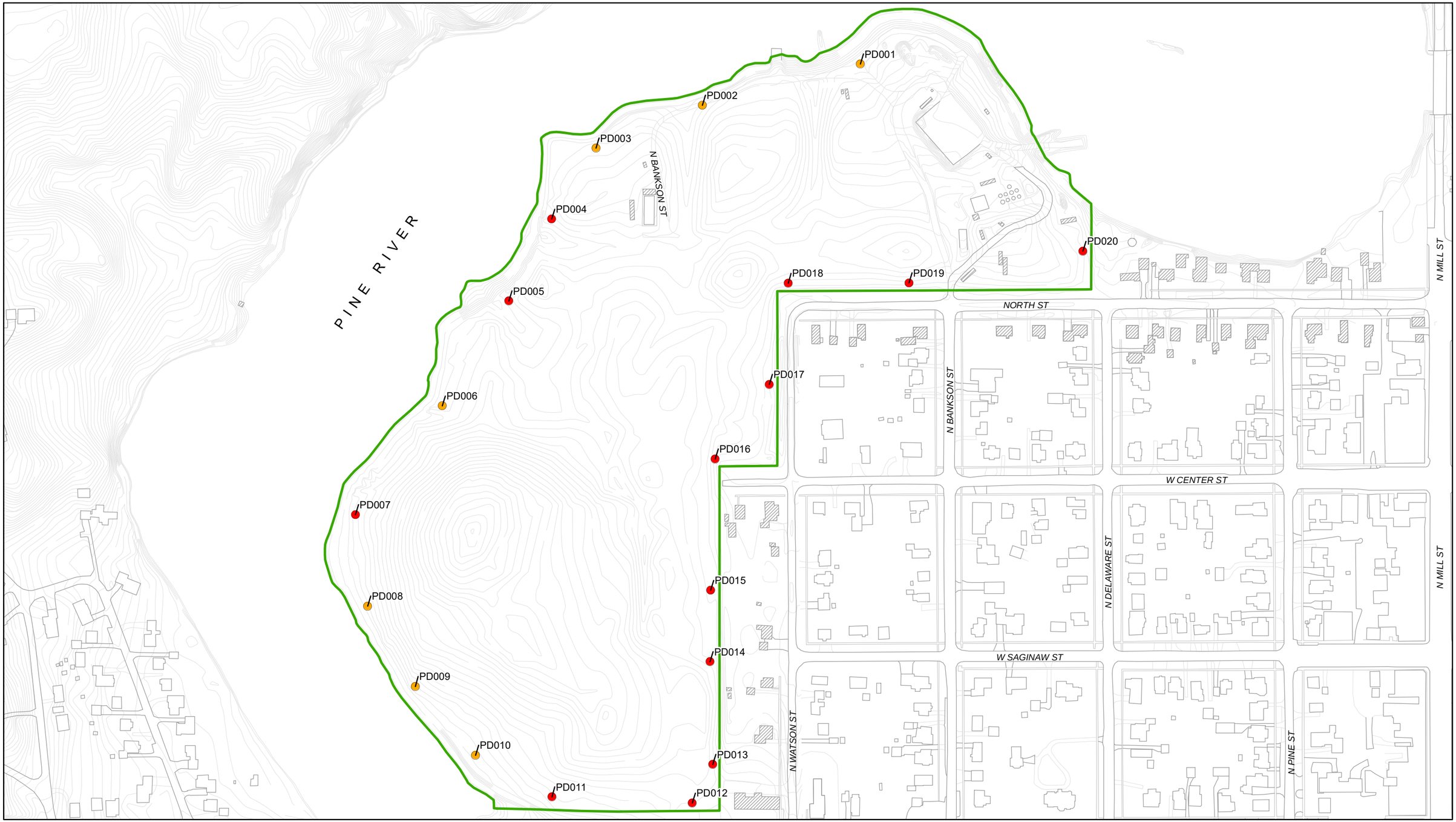

LEGEND

- Perimeter Drain Predesign Investigation Boring
- Perimeter Drain and Geotechnical Investigation Boring
- Former Plant Site

N

0 250 500

Approximate scale in feet

NOTES:

1. BASE MAP PROVIDED BY WESTON SOLUTIONS OF MICHIGAN, INC.
2. LAND SURVEY ELEVATIONS WERE REFERENCED TO NAVD OF 1988 FEET MSL. THE HORIZONTAL LOCATIONS WERE REFERENCED TO THE MICHIGAN STATE PLANE COORDINATE SYSTEM NAD83, INTERNATIONAL FEET - SOUTH (2113) ZONE.

FIGURE 2
Perimeter Drain and Geotechnical Predesign Investigation Soil Boring Locations
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

ch2m

\\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\MapFiles\2022\PD_WP\Figure_2_Soil_Boring_Locations.mxd

Attachment 1
Soil Boring Logs

PROJECT NUMBER	BORING NUMBER
D3542500	PD001

SOIL BORING LOG

PROJECT : Velsicol GLAES Contract - Perimeter Drain Investigation LOCATION : St. Louis, MI DATE/TIME: 6/15/2022 @ 0855

ELEVATION (ft amsl) : 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : Geoprobe 7822

WATER LEVELS : ~9.0' bgs LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.5 Topsoil	0	
	0-5.0	5.00	DPT1	0.5-5.0 (CL) Clay, brown, sand seam at 2.0-2.1, some silt, some gravel, dry top 2', damp 2'-5', hard, non plastic	0 0 0 0	
5						
	5.0-10.0	3.00	DPT2	5.0-7.0 No Recovery 7.0-9.0 (CL) Clay, Brown-gray, some sand and silt, trace gravel, damp to wet, stiff, low plastic to non plastic 9.0-9.5 (CL) Sandy clay, dark gray to black, wet, soft, non plastic 9.5-10.0 No Recovery	- - 0 0 0	Refusal at 9.5, step out 10' to SE
10						
	10.0-15.0	3.00	DPT3	10.0-12.0 No Recovery 12.0-14.2 (CL) Brown clay, interbedded with black sand (med. coarse), some staining with sand, stiff, low plastic, some silt, trace gravel, damp to wet 14.2-15.0 (CL) Clay, brown, some silt, trace gravel, low plastic, damp	- - 0 0 0	Slight odor Sample PD001 12-15 @ 0937' Composite sample from 10-18' submitted for laboratory
15						
	15.0-20.0	4.00	DPT4	15.0-16.0 No Recovery 16.0-17.0 (CL) Gray clay, trace silt and gravel, damp, stiff to medium stiff, medium plastic 17.0-19.0 (CL) Sandy clay, gray, trace gravel, wet, stiff, non plastic 19.0-20.0 (CL) Gray clay, hard, non plastic, trace sand and gravel, damp (till)	- 0 0 0 0	
20						
				End Of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD002

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/15/2022 @ 1000

ELEVATION (ft ams 727.09
DRILLING SUBCONTRAC Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : Geoprobe 7822

WATER LEVELS : ~8'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.50	DPT1	0-3.7 (CL) Brown Clay, dry, some sand and silt, trace gravel, hard, frangible 3.7-4.0 Pulverized Concrete 4.0-5.0 (CL) Sandy clay, dark brown to black, medium stiff, non plastic, damp	0 0 0 0 0	
5	5.0-10.0	3.50	DPT2	5.0-6.5 No Recovery .5 (CL) Sandy clay, dark brown to black, medium stiff, non plastic, damp, Wet 8.5-9.5 (SP) Clayey sand, fine to medium, medium dense, black, wet 9.5-10.0 Peat, some sand toward bottom	- 0 0 0 0	Sample PD002 7-9' @ 1020 Composite sample from 7-15' submitted for laboratory
10	10.0-15.0	5.00	DPT3	10.0-11.0 Peat, some sand toward bottom 11.0-13.0 (SP) Sand, fine, dark gray to brown, medium dense, wet, increased silt with depth 13.0-15.0 (CL) Clay, brown, medium plastic, firm becoming medium stiff with depth, trace gravel and silt	0 0 0 0 0	
15	15.0-20.0	2.00	DPT 4	15.0-18.0 No Recovery 18.0-18.5 (CL) Clay, brown, medium plastic, firm becoming medium stiff with depth, trace gravel and silt 18.5-18.7 (SP) Sand, medium coarse, wet, tan, medium dense 18.7-20.0 (CL) Clay, gray, stiff to hard, damp, trace gravel, non plastic, sandy gravel at bottom, (till)	- - - 0 0	
20				End Of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD003

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/15/2022 @ 1055
ELEVATION (ft ams 729.47
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~9.0'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	PID (ppm):	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) Comments:
	0-5.0	4.00	DPT1	0-1.0 Topsoil, sand, organics	0	
					0	
				1.0-4.0 (CL) Clay, brown, dry to damp with depth, some silt, trace gravel, hard to stiff, some magnesium oxide at bottom, increased gravel at bottom	0	
					0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	5.00	DPT2		0	
				5.0-7.5 (CL) Sandy clay, gray to dark gray, hard, non plastic, damp, trace gravel	0	
					0	
				7.5-9.0 (SP) Clayey sand, gray, damp, medium dense to dense, some gravel	0	
				9.0-9.5 (SP) Gravely sand, wet, medium dense, medium grain	0	
10				9.5-10.0 Magnesium Oxide with some sand		
	10.0-15.0	5.00	DPT3		0	
					0	
				10.0-15.0 Magnesium Oxide White to gray, black from 12.7-13.3, silty, wet, interbedded clay toward bottom, black 14.9-15.0 Peat	0	
					0	
15					80	Sample PD003 14-15' @ 1115 Composite sample from 13-19' submitted for laboratory analysis
	15.0-20.0	3.00	DPT4	15.0-17.0 No Recovery	0	
					0	
				17.0-17.3 Peat, black		
				17.3-19.0 (ML/CL) Silt grading to silty clay, brown, moist to wet, firm, low plastic, trace gravel	0	
					0	
				19.0-19.6 (SP) Fine sand, brown-gray, wet, medium dense, trace coarse sand		
20				19.6-20.0 (CL) Gray brown clay, stiff to hard, non plastic, trace gravel, (till)	0	
				End Of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD004

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/15/2022 @ 1250
ELEVATION (ft am: 728.94
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~8.0
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0-4.0 (CL) Brown clay, hard, dry, some sand decreasing with depth, frangible to non plastic	0 0 0 0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	2.50	DPT2	5.0-7.5 No Recovery	-	
				7.5-8.0 (CL) Brown clay, hard, dry, some sand decreasing with depth, frangible to non plastic	40	
				8.0-9.5 (SP) Sand, gray to dark gray at bottom, medium to coarse, wet, odor	70	
10				9.5-10.0 () Black, medium gravel, potential drain backfill, wet, odor	190	Sample PD004 9-10' @ 1300 Composite sample from 8-18' submitted for laboratory
	10.0-15.0	3.00	DPT3	10.0-12.5 No Recovery	-	
				12.5-13.5 Dark brown- black peat	77 9.5	
15				13.5-15.0 (SP) Sand, brown-tan, medium to coarse, silt seam at 14.5, wet, medium dense	12	
	15.0-20.0	3.00	DPT4	15.0-17.0 No Recovery	-	
				17.0-18.5 (SP) Fravely sand, brown tan, wet, medium dense, some silt	5.6	
				18.5-20.0 (CL) Clay, gray, stiff to hard, trace silt and gravel, damp, non plastic, (till)	6.5 0	
20				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD005

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/15/2022 @ 1325
ELEVATION (ft ams 727.7
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USEI Geoprobe 7822
WATER LEVELS : ~8.5
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0-3.5 (CL) Clay, brown, dry, frangible, trace gravel, some silt, hard, damp 3.0-3.5, wood at 3.2'	0	
					0	
					0	
				3.5-4.0 (SP) Sand, brown, fine to medium, trace coarse sand, moist, medium dense	0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	1.50	DPT2	5.0-8.5 No Recovery	-	
					-	
					-	
				8.5-10.0 (SP) Fine to medium sand, brown-tan, little silt, trace coarse sand and gravel, medium dense, wet	0	
10					0	
	10.0-15.0	5.00	DPT3	10.0-13.0 (SP) Fine to medium sand, brown-tan, little silt, trace coarse sand and gravel, medium dense, wet, coarsening with depth	0	
					0	
					0	
				13.0-15.0 (CL) Clay, brown, stiff, damp, non plastic, trace gravel, silt (ML) seam at 13.7-14.0, sandy clay 14.6-15	0	
15					0	
	15.0-20.0	3.00	DPT4	15.0-17.0 No Recovery	-	
					-	
				17.0-18.0 (SP) Sand, brown-gray, wet, medium dense, coarser with depth, medium- coarse, some fine	0	
				18.0-20.0 (CL) clay, gray, hard to stiff, non plastic, moist to damp, trace gravel, 0.2 seam of silt at top, (till)	0	Sample PD005 17-18' @ 1405 Composite sample from 10-18'
20					0	submitted for laboratory
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD006

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/15/2022 @ 1400
ELEVATION (ft am: 729.04
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~7.5/8
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0.0-4.0 (CL) Clay, brown, dry 0-2.5, damp 2.5-4.0, non plastic, some silt, hard, black seam at 3.5'	0 0 0 66	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	3.50	DPT2	5.0-6.5 No Recovery	-	
				6.5-7.7 (CL) Clay, brown, dry 0-2.5, damp 2.5-4.0, non plastic, some silt, hard	128 441	Sample PD006 7-8' @ 1440
				7.7-10.0 (SP) Sand, medium, medium dense, wet, dark brown to black, trace gravel	125 47	Composite sample from 5-10' submitted for laboratory
10						
	10.0-15.0	3.00	DPT3	10.0-12.0 No Recovery	- -	
				12.0-12.7 (SP) Dark gray to black, sand, fine-medium, trace gravel, wet, medium	0	
				12.7-15.0 (ML) Brown clayey silt, damp, medium stiff, non plastic, sand lense	0	
15				14.0-14.4 (wet)	0	
	15.0-20.0	3.00	DPT4	15.0-17.0 No Recovery	- -	
				17.0-17.5 (ML) Brown clayey silt, damp, medium stiff, non plastic, wet	60	
				17.0-20.0 (CL) Clay, gray, stiff to hard, some silt, trace gravel, moist to wet, clayey silt seam 18.0-18.4', non plastic, (till)	57 2	
20				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD007

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 0730

ELEVATION (ft ams 729.3
DRILLING SUBCONTRAC Coleman Engineering

DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822

WATER LEVELS : -
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.5 Topsoil, organics, dry	0	
	0-5.0	4.00	DPT1	0.5-4.0 (CL) Clay, brown gray, wet at 2.5, damp, trace gravel, hard	0 0 0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	4.00	DPT2	5.0-6.0 No Recovery	-	
				6.0-9.0 (CL) Clay, brown gray, damp, trace gravel, hard, Increased sand with depth	0 1.3 7.1	Sample PD007 8-9' @ 0745
10				9.0-10.0 (SP) Sand, gray to black, medium dense, medium, moist	3.9	Composite sample from 8-11' submitted for laboratory
	10.0-15.0	3.00	DPT3	10.0-12.0 No Recovery	- -	
				12.0-15.0 (CL) Sandy clay, brown, redish, hard, non plastic,damp, trace gravel, sandy gravel seam at 14.3'	1.6 0 2.5	
15						
	15.0-20.0	5.00	DPT4	15.0-16.5 (CL) Sandy clay, brown, redish, hard, non plastic,damp, trace gravel, silt seam at bottom	1.7 0	
				16.5-20.0 (CL) Clay, gray, hard, non plastic, damp, trace gravel and silt, (till)	1.5 4.6 3.2	
20						
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD008

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/16/2022 @ 0810

ELEVATION (ft am: 729.48
DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822

WATER LEVELS : ~8.4
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0.0-1.0 Topsoil, organics, clean sand bottom 0.2'	0	
					0	
				1.0-4.0 (CL) Clay, brown, hard, frangible, dry, trace gravel and sand	0	
					0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	3.50	DPT2	5.0-6.5 No Recovery	-	
					1.8	
				6.5-7.5 (CL) Clay, brown, hard, frangible, dry, trace gravel and sand	1.6	
				7.5-8.5 (CL) Sandy clay, dark gray, stiff, damp, non plastic	1.8	
10				8.5-10.0 (SP) Sand, dark gray-black, medium, medium dense, moist to wet, trace gravel	41.2	Sample PD008 9-10' @ 0830 Composite sample from 8-12'
	10.0-15.0	2.50	DPT3	10.0-12.5 No Recovery	-	submitted for laboratory
					-	
				12.5-13.0 (CL) Silty clay, brown, medium stiff, low plastic, moist	0.6	
					0.5	
15				13.0-15.0 (ML) Clayey silt, brown to tan, slight mottling, medium stiff, moist, non plastic	0.3	
	15.0-20.0	3.50	DPT4	15.0-17.5 No Recovery	-	
					-	
				17.5-18.4 (SP) Sand, fine-medium, moist, medium dense, trace gravel	0.7	
				18.4-19.0 (CL) Sandy clay, brown, hard, damp, non plastic, trace gravel and	2.3	
20				19.0-20.0 (CL) Clay, gray, hard, non plastic, damp, (till)	0	
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD009

SOIL BORING LOG

PROJECT : Velsicol GLAES Contract - MW-19 Area RDI
LOCATION : Velsicol FPS - Perimeter Drain
DATE/TIME: 6/16/2022 @ 0850
ELEVATION (ft am: 730.73
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~6.8'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.5 Topsoil, organics, dry, large rock at bottom	0	
	0-5.0	3.50	DPT1	0.5-3.5 (CL) Clay, brown, hard, some sand, trace gravel, non plastic, damp	0 0 0	
5				3.5-5.0 No Recovery	-	
	5.0-10.0	3.50	DPT2	5.0-6.5 No Recovery 6.5-6.8 (CL) Clay, brown, hard, some sand, trace gravel, non plastic, damp 6.8-9.5 (SP) Sand, brown-dark gray, medium-fine, medium dense, wet	- 1.2 1.6 4.3	
10				9.5-10.0 (CL) Silty clay, gray, wet, medium stiff, low plastic	3	
	10.0-15.0	3.00	DPT3	10.0-12.0 No Recovery 12.0-14.5 (CL) Silty clay, gray, medium stiff, low plastic, damp to wet	- - 2 6.2	
15				14.5-15.0 (ML) Silt, gray, hard, non plastic, damp, some coarse sand at top	9.1	Sample PD009 14-15' @ 0905 Composite sample from 7-10' submitted for laboratory
	15.0-20.0	4.00	DPT4	15.0-16.0 No Recovery 16.0-20.0 (CL) Clay, gray, hard, damp, some wet areas with sand, trace gravel, non plastic, fine sand seam top 0.2', (till)	- 0.7 1 0.5 0.4	
20				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD010

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 0920
ELEVATION (ft am: 729.63
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~8.5'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0.0-0.5 Topsoil, organics	0	
				0.5-4.0 (CL) Clay, brown-gray, hard, dry (some moisture at top), non plastic, trace sand and gravel and silt	0	
					0	
					0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	5.00	DPT2	-7.0 (CL) Clay, brown-gray, hard, dry , non plastic, trace sand and gravel and	0	
					62	
				7.0-8.5 (CL) Clay, dark gray, moist, increase sand at bottom, low plastic, stiff	11.2	
					60.6	
10				8.5-10.0 (SP) Sand, dark gray-black, fine-medium, medium dense, wet, clay seam 9.5-9.7	19.3	
	10.0-15.0	3.50	DPT3	10.0-11.5 No Recovery	-	
				11.5-13.0 (CL) Clay, dark gray, stiff, medium plastic, moist to wet, trace silt, hydrocarbon odor	186	Sample PD010 11-12' @ 0935 NTK (-)
					26.6	Composite sample from 8-15' submitted for laboratory
				13.0-14.5 (CL) Clay, brown, hard, non plastic, damp, some silt, trace gravel	11.6	
15				14.5-15.0 (ML) Silt, tan gray, hard, non plastic, sand seam 14.9-15.0	15.8	
	15.0-20.0	3.50	DPT4	15.0-16.5 No Recovery	-	
				16.5-18.0 (SP) Sand, tan, fine to medium, coarsening with depth, medium dense to loose, wet, fine gravel 17.5-18.0	15.8	
					1.5	
				18.0-20.0 (CL) Clay, gray, hard, non plastic, trace silt and gravel, damp, (till)	0	
20					0	
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD011

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/16/2022 @ 1000
ELEVATION (ft ams 731.6
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~9.5
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	3.50	DPT1	0-0.8 Topsoil, organics, dry	0	
				0.8-3.5 (CL) Clay, brown, some sand and silt, rock at 2.3, damp, stiff to hard, non plastic	0	
					0	
					0	
5				3.5-5.0 No Recovery	--	
	5.0-10.0	4.00	DPT2	5.0-6.0 No Recovery	--	
				6.0-10.0 (CL) Silty clay, brown, trace sand and gravel, stiff, low plastic, moist, wet sand seam 4.2-4.5	0	
					0	
					0	
10					0	Sample PD011 9-10' @ 1015 Composite sample from 6-10' submitted for laboratory
	10.0-15.0	4.00	DPT3	10.0-12.0 (ML) Clayey silt, gray, dry, trace gravel, hard, non plastic	--	
				12.0-14.0 (CL) Clay, gray, hard, non plastic, some silt, trace gravel, damp-dry, (till)	0	
					0	
					0	
15				End of Boring 14' bgs	0	
20						
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD012

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 1035
ELEVATION (ft am: 735.65
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : -
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.7 Topsoil, clayey, organics, some rock, sand at bottom	0	
	0-5.0	5.00	DPT1	0.7-4.5 (CL) Brown clay, hard, non plastic, dry, increased gravel 3.0-4.0	0 0 0	
5				4.5-5.0 (ML) Sandy silt, black, medium dense, dry	1.2	Sample PD012 4-5' @ 1050 Composite sample from 4-10' submitted for laboratory
	5.0-10.0	2.50	DPT2	5.0-7.5 No Recovery 7.5-8.5 (ML) Sandy silt, black, medium dense, dry, (Gray 7.5-8.0) 8.5-9.7 (SP) Fine sand, brown, medium dense, moist, trace gravel, rock	- - 0 0 0	
10				9.7-10.0 (CL) Silty clay, brown gray, medium stiff, damp, non plastic, trace		
	10.0-15.0	4.00	DPT3	10.0-11.0 No Recovery 11.0-15.0 (CL) Clay, gray, mottled, stiff, medium plastic, damp, trace gravel, (Sand seam 14.5, wet), some silt	- 0 0 0 0	
15						
	15.0-20.0	5.00	DPT4	15.0-20.0 (CL) Gray clay, hard, non plastic, damp, trace silt and gravel, (till)	0 0 0 0 0	
20				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD013

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/16/2022 @ 1215
ELEVATION (ft am: 735.61
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~7.5'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.6 Topsoil, organics, sandy, dry	0	
	0-5.0	4.50	DPT1	0.6-4.5 (CL) Clay, brown-gray, hard, non plastic, dry, trace gravel, some sand and silt	0 0 0 0	
5				4.5-5.0 No Recovery		
	5.0-10.0	4.00	DPT2	5.0-6.0 No Recovery	-	
				6.0-7.5 (ML) Sandy silt, black, moist, medium dense/stiff, low plastic	2.2 2	Sample PD013 6-7' @ 1230 Composite sample from 6-10' submitted for laboratory
				7.5-10.0 (SP) Silty sand, brown, decreasing silt with depth, wet, medium dense, trace gravel	0 0	
10						
	10.0-15.0	3.00	DPT3	10.0-12.0 No Recovery	- -	
				12.0-15.0 (CL) Silty clay, firm, medium plastic, trace gravel, wet sand seam at 14.3, fine sand at bottom	0 0 0	
15						
	15.0-20.0	4.00	DPT4	15.0-16.0 No Recovery	-	
				16.0-18.8 (CL) Silty clay, firm, medium plastic, trace gravel, fine sand at bottom	0 0 0	
20				18.8-20.0 (ML) Clayey silt, hard, non plastic, damp, gray, (till)	0	
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD014

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/16/2022 @ 1255
ELEVATION (ft am: 734.78
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : -
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	PID (ppm):	Comments:
				0-0.5 Topsoil, organics, dry, sandy	0	
	0-5.0	3.50	DPT1	0.5-3.5 (CL) Clay, brown-gray, some silt and sand, trace gravel, some slurry wall material at 3.1', dry to damp	0 0 72	
5				3.5-5.0 No Recovery	-	
	5.0-10.0	2.00	DPT2	5.0-8.0 No Recovery	- - -	
				8.0-9.0 (CL) Sandy clay, gray, soft, moist, medium plastic	179	
10				9.0-10.0 (SP) Sand, brown, fine - medium, medium dense, moist, odor	1423	Sample PD014 9-10' @ 1320 Composite sample from 8-11' submitted for laboratory
	10.0-15.0	4.00	DPT3	10.0-11.0 No Recovery	-	
				11.0-13.5 (CL) Clay, gray, stiff, low plastic, moist, trace gravel and silt	55.3 41.2	
				13.5-14.0 (SP) Sand, gray, fine with some clay, medium dense	7.3	
15				14.0-15.0 (CL) Clay, gray, stiff, low plastic, moist, trace gravel and silt, (till)	1.9	
	15.0-19.0	5.00	DPT4	15.0-20.0 (CL) Clay, gray, stiff, low plastic, moist, trace gravel and silt, sand seam 18.0-18.2, increased silt toward bottom, (till)	5.3 2.9 2.2 0	
20					0	
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD015

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : ST. Louis, MI
DATE/TIME: 6/16/2022 @ 1333
ELEVATION (ft am: 732.87
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~8'
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.8 Topsoil, organics, dry, sand at bottom	0	
	0-5.0	5.00	DPT1	0.8-3.5(CL) Clay, gray, hard, non plastic, some gravel, increase silt with depth	0 12.8	 Sample PD015 2-3' @ 1350
					8.5	Composite sample from 2-9' submitted for laboratory
5				3.5-5.0 (SP) Brown sand, medium, medium dense, gravel at top, damp	1.1	
	5.0-10.0	3.00	DPT2	5.0-7.0 No Recovery	- -	
				7.0-8.5 (SP) Brown sand, fine to medium, medium dense, damp, coarser at bottom	0 0	
10				8.5-10.0 (CL) Clay, gray, stiff, low plastic, damp	0	
	10.0-15.0	5.00	DPT3	10.0-11.5 (CL) Clay, gray, stiff, low plastic, damp	0 0	
				11.5-13.5 (ML) Silt, gray, very wet, medium dense, fine sand at bottom	0 0	
15				13.5-15.0 (CL) Clay, gray, damp, hard, non plastic, trace silt and gravel, (till)	0	
	15.0-20.0	5.00	DPT4	15.0-20.0 (CL) Clay, gray, damp, hard, non plastic, trace silt and gravel, (till)	0 0 0 0	
20				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD016

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 1405
ELEVATION (ft am: 730.85
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~9.0
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0-0.5 Topsoil, sandy 0.5-4.0 (CL) Clay, gray, dry, increased sand at top, frangible, trace silt and gravel 4.0-5.0 No Recovery	0.0 0.0 0.0 0.0 -	Sample PD016 3-4' @ 1420 Composite sample from 3-15' submitted for laboratory
5	5.0-10.0	1.00	DPT2	5.0-9.0 No Recovery 9.0-10.0 (CL) Sandy clay, soft, wet, medium plastic	- - - - 0.0	
10	10.0-15.0	1.00	DPT3	10.0-14.0 No Recovery 14.0-15.0 (CL) Sandy clay, soft, wet, medium plastic	- - - - 0.0	
15	15.0-20.0	4.00	DPT4	15.0-19.0 (CL) Clay, gray, hard, non-plastic, damp, trace silt and gravel, (sand seam 18.2-18.7, wet), (till) End of Boring 19' bgs	0.0 0.0 0.0 0.0	
20						
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD017

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 1435
ELEVATION (ft ams 727.7
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~6.5
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0-0.6 Topsoil, organics, sand at bottom	0	
				0.6-3.2 (CL) Clay, brown, hard, non plastic, trace gravel, some silt	0	
				3.2-4.0 (SP) Fine sand, black to gray, some silt, medium dense, damp	0	Sample PD017 3-4' @ 1450 Composite sample from 3-8'
5				4.0-5.0 No Recovery	-	submitted for laboratory
	5.0-10.0	3.50	DPT2	5.0-6.5 No Recovery	-	
				6.5-8.0 (SP) Sand, gray, medium, medium dense, wet, some gravel at bottom with coarse sand	0	
				8.0-10.0 (CL) Clay, brown to gray, stiff, low plastic, some silt, damp, till at 9'	0	
10					0	
	10.0-15.0	5.00	DPT3	10.0-15.0 (CL) Clay, gray, very stiff, non plastic, trace gravel, damp, (till)	0	
					0	
15					0	
				End of Boring 15' bgs		
20						
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD018

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation
LOCATION : St. Louis, MI
DATE/TIME: 6/16/2022 @ 1520
ELEVATION (ft am: 730.22
DRILLING SUBCONTRACTOR : Coleman Engineering
DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822
WATER LEVELS : ~7.5
LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
	0-5.0	4.00	DPT1	0-3.0 (CL) Clay, brown, dry, trace gravel, some sand, frangible, hard	0	
					0	
					0	
				3.0-4.0 (SP) Sand, dark brown, gravelly top 0.3', damp, medium, medium dense	0	
5				4.0-5.0 No Recovery	-	
	5.0-10.0	2.50	DPT2	5.0-7.5 No Recovery	-	
					-	
					0	
				7.5-10.0 (SP) Sand, dark brown, fine to medium, some coarse sand, wet, more fine sand at bottom, trace gravel, medium dense	0	Sample PD018 8-9' @ 1530
10					0	Composite sample from 3-10' submitted for laboratory
	10.0-15.0	2.00	DPT3	10.0-13.0 No Recovery	-	
					-	
					-	
				13.0-15.0 (SP) Sand, tan, fine to medium, very wet, loose to medium dense, trace gravel	0	
15					0	
	15.0-20.0	2.00	DPT4	15.0-18.0 No Recovery	-	
					-	
					-	
				18.0-20.0 (CL) Clay, gray, very stiff, non plastic, trace gravel and silt, damp, (till)	0	
20					0	
				End of Boring 20' bgs		
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD019

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation LOCATION : St. Louis, MI DATE/TIME: 6/16/2022 @ 1547

ELEVATION (ft am: 730.34 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822

WATER LEVELS : ~7.5 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.2 Topsoil, organics, dry	0	
				0.2-2.2 (CL) Clay, gray, dry, some sand and gravel, hard, frangible	0	
	0-5.0	4.00	DPT1	2.2-4.0 (SP) Sand, fine to medium, medium dense, brown-tan, increase clay toward bottom, damp	0	
5				4.0-5.0 No Recovery	0	
					-	
				5.0-7.5 No Recovery	-	
	5.0-10.0	2.50	DPT2		0	
				7.5-10.0 (SP) Sand, brown-tan, wet, some coarse sand, medium dense	0	
10					0	
				10.0-11.5 No Recovery	-	
	10.0-15.0	3.50	DPT3	11.5-14.0 (SP) Sand, brown-tan, wet, some coarse sand, medium dense, gray at bottom	0	
					0	Sample PD019 13-14' @ 1600
					5.1	Composite sample from 8-14' submitted for laboratory
15				14.0-15.0 (CL) Clay, gray, very stiff, damp, non plastic, trace gravel and silt, (till)	1.8	
				End of Boring 15' bgs		
20						
25						

PROJECT NUMBER	BORING NUMBER
D3542500	PD020

SOIL BORING LOG

PROJECT : Velsicol GLAES - Perimeter Drain Investigation LOCATION : ST. Louis, MI DATE/TIME: 6/16/2022 @ 1615

ELEVATION (ft ams 728.77 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USE Geoprobe 7822

WATER LEVELS : ~9.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	SOIL DESCRIPTION (SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINEROLOGY.)	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.) PID (ppm):	Comments:
				0-0.5 Topsoil, Organics	0	
				0.5-2.2 (CL) Clay, gray, hard, dry, non plastic, trace silt and gravel	0	
	0-5.0	3.00	DPT1	2.2-3.0 (SP) Sand, tan, medium, medium dense, some gravel, damp	0	Sample PD020 2-3' @ 1630 Composite sample from 10-15'
					-	submitted for laboratory
				3.0-5.0 No Recovery	-	
5					-	
					-	
	5.0-10.0	1.00	DPT2	5.0-9.0 No Recovery	-	
					-	
				9.0-10.0 (GW) Gravel, medium with 0.2' of sand at top, wet, mostly rounded, some sand at bottom	0	
10					0	
					0	
	10.0-15.0	5.00	DPT3	10.0-14.7 (SP) Sand, tan, medium, medium dense, wet, trace gravel	0	
					0	
				14.7-15.0 (CL) Clay, gray, very stiff, non plastic, damp, trace silt and gravel (till)	0	
15						
				End of Boring 15' bgs		
20						
25						

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5	SPT1	15,42,20,26	0-1.0 Pulverized Concrete 1-1.5 (CL) Sandy Clay, Brown, gravel, some silt, dry, hard, more sand at bottom 1.5-2.0 No Recovery	NA	NA	NA	No Sample
	2.5-4.5	1.5	SPT 2	13,9,9,8	2.5-4.5 (CL) Sandy Clay, Brown, gravel, some silt, dry, hard, more sand at bottom	NA	NA	NA	NA
5	5-7	1	SPT3	7,5,3,2	5.0-6.0 No Recovery 6.0-7.0 (CL) Sandy Clay, gray, trace gravel, wet, damp, medium stiff, low plastic	NA	NA	NA	(5-7) Sample @ 0955
	7.5-9.5	0.5	SPT 4	WOR,WOR,1,2	7.5-9.0 No Recovery 9.0-9.5 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(7.5-9.5) Sample @ 1015
10	10-12	0.5	SPT5	WOR,WOR,1 for 1'	10.0-11.5 No Recovery 11.5-12.0 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(10-12) Sample @ 1025
	12.5-14.5	0.5	SPT6	WOR x 4	12.5-14.0 No Recovery 14.0-14.5 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(12.5-14.5) Sample @ 1045
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	0.2	SPT 7	WOR x 4	15.0-16.8 No Recovery 16.8-17.0 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(15-17) Sample @ 1130
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	1.5'	ST 1	NA	20-23 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	NA	1kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1300
	23-25	1.5	SPT8	12,12,26,27	23.0-23.5 No Recovery 23.5-25 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25 kg/cm2	NA	(23-25) Sample @ 1315
25	25-28	-	ST2	NA	25-28 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25 kg/cm2	Shelby Tube 25-28	(25-28) Sample @ 1513
	28-30	1.5	SPT 9	38,45,50/0.4	28.0-28.5 No Recovery 28.5-30.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, small wet gravel layer top 0.2', till	NA	NA	NA	(28-30) Sample @ 1530
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	-	ST 3	NA	30-33 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25+ kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1615 (Laboratory Sample # ST (A, B, C))
	33-35	1.8	SPT10	37,40,41,50/0.4	33.0-33.2 No Recovery 33.2-35.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, sand seam bottom 0.2', till	NA	NA	NA	(33-35) Sample @ 1650
35	35-38	-	ST 4	NA	35-38 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25+ kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1720
	38-40	1	SPT 11	43,50/0.4	38.0-39.0 No Recovery 39.0-40.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	NA	NA	NA	(38-40) Sample @ 1730 (Laboratory Sample # 15)
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.9	SPT1	5,20,29,21	0-0.2 Topsoil, dry, silty, organics 0.2-1.9 (CL) Clay, brown, dry, some silt and gravel, hard, frangible	NA	NA	NA	(0-2) Sample @ 0949
	2.5-4.5	2	SPT 2	12,15,16,10	2.5-2.7 (ML) Sandy silt, some gravel, loose, dry 2.7-4.5 (CL) Clay, brown-gray, damp, very stiff, non-plastic,trace gravel and silt	NA	NA	NA	(2.5-4.5) Sample @ 0955
5	5-7	1.5	SPT3	6,4,5,4	5.0-5.5 No Recovery 5.5-7.0 (CL) Sandy clay, moist, gray-brown, some gravel and silt, non-plastic, medium stiff, gravel seam top 0.2'	2.0 TSF	NA	NA	(5-7) Sample @ 1050
	7.5-9.5	0.5	SPT 4	2,5,2,2	7.5-9.0 No Recovery 9.0-9.5 (CL) Sandy clay, moist, gray-brown, some gravel and silt, non-plastic, medium stiff, , small gravel layer at top 0.1, gray black with white magnesium oxide on shoe	NA	NA	NA	(7.5-9.5) Sample @ 1100
10	10-12	1	SPT5	1,1,2,2	10.0-11.0 No Recovery 11.0-12.0 (SP) Clayey sand, Dark gray to black, brick chunk at top, hydrocarbon odor, soft, loose, non-plastic, wet, gravel to 0.2'	NA	NA	NA	(10-12) Sample @ 1110
	12.5-14.5	1.5	SPT6	3,3,3,6	12.5-13.0 No Recovery 13.0-14.5 (CL) Clay, brown, some silt, moist, medium stiff, low-medium plastic, trace gravel, black wood 13.1-13.6, gravel at top 0.2'	2.0 TSF	NA	NA	(12.5-14.5) Sample @1115
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.8	SPT 7	4,4,8,12	15.0-15.2 No Recovery 15.2-17.0 (CL) Clay, brown, some silt, medium stiff, low-medium plastic, trace gravel, Sand seam at 16.7, wet, gravel at tip	2.0 TSF	NA	NA	(15-17) Sample at 1125 (Laboratory Sample # 7)
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	Hard drilling start @ 20'
20	20-23	1.9	ST 1	NA	20.0-23.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic	4.5+ TSF	1.13 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1215
	23-25	0.8	SPT8	43, 50/0.4	23.0-24.2 No Recovery 24.2-25.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	NA	NA	(23-25) Sample @ 1225
25	25-28	-	ST 2	NA	25-28 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	NA	NA	Shelby Tube 25-28	Encountered hard object @ 26.4, stopped and pulled tube and lost sample due to tube being damaged
	28-30	0.5	SPT 9	50/0.4	28.0-29.5 No Recovery 29.5-30.0 (CL) Sily clay, gray, damp to dry, hard, non plastic, trace gravel, till	4.5+ TSF	NA	NA	(28-30) Sample @ 1430
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	3	ST 3	NA	30-33 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	2.0 kg/cm2	Shelby Tube 30-33	Not pushed complete 3', 3' of recovery. Hard drilling @ 33', (30-33)Sample @ 1500
	33-35	2	SPT10	27,43,50, 50/0.4	33.0-35.0 (CL) Silty clay, gray, dry to damp, hard, trace gravel, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1525 (Laboratory Sample # 13)
35	35-38	-	ST 4	NA	35-38 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+TSF	1.0 kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1610
	38-40	2	SPT 11	26,36,48,43	38.0-40.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	NA	NA	(38-40) Sample @ 1620
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5	SPT1	9,11,16,23	0-0.3 Topsoil, dry, silt and sand, organics 0.3-1.5 (CL) Brown clay, some silt, sand, trace gravel, hard, frangible, sand seam at 0.9' 1.5-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 0845
	2.5-4.5	2	SPT 2	5,4,10,19	2.5-3.0 (CL) Brown clay, some silt, sand, trace gravel, hard, frangible 3.0-4.5 (CL) Clay, Brown, silty, trace gravel, stiff,moist, non plastic, some magnesium oxide bottom 0.2'	NA	NA	NA	(2.5-4.5) Sample @ 0850
5	5-7	2	SPT3	8,19,15,20	5.0-6.0 (CL) Clay, Brown, silty, trace gravel, stiff,moist, non plastic 6.0-7.0 (CL) Clay, brown-back, moist, some sand and silt, trace gravel, stiff, non plastic, hydrocarbon odor	4.5+ TSF	NA	NA	(5-7) Sample @ 1030, gravel after 7.3
	7.5-9.5	1.5	SPT 4	19,25,22,18	7.5-8.0 No Recovery 8.0-9.5 (SP) Sand, brown, some gravel, coarse - medium, medium dense, wet, slight chemical odor, more gravel at top	NA	NA	NA	(7.5-9.5) Sample @ 1045
10	10-12	2	SPT5	2,1,1,2	10.0-12.0 magnesium oxide, dark gray to white at top, with sand, wet	NA	NA	NA	(10-12) Sample @ 1055
	12.5-14.5	0.5	SPT6	0,1,1,2	12.5-14.0 No Recovery 14.0-14.3 magnesium oxide, white 14.3-14.5 Peat, black, slight odor	NA	NA	NA	(12.5-14.5) Sample @1105
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5	SPT 7	2,3,3,5	15.0-15.5 No Recovery 15.5-15.7 (CL) Black sandy clay, wet, soft, low plastic 15.7-17.0 (CL) Brown Clay, some sand, trace silt and gravel, medium stiff, low plastic, moist, increased silt with depth, decreased sand with depth	NA	NA	NA	(15-17) Sample at 1115 (Laboratory Sample # 7)
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	0.55	ST 1	NA	Bottom of shelby (CL) Gray clay, silty, very stiff, trace gravel, moist, non plastic, till	4.5+ TSF	1.0 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1150
	23-25	2	SPT8	26,27,36,36	23.0-25.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, till	4.5+ TSF	NA	NA	(23-25) Sample @ 1350
25	25-28	2.5	ST 2	NA	25.0-28.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, till	4.5 TSF	0.25 kg/cm2	Shelby Tube 25-28	(25-28) Sample @ 1350 (Laboratory Sample # ST (A, B, C))
30	28-30	2	SPT 9	7,10,14,19	28.0-30.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, increased silt, stiff, till	4.0 TSF	NA	NA	(28-30) Sample @ 1400

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	0	ST 3	NA	No Shelby tube sample recovery - tube destroyed during sample collection attempt.	NA	NA	NA	Shelby Tube 30-33, No recovery, Tube damaged
	33-35	2	SPT10	55,58,62,67	33.0-35.0 (ML) Clayey silt, Gray-brown, hard, slightly moist, trace sand and gravel - till, non plastic	NA	NA	NA	(33-35) Sample @ 0928 (7/9/22) (Laboratory Sample # 12)
35	35-38	0	ST 4	NA	No pitcher barrel/shelby tube sample - sampler damaged and inoperable	NA	NA	NA	Shelby Tube 35-38, No recovery, Tube damaged
	38-40	1.5	SPT 11	30,36,50/0.4	38.0-39.6 (ML) Clayey silt, Gray-brown, hard, slightly moist, trace sand and gravel - till, non plastic 39.6-40.0 (SP) Sand, Fine, gray-brown, wet, medium dense	>4.5 TSF	NA	NA	(38-40) Sample @ 1000
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	2	SPT1	8,15,22,11	0-0.4 Topsoil, dry, silty, organics 0.4-2.0 (CL) Brown-gray clay, hard, frangible, dry, silty, trace gravel, sand seam 0.8-1.0	3.5 TSF	NA	NA	(0-2) Sample @ 1630
	2.5-4.5	2	SPT 2	6,4,7,20	2.5-3.0 (CL) Brown-gray clay, hard, frangible, dry, silty, trace gravel, 3.0-4.5 (CL) Clay, brown-gray, moist to dry, some silt, trace gravel, very stiff-hard, non-plastic	4.5+ TSF	1.0 kg/cm2	NA	(2.5-4.5) Sample @ 1640
5	5-7	1.5	SPT3	11,13,8,6	5.0-5.5 No Recovery 5.5-6.6 (CL) Brown clay, silty, trace gravel, hard, moist, non-plastic 6.6-7.0 (ML) Black silt with fine sand, medium dense - soft, trace gravel, moist, odor, magnesium oxide, mottled	4.5+ TSF	0.25 kg/cm2	NA	(5-7) Sample @ 0800
	7.5-9.5	1	SPT 4	3,4,4,4	7.5-8.5 No Recovery 8.5-8.7 (ML) Black silt with fine sand, medium dense - soft, trace gravel, moist, odor, magnesium oxide, mottled 8.7-9.5 (SP) Light brown sand, medium, medium dense to loose, wet, trace gravel an clay, odor, decreasing clay with depth	NA	NA	NA	(7.5-9.5) Sample @ 0805
10	10-12	1.5	SPT5	8,10,12,8	10.0-11.8 (SP) Coarse sand with gravel, black, wet, medium dense 11.8-12.0 (ML) Light brown silt, stiff, moist, non-plastic,little clay	NA	NA	NA	(10-12) Sample @ 0820
	12.5-14.5	2	SPT6	7,14,20,19	12.5-14.5 (ML) Light brown silt, moist, soft-firm, low plastic, (sand seam 11.3-11.5', wet, medium)	2.0 TSF	0.5 kg/cm2	NA	(12.5-14.5) Sample @0830 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5	SPT 7	11,15,23,27	15.0-15.5 No Recovery 15.5-16.5 (GW) Sandy gravel, coarse sand, wet, interbedded silt (ML) loose-medium dense, trace clay 16.5-17.0 (CL) Light brown clay, silty, trace gravel, moist, very stiff-hard, non plastic, till	4.5+ TSF	0.63 kg/cm2	NA	(15-17) Sample at 0845
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	1.5	ST 1	NA	20-23 Bottom of shelby, (CL) Gray clay, silty, very stiff to hard, moist, trace gravel, non plastic, till	4.5+ TSF	1.0 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 0940
	23-25	2	SPT8	16,23,30,34	23.0-25.0 (CL) Gray clay, silty, trace gravel, very stiff to hard, moist, till	4.5+ TSF	~1.0 kg/cm2	NA	(23-25) Sample @ 0950
25	25-28	1.8.	ST 2	NA	25-28 Bottom of shelby (CL) Sandy clay, light to dark brown, some gravel, wet, very stiff, low plastic, till	4.5+ TSF	0.5 kg/cm2	Shelby Tube 25-28	Started shelby , got plugged, had to pull, clean and continue, (25-28) Sample @ 1150 (Laboratory Sample # ST (A, B, C))
30	28-30	0.9	SPT 9	20, 50/0.4	28.0-29.1 No Recovery 29.1-30.0 (CL) Gray sandy clay with gravel, some silt, wet to dry at bottom, non-plastic, hard, crumbly, till	4.5 TSF	1.0 kg/cm2	NA	(28-30) Sample @ 1210

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	0.8	ST 3	NA	30.0-33.0 Bottom of shelby (CL) Gray sandy clay with gravel, some silt, wet to dry at bottom, non-plastic, hard, crumbly (till), increased gravel, potentially clayey gravel with sand	4.5+ TSF	0.63 kg/cm2	Shelby Tube 30-33	Rough drilling ~35' due to presence of gravel, (30-33)Sample @ 1310
	33-35	0.7	SPT10	52, 50/0.3	33.0-34.3 No Recovery 33.4-35.0 (CL) Gray sandy clay, hard, some silt, trace gravel, non-plastic, moist, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1320 (Laboratory Sample # 13)
35	35-38	1	ST 4	NA	35.0-38.0 Bottom of shelby, (CL) Gray clay, silty, trace gravel, moist, low plastic, very stiff to hard, till	4.5+ TSF	1.0 kg/cm2	Shelby tube 35-38	Issues advancing - pushed 1.2' and stopped, (35-38) Sample @ 1410
	38-40	0.5	SPT 11	50/0.4	38.0-38.4 (ML) Gray silt, hard, trace gravel and minor clay, moist, low plasticity 38.4-38.5 (SP) Gray sand/gravel, medium-coarse, cobble at end, poorly sorted End of Boring 38.5' bgs	NA	NA	NA	(38-40) Sample @ 1440
40									
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5/2.0	SPT1	7,11,17,15	0.0-1.5 (CL) Brown silty clay, dry, frangible, sand seam 0.9-1.0', trace sand and gravel 1.5-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 0820
	2.5-4.5	1.8/2.0	SPT 2	11,11,11,8	2.5-2.7 No Recovery 2.7-4.5 (CL) Brown silty clay, hard, dry, frangible, trace gravel, crumbly	3.5 TSF	NA	NA	(2.5-4.5) Sample @ 0825, setup for mud
5	5-7	1.5/2.0	SPT3	7,9,11,10	5.0-5.5 No Recovery 5.5-7.0 (CL) Clay, brown-gray, moist, silty, trace gravel, very stiff, non plastic, sand seam 6.7-6.8 with black peat, odor, wet, medium	4.5+ TSF	NA	NA	(5-7) Sample @ 0920
	7.5-9.5	1.0/2.0	SPT 4	10,8,15,6	7.5-8.5 No Recovery 8.5-9.5 (SP) Sand, dark brown, fine-medium, medium dense, little clay, moist, trace gravel, little silt	NA	NA	NA	(7.5-9.5) Sample @ 0930
10	10-12	1.2/2.0	SPT5	2,2,3,4	10.0-10.8 No Recovery 10.8-12.0 (CL) Light brown clay, silty, mottling, moist, medium plastic, firm, trace sand, slight odor, increasing silt with depth	1.0 TSF	NA	NA	(10-12) Sample @ 0940
	12.5-14.5	1.5/2.0	SPT6	4,5,9,10	12.5-13.0 No Recovery 13.0-14.5 (CL) Light brown clay, silty, mottling, moist, trace sand, slight odor, increasing silt with depth, very stiff, low plastic, sand seam 14.2-14.3'	3.5 TSF	NA	NA	(12.5-14.5) Sample @ 0955
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	2.0/2.0	SPT 7	11,21,28,33	15.0-15.5 (SP) Clayey sand, some silt, trace gravel, medium dense, medium to fine, wet 15.5-17.0 (CL) Silty brown clay, moist, very stiff, non-plastic, trace gravel, mottling, some sand to little, till	4.5+ TSF	0.56 kg/cm2	NA	(15-17) Sample at 1010
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	Hard rough drilling 19'
20	20-22	1.5/2.0	SPT 8	19,23,24,34	20.0-20.5 No Recovery 20.5-22.0 (CL) Gray clay, silt, trace gravel, moist, very stiff, non-plastic, till	4.5+ TSF	2.25 kg/cm2	NA	(20-22) Sample @ 1035, Gravelly rough drilling @ ~ 23-24
25	22-28	NA	NA	NA	No Shelby, adjusted sampling	NA	NA	NA	NA
30	28-30	2.0/2.0	SPT 9	10,16,19,19	28.0-30.0 (CL) Gray clay, silt, trace gravel, moist, very stiff, non-plastic, till	4.5+ TSF	1.75 kg/cm2	NA	(28-30) Sample @ 1100

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	2.0/3.0	ST1	NA	30.0-33.0 Bottom of shelby, (CL) Clay, gray-brown, hard, moist, little sand and silt, trace gravel, till	4.5 TSF	1.25 kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1215
	33-35	2.0/2.0	SPT10	22,30,50,50/0.4	33.0-34.2 (CL) Clay, gray-brown, hard, moist, little sand and silt, trace gravel, till, Increasing silt bottom 0.2' 34.2-35.0 (SP) Sand, fine-medium with depth, tan, wet, trace gravel, dense	4.5+ TSF	1.125 kg/cm2	NA	(33-35) Sample @ 1230 (Laboratory Sample # 11)
35	35-38	2.2/3.0	ST 2	NA	35.0-38.0 Bottom of shelby, (CL) Gray clay, silty, very stiff - hard, trace gravel, moist, non-plastic, till	4.5+ TSF	1.5 kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1315
	38-40	0.2/2.0	SPT 11	50/0.2	38.0-39.8 No Recovery 39.8-40.0 (CL) Gray clay, silty, very stiff - hard, trace gravel, moist, non-plastic, till	4.5+ TSF	NA	NA	(38-40) Sample @ 1325
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.0/2.0	SPT1	5,14,27,18	0.0-0.3 Topsoil, organics 0.3-1.0 (ML) Sandy silt, light brown, dry, some clay, trace gravel, loose 1.0-2.0 No Recovery	3.5 TSF	NA	NA	(0-2) Sample @ 1630
	2.5-4.5	2.0/2.0	SPT 2	7,14,13,13	2.5-4.5 (CL) Silty Clay, brown, dry, frangible, trace gravel, hard, little sand	NA	NA	NA	(2.5-4.5) Sample @ 1645
5	5-7	1.5/1.5	SPT3	5,7,9,7	5.0-6.5 (CL) Clay, gray and brown, very stiff, moist, little fine sand and silt 6.5-7.0 (SM) Sand, fine, brown to black, medium dense, moist, stained with faint hydrocarbon odor	NA	NA	NA	(5-7) Sample @ 1725
	7.5-9.5	1.0/2.0	SPT 4	5,5,4,3	7.5-9.5 (CL) Sandy to silty clay, gray and brown, medium stiff, moist, trace gravel, hydrocarbon odor	NA	NA	NA	(7.5-9.5) Sample @ 1735
10	10-12	1.5/2.0	SPT5	3,5,6,10	10.0-11.5 (CL) Clay, gray-brown, stiff, moist, medium plastic, trace sand and gravel 11.5-12.0 (ML) Silt, gray, medium stiff, moist to wet	NA	NA	NA	(10-12) Sample @ 1745
	12.5-14.5	1.5/2.0	SPT6	7,7,7,10	12.5-14.5 (ML) Sandy silt, gray, medium stiff, wet, little clay	NA	NA	NA	(12.5-14.5) Sample @ 1750 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5/2.0	SPT 7	11,11,9,9	15.0-16.5 (SM) Sand, gray, medium dense, wet, trace coarse sand and gravel 16.5-17.0 (CL) Clay, gray brown, stiff, moist, some silt, little fine sand	NA	NA	NA	(15-17) Sample @ 1800
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	2.4/3.0	ST 1	NA	20-23 Bottom of shelby (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.5 kg/cm2	Shelby Tube 20-23	Sample 20-23 @ 0915
	23-25	1.5/2.0	SPT8	17,25,28,36	23.0-23.5 No Recovery 23.5-25.0 (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.5 kg/cm2	NA	(23-25) Sample @ 0920
25	25-28	--	ST 2	NA	25-28 Bottom of shelby, (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	2.0 kg/cm2	Shelby Tube 25-28	(35-28) Sample @ 1010
	28-30	2.0/2.0	SPT 9	12,15,19,28	28.0-30.0 (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.75 kg/cm2	NA	(28-30) Sample @ 1015
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	2.0/3.0	ST 3	NA	30.0-33.0 Bottom of shelby, (CL) Gray clay, silty, moist, very stiff, trace gravel, low plastic, till	3.0 TSF	1.5 kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1115 (Laboratory Sample # ST (A, B, C))
	33-35	2.0/2.0	SPT10	8,10,22,21	33.0-34.2 (CL) Gray clay, silty, moist, very stiff, trace gravel, low plastic, till 34.2-35.0 (ML) Gray silt, soft, low plastic, moist to wet, trace clay	2.5 TSF	1.5 kg/cm2	NA	(33-35) Sample @ 1250 (Laboratory Sample # 13)
35	35-38	1.0/3.0	ST 4	NA	35.0-38.0 Bottom of shelby, (ML) Gray silt, trace clay, soft, wet, medium plastic	1.5 TSF	NA	Shelby tube 35-38	(35-38) Sample @ 1345
	38-40	1.4/2.0	SPT 11	20,38,35,23	38.0-38.6 No Recovery 38.6-39.0 (ML) Gray silt, trace clay, soft, wet, medium plastic 39.0-40.0 (SP) Fine sand, fray, medium dense, wet, gravel at top decreasing to 0 at bottom	NA	NA	NA	(38-40) Sample @ 1400
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.0/2.0	SPT1	5,8,5,11	0.0-0.2 Topsoil, organics 0.2-1.0 (CL) Clay, brown, silty, some sand, trace gravel, dry, sand seam 0.8-1.0 1.0-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 1020
	2.5-4.5	0.5/2.0	SPT 2	8,20,22,20	2.5-4.0 No Recovery 4.0-4.5 (CL) Clay, brown, silty, some sand, trace gravel, dry	NA	NA	NA	(2.5-4.5) Sample @ 1030
5	5-7	1.5/1.5	SPT3	8,6,7,8	5.0-5.5 No Recovery 5.5-6.6 (CL) Clay, brown-gray, some sand and silt, trace gravel, moist, very stiff, non plastic 6.6-7.0 (SP) Sand, dark gray-black, medium, medium dense, wet, slight odor, trace silt	4.5+ TSF	NA	NA	(5-7) Sample @ 1118
	7.5-9.5	1.0/2.0	SPT 4	3,1,1,3	7.5-8.5 No Recovery 8.5-9.0 (SP) Sand, dark gray-black, medium, medium dense, wet, slight odor, trace silt 9.0-9.5 (CL) Sandy clay, increasing clay with depth, medium stiff, medium plastic, moist, peat at bottom, odor	NA	NA	NA	(7.5-9.5) Sample @ 1130
10	10-12	2.0/2.0	SPT5	3,5,6,9	10.0-11.5 (ML) Gray silt, wet, medium stiff, non-plastic, trace clay 11.5-12.0 (CL) Clay, brown, some silt, trace gravel, moist, non plastic	3.5 TSF	NA	NA	(10-12) Sample @ 1150
	12.5-14.5	2.0/2.0	SPT6	8,12,13,14	12.5-13.0 (CL) Clay, brown, some silt, trace gravel, moist, non plastic 13.0-14.0 (ML) Sandy silt to silty sand with depth, gray wet, soft to loose, non-low plastic 14.0-14.5 (CL) Clay, brown, silty, trace gravel, stiff, non-plastic, moist	4.0 TSF	NA	NA	(12.5-14.5) Sample @ 1205 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-18	NA	NA	NA	No Sampling	NA	NA	NA	NA
	18-20	1.5/2.0	SPT 7	17,21,22,34	18.0-20.0 (CL) Clay, brown, silty, trace gravel, stiff, non-plastic, moist	4.5+TSF	1.63 kg/cm2	NA	(18-20) Sample @ 1220
20	20-23	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	23-25	1.8/2.0	SPT8	15,18,49,50/0.4	23.0-23.2 No Recovery 23.2-24.5 (CL) Clay, brown, moist, some silt, trace gravel, very stiff, non-plastic, till 24.5-25.0 (SP) Sand, gray, medium, medium dense, wet, well sorted	4.5+ TSF	1.63 kg/cm2	NA	(23-25) Sample @ 1240 (Laboratory Sample # 8)
25	25-28	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube, Gravel ~ 27'
	28-30	2.0/2.0	SPT 9	29,39,39,40	28.0-30.0 (SP) Sand with gravel, tan-gray, medium dense-dense, medium-coarse, wet, little clay and silt, moderate cohesive	NA	NA	NA	(28-30) Sample @ 1315
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	33-35	0.4/2.0	SPT10	50/0.35	33.0-34.6 No Recovery 34.6-35.0 (CL) Clay, brown-gray, silty, trace gravel, moist, very stiff-hard, non-plastic, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1400
35	35-38	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	38-40	0.8/2.0	SPT 11	50,50/0.5,38,40	38.0-39.2 No Recovery 39.2-40.0 (CL) Clay, brown-gray, silty, trace gravel, moist, very stiff-hard, non-plastic, till	4.5+TSF	1.75 kg/cm2	NA	(38-40) Sample @ 1610
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

Attachment 2
Perimeter Drain Analytical Results

Attachment 2A
Tabulated Summary

Table A2-1. Perimeter Drain Analytical Results

		Location	PD001	PD002	PD003	PD004	PD005	PD006	PD007	PD008	PD009	PD010	PD011	PD012	PD013	PD014	PD015	PD016	PD017	PD018	PD019	PD020
		Sample Name	VCS-OU1-PD-SO-001-10.0/18.0	VCS-OU1-PD-SO-002-7.0/15.0	VCS-OU1-PD-SO-003-13.0/19.0	VCS-OU1-PD-SO-004-8.0/18.0	VCS-OU1-PD-SO-005-10.0/18.0	VCS-OU1-PD-SO-006-5.0/10.0	VCS-OU1-PD-SO-007-8.0/11.0	VCS-OU1-PD-SO-008-8.0/12.0	VCS-OU1-PD-SO-009-7.0/10.0	VCS-OU1-PD-SO-010-8.0/15.0	VCS-OU1-PD-SO-011-6.0/10.0	VCS-OU1-PD-SO-012-4.0/10.0	VCS-OU1-PD-SO-013-6.0/10.0	VCS-OU1-PD-SO-014-8.0/11.0	VCS-OU1-PD-SO-015-2.0/9.0	VCS-OU1-PD-SO-016-3.0/15.0	VCS-OU1-PD-SO-017-3.0/8.0	VCS-OU1-PD-SO-018-3.0/10.0	VCS-OU1-PD-SO-019-8.0/14.0	VCS-OU1-PD-SO-020-10.0/15.0
		Sample Date	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022	6/16/2022
Parameter	CAS number	Units																				
A2540G																						
Percent Solids	SOLID	percent	84.8	81.6	68.9	87.7	87.7	88.6	90.4	87.4	86.7	83.1	87.8	90.2	88.6	89.5	85.9	89.9	88.6	89.5	86.8	87.5
SFAM01.1																						
1,1-Dichloroethene	75-35-4	ug/l	50 U	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ	50 U	50 UJ	50 UJ	50 UJ	50 UJ	50 UJ
1,2-Dichloroethane	107-06-2	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
1,4-Dichlorobenzene	106-46-7	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
2,4,5-Trichlorophenol	95-95-4	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
2,4,6-Trichlorophenol	88-06-2	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
2,4-Dinitrotoluene	121-14-2	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
2-Butanone	78-93-3	ug/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
2-Methylphenol	95-48-7	ug/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
4-Methylphenol	106-44-5	ug/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Alpha-Chlordane	5103-71-9	ug/l	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Aroclor 1016	12674-11-2	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1221	11104-28-2	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1232	11141-16-5	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1242	53469-21-9	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1248	12672-29-6	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1254	11097-69-1	ug/kg	38 U	42 U	51 U	42 U	37 U	30000 J	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1260	11096-82-5	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1262	37324-23-5	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Aroclor 1268	11100-14-4	ug/kg	38 U	42 U	51 U	42 U	37 U	370 U	37 U	38 U	38 U	39 U	37 U	37 U	37 U	38 U	36 U	38 U	38 U	37 U	39 U	37 U
Arsenic	7440-38-2	ug/l	9 J	4.6 J	10 U	11	5.2 J	5.7 J	6.8 J	6.7 J	5.1 J	14	10 U	26	8.2 J	6.5 J	10 U	10 U	10 U	7.5 J	10 U	10 U
Barium	7440-39-3	ug/l	810	270	24 J	78 J	310	620	450	710	240	470	340	1200	740	460	500	480	510	440	220	52 J
Benzene	71-43-2	ug/l	50 U	15 J	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Cadmium	7440-43-9	ug/l	1.9 J	0.62 J	5 U	0.43 J	1.1 J	1.8 J	0.52 J	1.7 J	0.77 J	2.8 J	0.94 J	5	1.1 J	0.64 J	1.2 J	0.64 J	1.1 J	0.42 J	0.82 J	5 U
Carbon tetrachloride	56-23-5	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chlorinated Camphene	8001-35-2	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chlorobenzene	108-90-7	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chloroform	67-66-3	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chromium	7440-47-3	ug/l	8.1 J	2.4 J	2.6 J	5.4 J	9.6 J	6 J	1.1 J	5 J	2 J	17	4.8 J	33	7.3 J	3.6 J	1.1 J	1.4 J	1.2 J	7.1 J	4.3 J	10 U
Endrin	72-20-8	ug/l	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.7 J+	1 U	1 U
gamma-BHC (Lindane)	58-89-9	ug/l	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Heptachlor	76-44-8	ug/l	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Heptachlor Epoxide	1024-57-3	ug/l	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Hexachlorobenzene	118-74-1	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Hexachlorobutadiene	87-68-3	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Hexachloroethane	67-72-1	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Lead	7439-92-1	ug/l	310 J	29 J	41 J	24 J	140 J	380 J	7.7 J	83 J	24 J	110 J	6.3 J	290 J	28 J	14 J	9.1 J	5.7 J	10 UJ	36 J+	10 UJ	10 UJ
Mercury	7439-97-6	ug/l	0.2 UJ	0.2 UJ	0.53 J-	0.2 UJ	0.2 UJ	0.73 J-	0.2 UJ	0.14 J-	0.2 UJ	0.081 J-	0.2 UJ	0.2 UJ	0.2 UJ	0.042 J-	0.2 UJ	0.2 UJ	0.2 UJ	0.051 J-	0.2 UJ	0.2 UJ
Methoxychlor	72-43-5	ug/l	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Nitrobenzene	98-95-3	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Pentachlorophenol	87-86-5	ug/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Pyridine	110-86-1	ug/l	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Selenium	7782-49-2	ug/l	7.1 J	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	35 U	11 J	6.3 J	35 U	35 U	35 U	35 U	35 U	35 U	35 U
Silver	7440-22-4	ug/l	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	127-18-4	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 UJ	50 UJ	50 UJ	50 UJ
trans-Chlordane	5103-74-2	ug/l	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethylene	79-01-6	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 UJ	50 UJ	50 UJ	50 UJ
Vinyl Chloride	75-01-4	ug/l	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
SW1010																						
FLASH POINT	FLASHPT	deg f	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
SW8151A																						
2,4-Dichlorophenoxyacetic acid	94-75-7	mg/l	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Silvex (2,4,5-TP)	93-72-1	mg/l	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
SW9045																						
pH	PH	pH UNITS	7.84	8.58	9.64	8.2	8.34	9.12	8.14	8.05	7.98	8.08	7.78	7.94	7.87	7.93	7.73	8	7.89	8.04	8.06	8.44

Attachment 2B
Analytical Reports

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: ABLK538	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: ALCS538	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	22	J	ug/kg	22	J	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	23	J	ug/kg	23	J	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD Drilling Mud Drums	pH:	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 88.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8MS	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 88.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	170		ug/kg	170		1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	180		ug/kg	180		1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8MSD	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 88.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	170		ug/kg	170		1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	180		ug/kg	180		1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ9	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: Trip Blank	pH: 1.0	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK241	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Sample Number: VHBLK001	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ9** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-001	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-001	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	9.0	J	ug/L	9.0	J	1	YES	S2BVEM
Barium	Target	810		ug/L	810		1	YES	S2BVEM
Cadmium	Target	1.9	J	ug/L	1.9	J	1	YES	S2BVEM
Chromium	Target	8.1	J	ug/L	8.1	J	1	YES	S2BVEM
Lead	Target	310	J	ug/L	310	*	1	YES	S2BVEM
Selenium	Target	7.1	J	ug/L	7.1	J	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6D	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6D	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	5.8	J	ug/L	5.8	J	1	YES	S2BVEM
Barium	Target	790		ug/L	790		1	YES	S2BVEM
Cadmium	Target	1.6	J	ug/L	1.6	J	1	YES	S2BVEM
Chromium	Target	6.6	J	ug/L	6.6	J	1	YES	S2BVEM
Lead	Target	210		ug/L	210	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6L	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	50	U	ug/L	50	U	5	YES	S2BVEM
Barium	Target	730	J	ug/L	730	J	5	YES	S2BVEM
Cadmium	Target	25	U	ug/L	25	U	5	YES	S2BVEM
Chromium	Target	7.8	J	ug/L	7.8	J	5	YES	S2BVEM
Lead	Target	280		ug/L	280		5	YES	S2BVEM
Selenium	Target	180	U	ug/L	180	U	5	YES	S2BVEM
Silver	Target	50	U	ug/L	50	U	5	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6S	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Spike	1.0	J-	ug/L	1.0		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX6S	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Spike	53		ug/L	53		1	YES	S2BVEM
Barium	Spike	3100		ug/L	3100		1	YES	S2BVEM
Cadmium	Spike	61		ug/L	61		1	YES	S2BVEM
Chromium	Spike	230		ug/L	230		1	YES	S2BVEM
Lead	Spike	340		ug/L	340		1	YES	S2BVEM
Selenium	Spike	120		ug/L	120		1	YES	S2BVEM
Silver	Spike	46		ug/L	46		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX7	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-002	pH:	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX7	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-002	pH:	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	4.6	J	ug/L	4.6	J	1	YES	S2BVEM
Barium	Target	270		ug/L	270		1	YES	S2BVEM
Cadmium	Target	0.62	J	ug/L	0.62	J	1	YES	S2BVEM
Chromium	Target	2.4	J	ug/L	2.4	J	1	YES	S2BVEM
Lead	Target	29	J	ug/L	29	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX8	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-003	pH:	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.53	J-	ug/L	0.53		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX8	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-003	pH:	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	24	J	ug/L	24	J	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	2.6	J	ug/L	2.6	J	1	YES	S2BVEM
Lead	Target	41	J	ug/L	41	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX9	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-004	pH:	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEX9	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-004	pH:	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	11		ug/L	11		1	YES	S2BVEM
Barium	Target	78	J	ug/L	78	J	1	YES	S2BVEM
Cadmium	Target	0.43	J	ug/L	0.43	J	1	YES	S2BVEM
Chromium	Target	5.4	J	ug/L	5.4	J	1	YES	S2BVEM
Lead	Target	24	J	ug/L	24	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY0	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-005	pH:	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY0	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-005	pH:	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	5.2	J	ug/L	5.2	J	1	YES	S2BVEM
Barium	Target	310		ug/L	310		1	YES	S2BVEM
Cadmium	Target	1.1	J	ug/L	1.1	J	1	YES	S2BVEM
Chromium	Target	9.6	J	ug/L	9.6	J	1	YES	S2BVEM
Lead	Target	140	J	ug/L	140	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY1	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-006	pH:	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.73	J-	ug/L	0.73		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY1	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-006	pH:	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	5.7	J	ug/L	5.7	J	1	YES	S2BVEM
Barium	Target	620		ug/L	620		1	YES	S2BVEM
Cadmium	Target	1.8	J	ug/L	1.8	J	1	YES	S2BVEM
Chromium	Target	6.0	J	ug/L	6.0	J	1	YES	S2BVEM
Lead	Target	380	J	ug/L	380	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY2	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-007	pH:	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY2	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-007	pH:	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	6.8	J	ug/L	6.8	J	1	YES	S2BVEM
Barium	Target	450		ug/L	450		1	YES	S2BVEM
Cadmium	Target	0.52	J	ug/L	0.52	J	1	YES	S2BVEM
Chromium	Target	1.1	J	ug/L	1.1	J	1	YES	S2BVEM
Lead	Target	7.7	J	ug/L	7.7	J*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY3	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-008	pH:	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.14	J-	ug/L	0.14	J	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY3	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-008	pH:	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	6.7	J	ug/L	6.7	J	1	YES	S2BVEM
Barium	Target	710		ug/L	710		1	YES	S2BVEM
Cadmium	Target	1.7	J	ug/L	1.7	J	1	YES	S2BVEM
Chromium	Target	5.0	J	ug/L	5.0	J	1	YES	S2BVEM
Lead	Target	83	J	ug/L	83	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY4	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-009	pH:	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY4	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-009	pH:	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	5.1	J	ug/L	5.1	J	1	YES	S2BVEM
Barium	Target	240		ug/L	240		1	YES	S2BVEM
Cadmium	Target	0.77	J	ug/L	0.77	J	1	YES	S2BVEM
Chromium	Target	2.0	J	ug/L	2.0	J	1	YES	S2BVEM
Lead	Target	24	J	ug/L	24	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY5	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-010	pH:	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.081	J-	ug/L	0.081	J	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY5	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-010	pH:	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	14		ug/L	14		1	YES	S2BVEM
Barium	Target	470		ug/L	470		1	YES	S2BVEM
Cadmium	Target	2.8	J	ug/L	2.8	J	1	YES	S2BVEM
Chromium	Target	17		ug/L	17		1	YES	S2BVEM
Lead	Target	110	J	ug/L	110	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY6	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-011	pH:	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY6	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-011	pH:	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	340		ug/L	340		1	YES	S2BVEM
Cadmium	Target	0.94	J	ug/L	0.94	J	1	YES	S2BVEM
Chromium	Target	4.8	J	ug/L	4.8	J	1	YES	S2BVEM
Lead	Target	6.3	J	ug/L	6.3	J*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY7	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-012	pH:	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY7	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-012	pH:	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	26		ug/L	26		1	YES	S2BVEM
Barium	Target	1200		ug/L	1200		1	YES	S2BVEM
Cadmium	Target	5.0		ug/L	5.0		1	YES	S2BVEM
Chromium	Target	33		ug/L	33		1	YES	S2BVEM
Lead	Target	290	J	ug/L	290	*	1	YES	S2BVEM
Selenium	Target	11	J	ug/L	11	J	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY9	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-013	pH:	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEY9	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-013	pH:	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	8.2	J	ug/L	8.2	J	1	YES	S2BVEM
Barium	Target	740		ug/L	740		1	YES	S2BVEM
Cadmium	Target	1.1	J	ug/L	1.1	J	1	YES	S2BVEM
Chromium	Target	7.3	J	ug/L	7.3	J	1	YES	S2BVEM
Lead	Target	28	J	ug/L	28	*	1	YES	S2BVEM
Selenium	Target	6.3	J	ug/L	6.3	J	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ0	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-014	pH:	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.042	J-	ug/L	0.042	J	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ0	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-014	pH:	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	6.5	J	ug/L	6.5	J	1	YES	S2BVEM
Barium	Target	460		ug/L	460		1	YES	S2BVEM
Cadmium	Target	0.64	J	ug/L	0.64	J	1	YES	S2BVEM
Chromium	Target	3.6	J	ug/L	3.6	J	1	YES	S2BVEM
Lead	Target	14	J	ug/L	14	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ1	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-015	pH:	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ1	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-015	pH:	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	500		ug/L	500		1	YES	S2BVEM
Cadmium	Target	1.2	J	ug/L	1.2	J	1	YES	S2BVEM
Chromium	Target	1.1	J	ug/L	1.1	J	1	YES	S2BVEM
Lead	Target	9.1	J	ug/L	9.1	J*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ2	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-016	pH:	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ2	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-016	pH:	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	480		ug/L	480		1	YES	S2BVEM
Cadmium	Target	0.64	J	ug/L	0.64	J	1	YES	S2BVEM
Chromium	Target	1.4	J	ug/L	1.4	J	1	YES	S2BVEM
Lead	Target	5.7	J	ug/L	5.7	J*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ3	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-017	pH:	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ3	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-017	pH:	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	510		ug/L	510		1	YES	S2BVEM
Cadmium	Target	1.1	J	ug/L	1.1	J	1	YES	S2BVEM
Chromium	Target	1.2	J	ug/L	1.2	J	1	YES	S2BVEM
Lead	Target	10	UJ	ug/L	6.0	J*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ4	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-018	pH:	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.051	J-	ug/L	0.051	J	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ4	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-018	pH:	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	7.5	J	ug/L	7.5	J	1	YES	S2BVEM
Barium	Target	440		ug/L	440		1	YES	S2BVEM
Cadmium	Target	0.42	J	ug/L	0.42	J	1	YES	S2BVEM
Chromium	Target	7.1	J	ug/L	7.1	J	1	YES	S2BVEM
Lead	Target	36	J+	ug/L	36	*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ5	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-019	pH:	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ5	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-019	pH:	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	220		ug/L	220		1	YES	S2BVEM
Cadmium	Target	0.82	J	ug/L	0.82	J	1	YES	S2BVEM
Chromium	Target	4.3	J	ug/L	4.3	J	1	YES	S2BVEM
Lead	Target	10	UJ	ug/L	10	U*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ6	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD SB-020	pH:	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ6	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD SB-020	pH:	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	52	J	ug/L	52	J	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	UJ	ug/L	10	U*	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LCS01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Spike	21		ug/L	21		1	YES	S2BVEM
Barium	Spike	420		ug/L	420		1	YES	S2BVEM
Cadmium	Spike	9.7		ug/L	9.7		1	YES	S2BVEM
Chromium	Spike	21		ug/L	21		1	YES	S2BVEM
Lead	Spike	20		ug/L	20		1	YES	S2BVEM
Selenium	Spike	79		ug/L	79		1	YES	S2BVEM
Silver	Spike	18		ug/L	18		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB01	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	U	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	200	U	ug/L	200	U	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB02	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	UJ	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB02	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	200	U	ug/L	200	U	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: PBW01	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	U	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: PBW01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	200	U	ug/L	200	U	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEX6** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: PBW02	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	-0.039	J-	ug/L	-0.039	J	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ8	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location: PD Drilling Mud Drums	pH:	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	U	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: EXEZ8	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location: PD Drilling Mud Drums	pH:	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	11	J+	ug/L	11		1	YES	S2BVEM
Barium	Target	400		ug/L	400		1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	2.2	J	ug/L	2.2	J	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LCS01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Spike	21		ug/L	21		1	YES	S2BVEM
Barium	Spike	430		ug/L	430		1	YES	S2BVEM
Cadmium	Spike	9.9		ug/L	9.9		1	YES	S2BVEM
Chromium	Spike	23		ug/L	23		1	YES	S2BVEM
Lead	Spike	18		ug/L	18		1	YES	S2BVEM
Selenium	Spike	70		ug/L	70		1	YES	S2BVEM
Silver	Spike	22		ug/L	22		1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB01	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	U	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: LEB01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	6.2	J	ug/L	6.2	J	1	YES	S2BVEM
Barium	Target	200	U	ug/L	200	U	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: PBS01	Method: Mercury by Cold Vapor	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Mercury	Target	0.20	U	ug/L	0.20	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0009/EXEZ8** **Lab Name: Bonner Analytical Testing Co.**

Sample Number: PBW01	Method: Metals by ICP-AES	Matrix: Water	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids:	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Arsenic	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Barium	Target	200	U	ug/L	200	U	1	YES	S2BVEM
Cadmium	Target	5.0	U	ug/L	5.0	U	1	YES	S2BVEM
Chromium	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Lead	Target	10	U	ug/L	10	U	1	YES	S2BVEM
Selenium	Target	35	U	ug/L	35	U	1	YES	S2BVEM
Silver	Target	10	U	ug/L	10	U	1	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX6	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-001	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX6	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-001	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	20	JN	ug/L	20	JN	10.0	YES	NV
Isobutyl acetate	TIC	21	JN	ug/L	21	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	52	JN	ug/L	52	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	44	JN	ug/L	44	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX6	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-001	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	34	JN	ug/L	34	JN	10.0	YES	NV
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	86	JN	ug/L	86	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	27	JN	ug/L	27	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	90	JN	ug/L	90	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	28	JN	ug/L	28	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX7	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-002	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX7	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-002	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	44	JN	ug/L	44	JN	10.0	YES	NV
Isobutyl acetate	TIC	21	JN	ug/L	21	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	51	JN	ug/L	51	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX7	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-002	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	15	J	ug/L	15	J	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	170	JN	ug/L	170	JN	10.0	YES	NV
Isopropyl butyrate	TIC	87	JN	ug/L	87	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	28	JN	ug/L	28	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	83	JN	ug/L	83	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	26	JN	ug/L	26	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX8	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-003	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX8	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-003	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	45	JN	ug/L	45	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, propyl ester	TIC	21	JN	ug/L	21	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX8	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-003	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	67	JN	ug/L	67	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
n-Propyl acetate	TIC	130	JN	ug/L	130	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX9	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-004	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX9	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-004	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isobutyl acetate	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, propyl ester	TIC	46	JN	ug/L	46	JN	10.0	YES	NV
Isopropyl butyrate	TIC	55	JN	ug/L	55	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX9	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-004	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Acetic acid, butyl ester	TIC	36	JN	ug/L	36	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	91	JN	ug/L	91	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Isopropyl butyrate	TIC	97	JN	ug/L	97	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY0	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-005	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY0	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-005	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isobutyl acetate	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	46	JN	ug/L	46	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Isopropyl butyrate	TIC	54	JN	ug/L	54	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY0	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-005	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	37	JN	ug/L	37	JN	10.0	YES	NV
n-Propyl acetate	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	28	JN	ug/L	28	JN	10.0	YES	NV
Isopropyl butyrate	TIC	98	JN	ug/L	98	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	30	JN	ug/L	30	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	91	JN	ug/L	91	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY1	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-006	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY1	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-006	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	79	JN	ug/L	79	JN	10.0	YES	NV
Isopropyl butyrate	TIC	49	JN	ug/L	49	JN	10.0	YES	NV
Phenol, 4,4-(1-methylethylidene)b	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY1	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-006	pH: 6.0	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	170	JN	ug/L	170	JN	10.0	YES	NV
Total Alkanes	TIC	52		ug/L	52		10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	30	JN	ug/L	30	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	69	JN	ug/L	69	JN	10.0	YES	NV
Isopropyl butyrate	TIC	85	JN	ug/L	85	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY2	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-007	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY2	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-007	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isobutyl acetate	TIC	23	JN	ug/L	23	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	61	JN	ug/L	61	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	53	JN	ug/L	53	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	23	JN	ug/L	23	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	23	JN	ug/L	23	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY2	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-007	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	110	JN	ug/L	110	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	98	JN	ug/L	98	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	32	JN	ug/L	32	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	28	JN	ug/L	28	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
n-Propyl acetate	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	34	JN	ug/L	34	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY3	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-008	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY3	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-008	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	100	JN	ug/L	100	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	67	JN	ug/L	67	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY3	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-008	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Propanoic acid, 1-methylethyl este	TIC	28	JN	ug/L	28	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	27	JN	ug/L	27	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	85	JN	ug/L	85	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Isopropyl butyrate	TIC	91	JN	ug/L	91	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY4	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-009	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY4	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-009	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	120	JN	ug/L	120	JN	10.0	YES	NV
Isopropyl butyrate	TIC	66	JN	ug/L	66	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY4	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-009	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Acetic acid, butyl ester	TIC	33	JN	ug/L	33	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Isopropyl butyrate	TIC	81	JN	ug/L	81	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	80	JN	ug/L	80	JN	10.0	YES	NV
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	25	JN	ug/L	25	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY5	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-010	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY5	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-010	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isobutyl acetate	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	52	JN	ug/L	52	JN	10.0	YES	NV
Mesitylene	TIC	40	JN	ug/L	40	JN	10.0	YES	NV
Benzenesulfonamide, N,4-dimethyl-	TIC	31	JN	ug/L	31	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	45	JN	ug/L	45	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY5	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-010	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	90	JN	ug/L	90	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	85	JN	ug/L	85	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	34	JN	ug/L	34	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	27	JN	ug/L	27	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY6	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-011	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY6	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-011	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	24	JN	ug/L	24	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	27	JN	ug/L	27	JN	10.0	YES	NV
Isopropyl butyrate	TIC	66	JN	ug/L	66	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	57	JN	ug/L	57	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Naph thalene	TIC	21	JN	ug/L	21	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY6	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-011	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY7	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-012	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY7	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-012	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	21	JN	ug/L	21	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	46	JN	ug/L	46	JN	10.0	YES	NV
Isopropyl butyrate	TIC	53	JN	ug/L	53	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY7	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-012	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	71	JN	ug/L	71	JN	10.0	YES	NV
n-Propyl acetate	TIC	140	JN	ug/L	140	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	66	JN	ug/L	66	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY9	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-013	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY9	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-013	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	32	JN	ug/L	32	JN	10.0	YES	NV
Isopropyl butyrate	TIC	51	JN	ug/L	51	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	23	JN	ug/L	23	JN	10.0	YES	NV
2,3-Hexanedione	TIC	21	JN	ug/L	21	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	22	JN	ug/L	22	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY9	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-013	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	79	JN	ug/L	79	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
n-Propyl acetate	TIC	160	JN	ug/L	160	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	34	JN	ug/L	34	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ0	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-014	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ0	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-014	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, 2-methyl-, 1-methy	TIC	25	JN	ug/L	25	JN	10.0	YES	NV
Isobutyl acetate	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	34	JN	ug/L	34	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Benzene, 1,2,3-trimethyl-	TIC	35	JN	ug/L	35	JN	10.0	YES	NV
Isopropyl butyrate	TIC	57	JN	ug/L	57	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ0	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-014	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	140	JN	ug/L	140	JN	10.0	YES	NV
Isopropyl butyrate	TIC	90	JN	ug/L	90	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	33	JN	ug/L	33	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	59	JN	ug/L	59	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	30	JN	ug/L	30	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ1	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-015	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ1	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-015	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	31	JN	ug/L	31	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	21	JN	ug/L	21	JN	10.0	YES	NV
Isopropyl butyrate	TIC	53	JN	ug/L	53	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	24	JN	ug/L	24	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ1	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-015	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	90	JN	ug/L	90	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	38	JN	ug/L	38	JN	10.0	YES	NV
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	66	JN	ug/L	66	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	32	JN	ug/L	32	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	29	JN	ug/L	29	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ2	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-016	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ2	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-016	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	51	JN	ug/L	51	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	22	JN	ug/L	22	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	31	JN	ug/L	31	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	24	JN	ug/L	24	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ2	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-016	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	91	JN	ug/L	91	JN	10.0	YES	NV
n-Propyl acetate	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	33	JN	ug/L	33	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	30	JN	ug/L	30	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	36	JN	ug/L	36	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ3	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-017	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ3	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-017	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Isobutyl acetate	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	37	JN	ug/L	37	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	25	JN	ug/L	25	JN	10.0	YES	NV
Isopropyl butyrate	TIC	60	JN	ug/L	60	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	26	JN	ug/L	26	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ3	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-017	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Propanoic acid, propyl ester	TIC	65	JN	ug/L	65	JN	10.0	YES	NV
n-Propyl acetate	TIC	180	JN	ug/L	180	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	39	JN	ug/L	39	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	30	JN	ug/L	30	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	32	JN	ug/L	32	JN	10.0	YES	NV
Isopropyl butyrate	TIC	89	JN	ug/L	89	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ4	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-018	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.7	J+	ug/L	1.7		10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ4	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-018	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Propanoic acid, 2-methyl-, 1-methy	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isobutyl acetate	TIC	27	JN	ug/L	27	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	25	JN	ug/L	25	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	38	JN	ug/L	38	JN	10.0	YES	NV
Isopropyl butyrate	TIC	65	JN	ug/L	65	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ4	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-018	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Isopropyl butyrate	TIC	97	JN	ug/L	97	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	66	JN	ug/L	66	JN	10.0	YES	NV
n-Propyl acetate	TIC	190	JN	ug/L	190	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	33	JN	ug/L	33	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	35	JN	ug/L	35	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	41	JN	ug/L	41	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-019	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-019	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	28	JN	ug/L	28	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, propyl ester	TIC	40	JN	ug/L	40	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	27	JN	ug/L	27	JN	10.0	YES	NV
Isobutyl acetate	TIC	29	JN	ug/L	29	JN	10.0	YES	NV
Isopropyl butyrate	TIC	64	JN	ug/L	64	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-019	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
n-Propyl acetate	TIC	210	JN	ug/L	210	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	34	JN	ug/L	34	JN	10.0	YES	NV
Isopropyl butyrate	TIC	97	JN	ug/L	97	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	71	JN	ug/L	71	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Acetic acid, butyl ester	TIC	44	JN	ug/L	44	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	35	JN	ug/L	35	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD SB-020	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD SB-020	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Acetic acid, butyl ester	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	25	JN	ug/L	25	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	37	JN	ug/L	37	JN	10.0	YES	NV
Isobutyl acetate	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
Isopropyl butyrate	TIC	60	JN	ug/L	60	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD SB-020	pH: 6.0	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	UJ	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Propanoic acid, 2-methyl-, 1-methy	TIC	33	JN	ug/L	33	JN	10.0	YES	NV
Isopropyl butyrate	TIC	96	JN	ug/L	96	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	32	JN	ug/L	32	JN	10.0	YES	NV
Total Alkanes	TIC			ug/L			10.0	YES	NV
n-Propyl acetate	TIC	200	JN	ug/L	200	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	72	JN	ug/L	72	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	42	JN	ug/L	42	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: PBLK738	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Heptachlor	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Heptachlor epoxide	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Endrin	Target	0.10	U	ug/L	0.10	U	1.0	YES	S2BVEM
Methoxychlor	Target	0.50	U	ug/L	0.50	U	1.0	YES	S2BVEM
cis-Chlordane	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
trans-Chlordane	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Toxaphene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: PLCS738	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Spike	0.044	J	ug/L	0.044	J	1.0	YES	S2BVEM
Heptachlor	Spike	0.046	J	ug/L	0.046	J	1.0	YES	S2BVEM
Heptachlor epoxide	Spike	0.048	J	ug/L	0.048	J	1.0	YES	S2BVEM
Endrin	Spike	0.094	JP	ug/L	0.094	JP	1.0	YES	S2BVEM
Methoxychlor	Spike	0.50		ug/L	0.50		1.0	YES	S2BVEM
cis-Chlordane	Spike	0.047	J	ug/L	0.047	J	1.0	YES	S2BVEM
trans-Chlordane	Spike	0.046	J	ug/L	0.046	J	1.0	YES	S2BVEM
Toxaphene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: PLEB708	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SBLK745	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
2-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
4-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Hexachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Nitrobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobutadiene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Pentachlorophenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SBLK746	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
2-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
4-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Hexachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Nitrobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobutadiene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Pentachlorophenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SBLK766	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
2-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
4-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Hexachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Nitrobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobutadiene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Pentachlorophenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SBLK767	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
2-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
4-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Hexachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Nitrobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobutadiene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Pentachlorophenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SLCS745	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Spike	30		ug/L	30		1.0	YES	S2BVEM
2-Methylphenol	Spike	30		ug/L	30		1.0	YES	S2BVEM
4-Methylphenol	Spike	30		ug/L	30		1.0	YES	S2BVEM
Hexachloroethane	Spike	31		ug/L	31		1.0	YES	S2BVEM
Nitrobenzene	Spike	35		ug/L	35		1.0	YES	S2BVEM
Hexachlorobutadiene	Spike	30		ug/L	30		1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Spike	34		ug/L	34		1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Spike	34		ug/L	34		1.0	YES	S2BVEM
2,4-Dinitrotoluene	Spike	41		ug/L	41		1.0	YES	S2BVEM
Hexachlorobenzene	Spike	31		ug/L	31		1.0	YES	S2BVEM
Pentachlorophenol	Spike	28		ug/L	28		1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SLCS746	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Spike	33		ug/L	33		1.0	YES	S2BVEM
2-Methylphenol	Spike	33		ug/L	33		1.0	YES	S2BVEM
4-Methylphenol	Spike	33		ug/L	33		1.0	YES	S2BVEM
Hexachloroethane	Spike	34		ug/L	34		1.0	YES	S2BVEM
Nitrobenzene	Spike	38		ug/L	38		1.0	YES	S2BVEM
Hexachlorobutadiene	Spike	33		ug/L	33		1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Spike	37		ug/L	37		1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Spike	38		ug/L	38		1.0	YES	S2BVEM
2,4-Dinitrotoluene	Spike	45		ug/L	45		1.0	YES	S2BVEM
Hexachlorobenzene	Spike	33		ug/L	33		1.0	YES	S2BVEM
Pentachlorophenol	Spike	32		ug/L	32		1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SLCS766	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Spike	34		ug/L	34		1.0	YES	S2BVEM
2-Methylphenol	Spike	34		ug/L	34		1.0	YES	S2BVEM
4-Methylphenol	Spike	35		ug/L	35		1.0	YES	S2BVEM
Hexachloroethane	Spike	35		ug/L	35		1.0	YES	S2BVEM
Nitrobenzene	Spike	39		ug/L	39		1.0	YES	S2BVEM
Hexachlorobutadiene	Spike	33		ug/L	33		1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Spike	38		ug/L	38		1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Spike	39		ug/L	39		1.0	YES	S2BVEM
2,4-Dinitrotoluene	Spike	50		ug/L	50		1.0	YES	S2BVEM
Hexachlorobenzene	Spike	34		ug/L	34		1.0	YES	S2BVEM
Pentachlorophenol	Spike	35		ug/L	35		1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SLCS767	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Spike	33		ug/L	33		1.0	YES	S2BVEM
2-Methylphenol	Spike	33		ug/L	33		1.0	YES	S2BVEM
4-Methylphenol	Spike	34		ug/L	34		1.0	YES	S2BVEM
Hexachloroethane	Spike	33		ug/L	33		1.0	YES	S2BVEM
Nitrobenzene	Spike	38		ug/L	38		1.0	YES	S2BVEM
Hexachlorobutadiene	Spike	33		ug/L	33		1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Spike	37		ug/L	37		1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Spike	38		ug/L	38		1.0	YES	S2BVEM
2,4-Dinitrotoluene	Spike	50		ug/L	50		1.0	YES	S2BVEM
Hexachlorobenzene	Spike	33		ug/L	33		1.0	YES	S2BVEM
Pentachlorophenol	Spike	33		ug/L	33		1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: SLEB708	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK145	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK147	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: VHBLK001	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Isopropyl Alcohol	TIC	29	JN	ug/L	29	JN	1.0	YES	NV
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX6** **Lab Name: Chemtech Consulting Group**

Sample Number: VLEB709	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Isopropyl butyrate	TIC	120	JN	ug/L	120	JN	10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	36	JN	ug/L	36	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	120	JN	ug/L	120	JN	10.0	YES	NV
n-Propyl acetate	TIC	210	JN	ug/L	210	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	40	JN	ug/L	40	JN	10.0	YES	NV
Propanoic acid, 2-methyl-, 1-methy	TIC	30	JN	ug/L	30	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: ABLK729	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: ABLK729	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: ALCS729	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	26	J	ug/kg	26	J	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	28	J	ug/kg	28	J	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX6	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-001	pH:	Sample Date: 06/15/2022	Sample Time: 09:37:00
% Moisture:		% Solids: 87.2	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX7	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-002	pH:	Sample Date: 06/15/2022	Sample Time: 10:20:00
% Moisture:		% Solids: 77.6	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1221	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1232	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1242	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1248	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1254	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1260	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1262	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1268	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX8	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-003	pH:	Sample Date: 06/15/2022	Sample Time: 11:15:00
% Moisture:		% Solids: 64.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1221	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1232	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1242	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1248	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1254	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1260	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1262	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM
Aroclor-1268	Target	51	U	ug/kg	51	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEX9	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-004	pH:	Sample Date: 06/15/2022	Sample Time: 13:00:00
% Moisture:		% Solids: 78.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1221	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1232	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1242	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1248	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1254	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1260	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1262	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM
Aroclor-1268	Target	42	U	ug/kg	42	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY0	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-005	pH:	Sample Date: 06/15/2022	Sample Time: 14:05:00
% Moisture:		% Solids: 88.8	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY1	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-006	pH:	Sample Date: 06/15/2022	Sample Time: 14:40:00
% Moisture:		% Solids: 88.8	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1221	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1232	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1242	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1248	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1254	Target	30000	J	ug/kg	30000	DP	100.0	YES	S2BVEM
Aroclor-1260	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1262	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM
Aroclor-1268	Target	370	U	ug/kg	370	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY2	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-007	pH:	Sample Date: 06/16/2022	Sample Time: 07:45:00
% Moisture:		% Solids: 88.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY3	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-008	pH:	Sample Date: 06/16/2022	Sample Time: 08:30:00
% Moisture:		% Solids: 85.7	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY4	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-009	pH:	Sample Date: 06/16/2022	Sample Time: 09:05:00
% Moisture:		% Solids: 87.4	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY5	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-010	pH:	Sample Date: 06/16/2022	Sample Time: 09:35:00
% Moisture:		% Solids: 85.1	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1221	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1232	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1242	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1248	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1254	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1260	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1262	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1268	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY6	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-011	pH:	Sample Date: 06/16/2022	Sample Time: 10:15:00
% Moisture:		% Solids: 88.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY7	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-012	pH:	Sample Date: 06/16/2022	Sample Time: 10:50:00
% Moisture:		% Solids: 88.9	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY8	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: Trip Blank	pH: 1.0	Sample Date: 06/16/2022	Sample Time: 12:00:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEY9	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-013	pH:	Sample Date: 06/16/2022	Sample Time: 12:30:00
% Moisture:		% Solids: 89.6	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ0	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-014	pH:	Sample Date: 06/16/2022	Sample Time: 13:20:00
% Moisture:		% Solids: 86.1	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ1	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-015	pH:	Sample Date: 06/16/2022	Sample Time: 13:50:00
% Moisture:		% Solids: 91.6	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1221	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1232	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1242	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1248	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1254	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1260	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1262	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM
Aroclor-1268	Target	36	U	ug/kg	36	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ2	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-016	pH:	Sample Date: 06/16/2022	Sample Time: 14:20:00
% Moisture:		% Solids: 86.5	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ3	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-017	pH:	Sample Date: 06/16/2022	Sample Time: 14:50:00
% Moisture:		% Solids: 86.3	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1221	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1232	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1242	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1248	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1254	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1260	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1262	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM
Aroclor-1268	Target	38	U	ug/kg	38	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ4	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-018	pH:	Sample Date: 06/16/2022	Sample Time: 15:30:00
% Moisture:		% Solids: 89.7	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-019	pH:	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 85.2	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1221	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1232	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1242	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1248	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1254	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1260	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1262	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1268	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5MS	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 85.2	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	110		ug/kg	110		1.0	YES	S2BVEM
Aroclor-1221	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1232	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1242	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1248	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1254	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	120		ug/kg	120		1.0	YES	S2BVEM
Aroclor-1262	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1268	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ5MSD	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 06/16/2022	Sample Time: 16:00:00
% Moisture:		% Solids: 85.2	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	100		ug/kg	100		1.0	YES	S2BVEM
Aroclor-1221	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1232	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1242	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1248	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1254	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	110		ug/kg	110		1.0	YES	S2BVEM
Aroclor-1262	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM
Aroclor-1268	Target	39	U	ug/kg	39	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK146	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Sample Number: VHBLK001	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEX7** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: ABLK793	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: ALCS793	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date:	Sample Time:
% Moisture:		% Solids: 100	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	23	J	ug/kg	23	J	1.0	YES	S2BVEM
Aroclor-1221	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1232	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1242	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1248	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1254	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	24	J	ug/kg	24	J	1.0	YES	S2BVEM
Aroclor-1262	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM
Aroclor-1268	Target	33	U	ug/kg	33	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location: PD SB-020	pH:	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 88.3	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6MS	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 88.3	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	140		ug/kg	140		1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	140		ug/kg	140		1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ6MSD	Method: Aroclors	Matrix: Soil	MA Number:
Sample Location:	pH:	Sample Date: 06/16/2022	Sample Time: 16:30:00
% Moisture:		% Solids: 88.3	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Aroclor-1016	Spike	170		ug/kg	170		1.0	YES	S2BVEM
Aroclor-1221	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1232	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1242	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1248	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1254	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1260	Spike	160		ug/kg	160		1.0	YES	S2BVEM
Aroclor-1262	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM
Aroclor-1268	Target	37	U	ug/kg	37	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ7	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: Trip Blank	pH: 1.0	Sample Date: 06/16/2022	Sample Time: 16:45:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK146	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Sample Number: VHBLK001	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Dichlorodifluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Vinyl chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromomethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichlorofluoromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloro-1,2,2-trifluoroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Acetone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Carbon disulfide	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl Acetate	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylene chloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methyl tert-butyl Ether	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,2-Dichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Butanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Bromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chloroform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,1-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Cyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Benzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Trichloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Methylcyclohexane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromodichloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
cis-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
4-Methyl-2-pentanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Toluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
trans-1,3-Dichloropropene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2-Trichloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2-Hexanone	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Dibromochloromethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromoethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Chlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Ethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
o-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
m,p-Xylene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Styrene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Bromoform	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Isopropylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,1,2,2-Tetrachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2-Dibromo-3-chloropropane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,4-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,3,5-Trimethylbenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ6** **Lab Name: Chemtech Consulting Group**

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
1,2,4-trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
1,2,3-Trichlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8	Method: Pesticides	Matrix: Water	MA Number:
Sample Location: PD Drilling Mud Drums	pH: 6.0	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location: PD Drilling Mud Drums	pH: 6.0	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
1-Hexanol, 2-ethyl-	TIC	35	JN	ug/L	35	JN	10.0	YES	NV
Isopropyl butyrate	TIC	40	JN	ug/L	40	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: EXEZ8	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location: PD Drilling Mud Drums	pH: 5.0	Sample Date: 07/20/2022	Sample Time: 13:30:00
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
n-Propyl acetate	TIC	120	JN	ug/L	120	JN	10.0	YES	NV
Isopropyl butyrate	TIC	63	JN	ug/L	63	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	51	JN	ug/L	51	JN	10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: PBLK542	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Heptachlor	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Heptachlor epoxide	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Endrin	Target	0.10	U	ug/L	0.10	U	1.0	YES	S2BVEM
Methoxychlor	Target	0.50	U	ug/L	0.50	U	1.0	YES	S2BVEM
cis-Chlordane	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
trans-Chlordane	Target	0.050	U	ug/L	0.050	U	1.0	YES	S2BVEM
Toxaphene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: PLCS542	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Spike	0.054		ug/L	0.054		1.0	YES	S2BVEM
Heptachlor	Spike	0.045	J	ug/L	0.045	J	1.0	YES	S2BVEM
Heptachlor epoxide	Spike	0.046	J	ug/L	0.046	J	1.0	YES	S2BVEM
Endrin	Spike	0.091	J	ug/L	0.091	J	1.0	YES	S2BVEM
Methoxychlor	Spike	0.51		ug/L	0.51		1.0	YES	S2BVEM
cis-Chlordane	Spike	0.045	J	ug/L	0.045	J	1.0	YES	S2BVEM
trans-Chlordane	Spike	0.046	J	ug/L	0.046	J	1.0	YES	S2BVEM
Toxaphene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: PLEB514	Method: Pesticides	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
gamma-BHC (Lindane)	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Heptachlor epoxide	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Endrin	Target	1.0	U	ug/L	1.0	U	10.0	YES	S2BVEM
Methoxychlor	Target	5.0	U	ug/L	5.0	U	10.0	YES	S2BVEM
cis-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
trans-Chlordane	Target	0.50	U	ug/L	0.50	U	10.0	YES	S2BVEM
Toxaphene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: SBLK541	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
2-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
4-Methylphenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Hexachloroethane	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Nitrobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobutadiene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Hexachlorobenzene	Target	5.0	U	ug/L	5.0	U	1.0	YES	S2BVEM
Pentachlorophenol	Target	10	U	ug/L	10	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: SLCS541	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Spike	25		ug/L	25		1.0	YES	S2BVEM
2-Methylphenol	Spike	40		ug/L	40		1.0	YES	S2BVEM
4-Methylphenol	Spike	40		ug/L	40		1.0	YES	S2BVEM
Hexachloroethane	Spike	43		ug/L	43		1.0	YES	S2BVEM
Nitrobenzene	Spike	44		ug/L	44		1.0	YES	S2BVEM
Hexachlorobutadiene	Spike	42		ug/L	42		1.0	YES	S2BVEM
2,4,6-Trichlorophenol	Spike	43		ug/L	43		1.0	YES	S2BVEM
2,4,5-Trichlorophenol	Spike	45		ug/L	45		1.0	YES	S2BVEM
2,4-Dinitrotoluene	Spike	55		ug/L	55		1.0	YES	S2BVEM
Hexachlorobenzene	Spike	40		ug/L	40		1.0	YES	S2BVEM
Pentachlorophenol	Spike	42		ug/L	42		1.0	YES	S2BVEM

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: SLEB514	Method: Semivolatiles	Matrix: Water	MA Number:
Sample Location:	pH: 6.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Pyridine	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
2-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
4-Methylphenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Hexachloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Nitrobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobutadiene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,6-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4,5-Trichlorophenol	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2,4-Dinitrotoluene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Hexachlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Pentachlorophenol	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK239	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: VBLK241	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: .0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: VHBLK001	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	1.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	1.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			1.0	YES	NV

Sample Summary Report

Project Name: VELSICOL CHEMICAL Project **GroupID: 50011/68HERH20D0011/EXEZ8** **Lab Name: Chemtech Consulting Group**

Sample Number: VLEB515	Method: Volatile Organics	Matrix: Water	MA Number:
Sample Location:	pH: 1.0	Sample Date:	Sample Time:
% Moisture:		% Solids: 0.0	

Analyte Name	Analyte Type	Validation Result	Validation Flag	Units	Lab Result	Lab Flag	Dilution Factor	Reportable	Validation Level
Vinyl chloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,1-Dichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
2-Butanone	Target	100	U	ug/L	100	U	10.0	YES	S2BVEM
Chloroform	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Carbon tetrachloride	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Benzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,2-Dichloroethane	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Trichloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Tetrachloroethene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Chlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
1,4-Dichlorobenzene	Target	50	U	ug/L	50	U	10.0	YES	S2BVEM
Total Alkanes	TIC			ug/L			10.0	YES	NV
Propanoic acid, 1-methylethyl este	TIC	26	JN	ug/L	26	JN	10.0	YES	NV
n-Propyl acetate	TIC	130	JN	ug/L	130	JN	10.0	YES	NV
Isopropyl butyrate	TIC	71	JN	ug/L	71	JN	10.0	YES	NV
Propanoic acid, propyl ester	TIC	59	JN	ug/L	59	JN	10.0	YES	NV
Acetic acid, butyl ester	TIC	29	JN	ug/L	29	JN	10.0	YES	NV

Attachment 2C
Data Validation Memorandum

TECHNICAL MEMORANDUM

Analytical Data Summary of the Perimeter Drain Sampling at the Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan

PREPARED FOR:	U.S. Environmental Protection Agency
PREPARED BY:	Shannon Olson/CH2M HILL
DATE:	March 1, 2023

The objective of the Data Validation memorandum is to assess the data quality of analytical results for soil investigation derived waste (IDW) samples collected during the field investigation conducted at the Velsicol Chemical Corporation Superfund Site in St. Louis, Michigan, June 15 and June 16, 2022, and July 20, 2022. Samples were collected and analyzed with the objective to evaluate future excavated soils for waste disposal options. Guidance used for this data assessment came from the site-specific *Quality Assurance Project Plan (QAPP): Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 0* (CH2M 2021), QAPP*: Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 1* (CH2M 2022), *U.S. Environmental Protection Agency (USEPA) National Functional Guidelines for Organic Superfund Methods Data Review* (USEPA 2020a); *USEPA National Functional* Guidelines for Inorganic Superfund Methods Data Review (USEPA 2020b); and individual method requirements.

This report is intended as a general data quality assessment designed to summarize laboratory data issues.

Analytical Data

The samples were collected by CH2M and were analyzed by the Contract Laboratory Program (CLP) or CT Laboratory in Baraboo, Wisconsin. The soil IDW sample was analyzed for toxicity characteristic leaching procedure (TCLP) volatile organic compounds (VOCs), TCLP semi volatile organic compounds (SVOCs), TCLP pesticides, TCLP herbicides, polychlorinated biphenyls (PCBs), TCLP metals, pH, and flashpoint. As part of the quality assurance process outlined in the site-specific *QAPP: Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 0* (CH2M 2021) and QAPP*: Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 1* (CH2M 2022), quality control (QC) samples were collected in the field to complement the assessment of overall data quality and usability. The QC samples consisted of aliquots for laboratory matrix spike (MS)/matrix spike duplicates (MSD) and trip blank (TB) samples.

The following samples were collected:

June:

- 20 soil IDW samples analyzed for TCLP VOCs, TCLP SVOCs, TCLP pesticides, TCLP herbicides, PCBs, TCLP metals, pH, and flashpoint
- 1 MS/MSD
- 2 TBs

July:

- One soil IDW sample analyzed for TCLP VOCs, TCLP SVOCs, TCLP pesticides, TCLP herbicides, PCBs, TCLP metals, pH, and flashpoint
- 1 MS/MSD
- 1 TB

The TCLP VOC, TCLP SVOC, TCLP pesticide, PCB and TCLP metal analyses were performed by the CLP and reported in seven sample delivery groups (SDGs). The TCLP herbicide, pH and flashpoint analyses were performed by CT Laboratory and were reported in two SDGs. The samples were shipped by overnight carrier to the laboratory for analysis. The samples were analyzed for the methods listed in Table 1.

TABLE 1
Analytical Parameters

Parameter	Method	Laboratory
TCLP VOCs, TCLP SVOCs, TCLP Pesticides, PCBs and TCLP Metals (including Mercury) in IDW-Soil	SFAM01.1	CLP
TCLP Herbicides in IDW-Soil	SW-846 1311/8151	CT Laboratory
pH in IDW-Soil	SW-846 9045D	CT Laboratory
Flashpoint in IDW Soil	SW-846 1010A	CT Laboratory

One hundred percent of the CLP data were reviewed/validated by USEPA contractor, Environmental Services Assistance Team (ESAT), except for TB contamination. The CH2M chemist confirmed that TBs met the projects data quality objectives. Attachment 1 contains the case narratives prepared by Techlaw ESAT. The CH2M chemist validated the data analyzed by CT Laboratory. The findings of both ESAT's validation and CH2M's validation of the non-CLP analyses are summarized in the following paragraphs.

The assessment of data included a review of the following:

- Completeness (i.e., verification that all of the samples were analyzed for the requested analytical parameters)
- Chain-of-custody documentation
- Holding times and sample receipt conditions
- Initial and continuing calibration precision and accuracy
- Required QC samples at the specified frequencies
- Flagging for calibration, method, and field blanks
- Laboratory control sample (LCS) accuracy
- MS/MSD precision and accuracy
- Post-digestion spike precision and accuracy where applicable
- Surrogate spike accuracy where applicable
- Internal standard accuracy where applicable
- Interference check sample accuracy where applicable
- Serial dilution precision where applicable
- Column differential precision where applicable
- Duplicates where applicable

Standard data qualifiers were added as a means of classifying the data as to their conformance to quality assurance (QA)/QC requirements. Multiple qualifiers are routinely applied to specific sample method/matrix/analyte combinations, but there will be only one final qualifier. A final qualifier is applied to the data and is the most conservative of the applied validation qualifiers. The data qualifiers are defined as follows:

[U] The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

[UJ] The analyte was analyzed for, but not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

[J] The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

[J+] The result is an estimated quantity, but the result may be biased high.

[J-] The result is an estimated quantity, but the result may be biased low.

Findings

The following subsections summarize the data validation findings and usability of the final reportable results. J qualifiers were applied to sample results that were reported between the method detection limit (MDL) and the contract required quantitation limit (CRQL).

Holding Time and Temperature

All preservation, temperature and holding time acceptance criteria were met.

Calibration

Initial and continuing calibration verifications were performed as required by the applicable analytical methods, and all acceptance criteria were met.

Calibration Blanks

Calibration blanks were analyzed at the required frequency, as required for the metal's analysis, and were free of contamination except as noted below.

- One initial calibration blank (ICB) for TCLP mercury associated with IDW soil sample EXEX6 in SDG EXEX6 was detected less than or equal to the MDL but greater than the CRQL. The associated non-detected result was qualified estimated as UJ.
- One continuing calibration blank (CCB) for TCLP lead associated with IDW soil sample EXEZ3 in SDG EXEX6 was detected less than the CRQL. The detected result was qualified as not detected, was reported at the CRQL and flagged U because the sample concentration was less than the CRQL.
- One CCB for TCLP lead associated with IDW soil sample EXEZ4 in SDG EXEX6 was detected less than the CRQL. The associated detected result was qualified estimated as J+ because the sample concentration was greater than or equal to the CRQL.
- One CCB for TCLP mercury associated with IDW soil sample EXEX6 in SDG EXEX6 was detected less than or equal to the MDL but greater than the CRQL. The associated non-detected result was qualified estimated as UJ.

Method Blanks

Method blanks were analyzed at the required frequency and were free of contamination except as noted below.

- The method blank for TCLP arsenic associated with IDW soil sample EXEZ8 in SDG EXEZ8 was detected less than the CRQL. The associated detected result was qualified estimated as J+ because the sample concentration was greater than or equal to the CRQL.
- The method blank for TCLP mercury associated with all the IDW soil samples in SDG EXEX6 was detected less than or equal to the MDL but greater than the CRQL. Detects were qualified estimated as J- or were not qualified. Non-detected results were qualified estimated as UJ.

Field Blanks

Three TBs were collected and analyzed at the required frequency and were free of contamination.

Laboratory Control Samples

LCSs were analyzed as required and all accuracy criteria were met.

Matrix and Post-Digestion (Metals) Spikes

MS/MSDs were analyzed as required, and all accuracy and precision criteria were met except as noted below.

- The MS/MSD relative percent difference (RPD) was exceeded for aroclor-1016 associated with the PCB analysis for IDW soil sample EXEZ6 in SDG EXEZ6. The associated result in the parent sample was non-detect and was therefore not qualified.

Surrogates

Surrogates were added in the laboratory as required by the applicable analytical methods and acceptance criteria were met except as noted below.

- One or more surrogate was recovered greater than the upper control limit for the following SDGs, indicating a possible high bias. Detected results were qualified as estimated and flagged J+ in the associated samples. Non-detected results were not qualified.
  - TCLP SVOC surrogates (nitrobenzene-d5 and 2-nitrophenol-d4) associated with IDW soil samples EXEY6 and EXEZ6 in SDG EXEX6
  - TCLP pesticide surrogates (tetrachloro-m-xylene and decachlorobiphenyl) associated with IDW soil samples EXEX6, EXEZ4, EXEZ5 and EXEZ6 in SDG EXEX6
  - PCB surrogate (decachlorobiphenyl) associated with IDW soil samples EXEY1 and EXEY6 in SDG EXEX7
- One or more TCLP VOC surrogate (vinyl chloride-d3, chloroethane-d5, 1,1-dichloroethene-d2 and/or toluene-d8) was recovered less than the lower control limit for several IDW soil samples in SDG EXEX6, indicating a possible low bias. The data were qualified as estimated non-detected results and flagged UJ in the associated samples.

Internal Standards

Internal standards were added in the laboratory as required by the applicable analytical method and all acceptance criteria were met.

Interference Check Sample

Interference check samples were analyzed as required for the metal's analysis, and all accuracy criteria were met.

Serial Dilution

Serial dilutions were analyzed as required for the metal's analysis, and all precision criteria were met.

Column Differential

The RPD between the primary and confirmation columns were calculated to determine the precision of the pesticide and PCB results. The RPDs were within the established QC limits except as noted below.

- The RPD between the columns exceeded 25 percent for aroclor-1254 associated with IDW soil sample EXEY1 in SDG EXEX7. The associated detected result was qualified estimated as J.

Laboratory Duplicates

The RPD between the field sample and laboratory duplicate concentrations for the metals analysis was calculated to determine the precision of the results. The RPDs were within the established QC limits except as noted below.

- The RPD between the field sample and the laboratory duplicate exceeded 20 percent and the analyte results were greater than or equal to five times the CRQL in both the native and duplicate sample for TCLP lead associated with IDW soil sample EXEX6 in SDG EXEX6. The associated detected result was qualified estimated as J.

Overall Assessment

The final activity in the data quality evaluation is an assessment of whether the data meet the data quality objectives using the criteria of precision, accuracy, representativeness, comparability, and completeness (PARCC). The goal of the assessment was to demonstrate that a sufficient number of representative samples were collected, and the resulting analytical data can be used to support the decision-making process.

1. The precision and accuracy of the data, as measured by field and laboratory QC indicators, indicate that the data quality objectives were generally met with several analytes flagged estimated as "J", "J-", "J+", "UJ" or "U" due to blank, surrogate, column differential and laboratory duplicate issues. Data users should consider the impact to any result that is qualified as estimated as it may contain a bias which could affect the decision-making process.

2. Representativeness of the data was verified through the sample collection, storage, and preservation procedures and the verification of holding-time compliance. All objectives were met.

3. Comparability of the data was verified using standard analytical procedures and standard units for reporting. Results obtained are comparable to industry standards in that the collection and analytical techniques followed approved, documented procedures.

4. Completeness is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. Completeness is expressed as the percentage of valid or usable measurements compared to planned measurements. Valid data are defined as the data that are not rejected for project use. No data were rejected therefore the completeness goal of 90 percent was met for all analyte/method combinations. All non-rejected data as qualified, can be used in the project-making process.

References

CH2M HILL. 2021. *Quality Assurance Project Plan, Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 0.* December.

CH2M HILL. 2022. *Quality Assurance Project Plan, Velsicol Chemical Corporation Superfund Site – Remedial Design, St. Louis, Michigan, Revision 1.* March.

USEPA. 2020a. *National Functional Guidelines for Organic Superfund Methods Data Review*. November.

USEPA. 2020b. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. November.

Attachment 1

Region 5 ICF-ESAT Document Control Number: 00490
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on 04/29/2022

FROM: Leila Barber, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsy.xayachack@jacobs.com
EPA Data User:	US EPA Superfund
Contact Person's Name:	Tom Alcamo
Contact email address:	alcamo.tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical, MI

CASE NUMBER: 50011 SDG NUMBER: EXEX6

Number and Type of Samples: 20 TCLP soils (ICP-AES, Hg)

Sample Numbers: EXEX6- EXEX9, EXEY0-EXEY9, EXEZ0-EXEZ6

Laboratory: Bonner Analytical Testing Company (BON)

The following are our findings:

Case: 50011
Site: Velsicol Chemical

SDG: EXEX6
Laboratory: Bonner Analytical Testing Company

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

Twenty (20) TCLP soil samples, numbered below, were collected on 06/15/2022 and 06/16/2022. The lab, Bonner Analytical Testing Company located in Hattiesburg, MS, received the samples on 06/17/2022 and 06/18/2022 in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses conducted by lab
EXEX6	VCS-OU1-PD-SO-001-10.0/18.0	2206250-01	06/15/2022 09:37	0.6°C	ICP-AES, Hg
EXEX7	VCS-OU1-PD-SO-002-7.0/15.0	2206250-02	06/15/2022 10:20	0.6°C	ICP-AES, Hg
EXEX8	VCS-OU1-PD-SO-003-13.0/19.0	2206250-03	06/15/2022 11:15	0.6°C	ICP-AES, Hg
EXEX9	VCS-OU1-PD-SO-004-8.0/18.0	2206250-04	06/15/2022 13:00	0.6°C	ICP-AES, Hg
EXEY0	VCS-OU1-PD-SO-005-10.0/18.0	2206250-05	06/15/2022 14:05	0.6°C	ICP-AES, Hg
EXEY1	VCS-OU1-PD-SO-006-5.0/10.0	2206250-06	06/15/2022 14:40	0.6°C	ICP-AES, Hg
EXEY2	VCS-OU1-PD-SO-007-8.0/11.0	2206250-07	06/16/2022 07:45	0.6°C	ICP-AES, Hg
EXEY3	VCS-OU1-PD-SO-008-8.0/12.0	2206250-08	06/16/2022 08:30	0.6°C	ICP-AES, Hg
EXEY4	VCS-OU1-PD-SO-009-7.0/10.0	2206250-09	06/16/2022 09:05	0.6°C	ICP-AES, Hg
EXEY5	VCS-OU1-PD-SO-010-8.0/15.0	2206250-10	06/16/2022 09:35	0.6°C	ICP-AES, Hg
EXEY6	VCS-OU1-PD-SO-011-6.0/10.0	2206250-11	06/16/2022 10:15	0.6°C	ICP-AES, Hg
EXEY7	VCS-OU1-PD-SO-012-4.0/10.0	2206250-12	06/16/2022 10:50	0.6°C	ICP-AES, Hg
EXEY9	VCS-OU1-PD-SO-013-6.0/10.0	2206250-13	06/16/2022 12:30	4.0°C	ICP-AES, Hg
EXEZ0	VCS-OU1-PD-SO-014-8.0/11.0	2206250-14	06/16/2022 13:20	4.0°C	ICP-AES, Hg
EXEZ1	VCS-OU1-PD-SO-015-2.0/9.0	2206250-15	06/16/2022 13:50	4.0°C	ICP-AES, Hg
EXEZ2	VCS-OU1-PD-SO-016-3.0/15.0	2206250-16	06/16/2022 14:20	4.0°C	ICP-AES, Hg

EXEZ3	VCS-OU1-PD-SO-017-3.0/8.0	2206250-17	06/16/2022 14:50	4.0°C	ICP-AES, Hg
EXEZ4	VCS-OU1-PD-SO-018-3.0/10.0	2206250-18	06/16/2022 15:30	4.0°C	ICP-AES, Hg
EXEZ5	VCS-OU1-PD-SO-019-8.0/14.0	2206250-19	06/16/2022 16:00	4.0°C	ICP-AES, Hg
EXEZ6	VCS-OU1-PD-SO-020-10.0/15.0	2206250-20	06/16/2022 16:30	4.0°C	ICP-AES, Hg

All samples were analyzed for ICP-AES metals and Mercury. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund QAPP (Quality Assurance Project Plan), November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Inorganic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-003-r0.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 10. – QAPP Compliance

Case: 50011
Site: Velsicol Chemical

SDG: EXEX6
Laboratory: Bonner Analytical Testing Company

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE:

NONE FOUND.

3. CALIBRATION:

NONE FOUND.

4. BLANKS:

Method -Metals by ICP-AES

EXES-0150
The following samples have analyte results less than CRQLs. The associated CCB analyte results are less than CRQLs. Detects are qualified as U. Sample results are reported at CRQLs.

Lead
EXEZ3

EXES-0167
The following samples have analyte results greater than or equal to the CRQLs. The associated CCB analyte results are less than the CRQLs. Detects are qualified as estimated J+ or no qualification.

Lead
EXEZ4

Method -Mercury by Cold Vapor

EXES-0174
The following samples are associated with ICB that has analyte results less than or equal to (-MDLs) but greater than (-CRQLs). Detects are qualified as estimated J-or no qualification. Nondetects are qualified as estimated UJ.

Mercury
EXEX6, EXEX6D, EXEX6S, LEB02, PBW02

EXES-0175

The following samples are associated with CCB that has analyte results less than or equal to (-MDLs) but greater than (-CRQLs). Detects are qualified as estimated J-or no qualification. Nondetects are qualified as estimated UJ.

Mercury
EXEX6, EXEX6D, EXEX6S, LEB02, PBW02

EXES-0176
The following samples are associated with preparation blank (PB) that has analyte results less than or equal to (-MDL) but greater than (-CRQL). Detects are qualified as estimated J-or no qualification. Nondetects are qualified as estimated UJ.

Mercury
EXEX6, EXEX6D, EXEX6S, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5, EXEZ6

5. INTERFERENCE CHECK SAMPLE:

NONE FOUND.

6. LABORATORY CONTROL SAMPLE:

NONE FOUND.

7. MATRIX SPIKES:

NONE FOUND.

8. SERIAL DILUTION:

NONE FOUND.

9. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS

Method -Metals by ICP-AES

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

Arsenic
EXEX6, EXEX6D, EXEX7, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY9, EXEZ0, EXEZ4

Barium
EXEX6L, EXEX8, EXEX9, EXEZ6

Cadmium
EXEX6, EXEX6D, EXEX7, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5

Chromium
EXEX6, EXEX6D, EXEX6L, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY6, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5

Lead
EXEY2, EXEY6, EXEZ1, EXEZ2

Selenium
EXEX6, EXEY7, EXEY9

Method -Mercury by Cold Vapor

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

Mercury
EXEY3, EXEY5, EXEZ0, EXEZ4, PBW02.

10. DUPLICATES:

Method -Metals by ICP-AES

EXES-601
The following samples are associated with a Duplicate sample that has analyte results are greater than or equal to 5xCRQL in both Duplicate and original samples and RPD is greater than 20. Detects are qualified as J. Nondetects are qualified as UJ.

Lead
EXEX6D

11. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

12. DOCUMENTATION:

The COC only listed TCLP metals for analysis but TCLP Hg was also scheduled. As per Region 5, the laboratory also performed Hg analysis.

Case: 50011
Site: Velsicol Chemical

SDG: EXEX6
Laboratory: Bonner Analytical Testing Company

EXES SFAM01.1 Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Region 5 ICF-ESAT Document Control Number: 00558
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on 04/29/2022

FROM: Leila Barber, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com

EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.Tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Plant, MI

CASE NUMBER: 50011 SDG NUMBER: EXEZ8

Number and Type of Samples: 1 soil TCLP (ICP-AES, 1 Hg)

Sample Numbers: EXEZ8

Laboratory: Bonner Analytical Testing Company (BON)

The following are our findings:

Case: 50011
Site: Velsicol Chemical Testing

SDG: EXEZ8
Laboratory: Bonner Analytical Testing Company

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

One (01) TCLP soil sample, numbered EXEZ8, was collected on 07/20/2022. The lab, Bonner Analytical Testing Company located in Hattiesburg, MS received the samples on 07/21/2022 in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses
VSC-OU1-PD-IDW-SO-072022	EXEZ8	2207294-01	07/20/2022 13:30	0.0°C	ICP-AES, Hg

All samples were analyzed for TCLP ICP-AES metals and TCLP Mercury. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical QAPP (Quality Assurance Project Plan), November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Inorganic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-003-r0.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

Case: 50011
Site: Velsicol Chemical Testing

SDG: EXEZ8
Laboratory: Bonner Analytical Testing Company

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE:

NONE FOUND.

3. CALIBRATION:

NONE FOUND.

4. BLANKS:

Method - Metals by ICP-AES

EXES-1156
The following samples have analyte results reported greater than or equal to CRQLs. The associated TCLP/SPLP blank results are less than CRQLs. Detects are qualified as estimated J+ or no qualification.

Arsenic
EXEZ8

5. INTERFERENCE CHECK SAMPLE:

NONE FOUND.

6. LABORATORY CONTROL SAMPLE:

NONE FOUND.

7. MATRIX SPIKES:

NONE FOUND.

8. SERIAL DILUTION:

NONE FOUND.

9. INTERNAL STANDARDS:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS

Method - Metals by ICP-AES

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

Arsenic
LEB01

Chromium
EXEZ8

11. DUPLICATES:

NONE FOUND.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

13. DOCUMENTATION:

TCLP Hg analysis was not listed on the COC. Per Region 5, TCLP Hg analysis was also performed.

Case: 50011
Site: Velsicol Chemical Testing

SDG: EXEZ8
Laboratory: Bonner Analytical Testing Company

EXES SFAM01.1 Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Region 5 ICF-ESAT Document Control Number: 00491
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on: 04/29/2022

FROM: Martin Sarmiento, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com
EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Superfund Site, St. Louis, MI

CASE NUMBER: 50011 SDG NUMBER: EXEX6

Number and Type of Samples: 20 TCLP Soils (L/M VOA, SVOA, PEST)

Sample Numbers: EXEX6-EXEX9, EXEY0-EXEY7, EXEY9, EXEZ0-EXEZ6

Laboratory: Chemtech Consulting Group (CHM), NJ

The following are our findings:

Case: 50011
Site: Velsicol Chemical Superfund Site, St. Louis, MI

SDG: EXEX6
Laboratory: CHM

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

Twenty (20) soil samples identified in the table below were collected on 06/15/2022 and 06/16/2022. The samples were submitted to the laboratory, Chemtech Consulting Group, located in Mountainside, NJ. The samples were received on 06/17/2022 and 06/18/2022 intact and in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses
EXEX6	VCS-OU1-PD-SO-001-10.0/18.0	N3392-01	06/15/2022 09:37	2.1°C	L/M VOA, SVOA, PEST
EXEX7	VCS-OU1-PD-SO-002-7.0/15.0	N3392-02	06/15/2022 10:20	2.1°C	L/M VOA, SVOA, PEST
EXEX8	VCS-OU1-PD-SO-003-13.0/19.0	N3392-03	06/15/2022 11:15	2.1°C	L/M VOA, SVOA, PEST
EXEX9	VCS-OU1-PD-SO-004-8.0/18.0	N3392-04	06/15/2022 13:00	2.1°C	L/M VOA, SVOA, PEST
EXEY0	VCS-OU1-PD-SO-005-10.0/18.0	N3392-05	06/15/2022 14:05	2.1°C	L/M VOA, SVOA, PEST
EXEY1	VCS-OU1-PD-SO-006-5.0/10.0	N3392-06	06/15/2022 14:40	2.1°C	L/M VOA, SVOA, PEST
EXEY2	VCS-OU1-PD-SO-007-8.0/11.0	N3392-07	06/16/2022 07:45	2.1°C	L/M VOA, SVOA, PEST
EXEY3	VCS-OU1-PD-SO-008-8.0/12.0	N3392-08	06/16/2022 08:30	2.1°C	L/M VOA, SVOA, PEST
EXEY4	VCS-OU1-PD-SO-009-7.0/10.0	N3392-09	06/16/2022 09:05	2.1°C	L/M VOA, SVOA, PEST
EXEY5	VCS-OU1-PD-SO-010-8.0/15.0	N3392-10	06/16/2022 09:35	2.1°C	L/M VOA, SVOA, PEST
EXEY6	VCS-OU1-PD-SO-011-6.0/10.0	N3392-11	06/16/2022 10:15	2.1°C	L/M VOA, SVOA, PEST
EXEY7	VCS-OU1-PD-SO-012-4.0/10.0	N3392-12	06/16/2022 10:50	2.1°C	L/M VOA, SVOA, PEST
EXEY9	VCS-OU1-PD-SO-013-6.0/10.0	N3392-14	06/16/2022 12:30	2.3°C	L/M VOA, SVOA, PEST
EXEZ0	VCS-OU1-PD-SO-014-8.0/11.0	N3392-15	06/16/2022 13:20	2.3°C	L/M VOA, SVOA, PEST
EXEZ1	VCS-OU1-PD-SO-015-2.0/9.0	N3392-16	06/16/2022 13:50	2.3°C	L/M VOA, SVOA, PEST
EXEZ2	VCS-OU1-PD-SO-016-3.0/15.0	N3392-17	06/16/2022 14:20	2.3°C	L/M VOA, SVOA, PEST
EXEZ3	VCS-OU1-PD-SO-017-3.0/8.0	N3392-18	06/16/2022 14:50	2.3°C	L/M VOA, SVOA, PEST

EXEZ4	VCS-OU1-PD-SO-018-3.0/10.0	N3392-19	06/16/2022 15:30	2.3°C	L/M VOA, SVOA, PEST
EXEZ5	VCS-OU1-PD-SO-019-8.0/14.0	N3392-20	06/16/2022 16:00	2.3°C	L/M VOA, SVOA, PEST
EXEZ6	VCS-OU1-PD-SO-020-10.0/15.0	N3392-21	06/16/2022 16:30	2.3°C	L/M VOA, SVOA, PEST

All samples were analyzed for L/M VOA, SVOA, and PEST. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund QAPP (Quality Assurance Project Plan), Rev 5/21/21 and November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Organic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-005-r0.

No samples were designated by the samplers to be used for laboratory QC, i.e., MS/MSD analyses.

No samples were identified as trip blanks, field blanks or field duplicates.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE AND SYSTEM PERFORMANCE:

NONE FOUND.

3. CALIBRATION:

Method - Volatile Organics

EXES-988
The following samples are associated with an initial calibration in which a DMC did not meet relative response factor (RRF) criteria. Detects are not qualified. Nondetects are not qualified.

> EXEX6, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5, EXEZ6, VBLK145, VBLK147, VHBLK001
> trans-1,3-Dichloropropene-d4

EXES-614
The following samples are associated with an opening or closing CCV with DMC RRF exceeding criteria. Detects are not qualified. Nondetects are not qualified.

> EXEX6, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ2, EXEZ3, EXEZ4, VBLK145
> trans-1,3-Dichloropropene-d4

Method - Semivolatiles

EXES-793
The following samples are associated with an initial calibration percent relative standard deviation (%RSD) outside criteria. Detects are qualified as estimated J. Nondetects are not qualified or qualified as estimated UJ.

> EXEX6, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5, EXEZ6, SBLK745, SBLK746, SBLK766, SBLK767, SLCS745, SLCS746, SLCS766, SLCS767
> 2-Nitrophenol, 2-Nitroaniline

EXES-1209
The following samples are associated with an opening or closing CCV with % Difference exceeding criteria. Detects are qualified as estimated J. Nondetects are qualified as estimated UJ.

EXEX6, EXEX8, EXEY1, EXEY4, EXEY5, EXEZ0, EXEZ2, EXEZ4, SBLK745, SBLK746, SLCS745, SLCS746, SLCS766, SLCS767
2,4-Dinitrophenol

4. BLANKS

NONE FOUND.

5. DEUTERATED MONITORING COMPOUNDS / SURROGATES

Method - Volatile Organics

EXES-792
The following samples have DMC/surrogate percent recoveries less than the primary minimum criteria but greater than or equal to the expanded minimum criteria. Detects are qualified as estimated J-. Nondetects are qualified as estimated UJ.

EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ2
1,1-Dichloroethene, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene

EXEZ3, EXEZ5[Reinjection-01], EXEZ6
1,1-Dichloroethene, trans-1,2-Dichloroethene, cis-1,2-Dichloroethenem, Trichloroethene, Toluene, Tetrachloroethene, Ethylbenzene, o-Xylene, m,p-Xylene, Styrene

EXEZ4
Dichlorodifluoromethane, Chloromethane, Bromomethane, Chloroethane, 1,1-Dichloroethene, Carbon disulfide, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Toluene, Tetrachloroethene, Ethylbenzene, o-Xylene, m,p-Xylene, Styrene

EXEZ5
Vinyl chloride, 1,1-Dichloroethene, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Toluene, Tetrachloroethene, Ethylbenzene, o-Xylene, m,p-Xylene, Styrene

EXES-982
The following samples have DMC/surrogate percent recoveries greater than the primary maximum criteria. Detects are qualified as estimated J+.

EXEZ5[Reinjection-01]
Acetone, 2-Butanone, 4-Methyl-2-pentanone, 2-Hexanone

EXEZ6
4-Methyl-2-pentanone, 2-Hexanone

Method - Semivolatiles

EXES-982
The following samples have DMC/surrogate percent recoveries greater than the primary maximum criteria. Detects are qualified as estimated J+.

EXEY6, EXEZ6
Acetophenone, N-Nitroso-di-n-propylamine, Hexachloroethane, Nitrobenzene, Isophorone, 2-Nitrophenol, Hexachlorocyclopentadiene, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, N-Nitrosodiphenylamine, 3,3'-Dichlorobenzidine

EXEY7, EXEZ3, EXEZ4
Isophorone, 2-Nitrophenol

Method - Pesticides

EXES-795
The following samples have surrogate percent recoveries greater than the expanded maximum criteria Detects are qualified as estimated J+.

EXEX6, EXEZ4, EXEZ5, EXEZ6
alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (Lindane), Heptachlor, Aldrin, Heptachlor epoxide, Endosulfan I, Dieldrin, 4,4'-DDE, Endrin, Endosulfan II, 4,4'-DDD, Endosulfan Sulfate, 4,4'-DDT, Methoxychlor, Endrin ketone, Endrin Aldehyde, cis-Chlordane, trans-Chlordane, Toxaphene

6. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Method - Pesticides

EXES-041
The following samples are not associated with Matrix Spike sample. Detects are not qualified. Nondetects are not qualified.

EXEX6, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5, EXEZ6

EXES-042
The following samples are not associated with Matrix Spike sample. Detects are not qualified. Nondetects are not qualified.

EXEX6, EXEX7, EXEX8, EXEX9, EXEY0, EXEY1, EXEY2, EXEY3, EXEY4, EXEY5, EXEY6, EXEY7, EXEY9, EXEZ0, EXEZ1, EXEZ2, EXEZ3, EXEZ4, EXEZ5, EXEZ6

7. CLEANUP PROCEDURES

NONE FOUND.

8 LABORATORY CONTROL SAMPLE:

NONE FOUND.

9. INTERNAL STANDARD:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS:

Method - Volatile Organics

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

EXEX7
Benzene

Method – Pesticides

EXES-1509
The following samples have a result difference between the two columns greater than 25%. Detects are qualified as estimated J.

PLCS738
Endrin

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

PLCS738
gamma-BHC (Lindane), Heptachlor, Heptachlor epoxide, Endrin, cis-Chlordane, trans-Chlordane

11. FIELD QC SAMPLES:

Review not required under specified validation stage.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15,

#19, #35 & #36). No MS/MSD was analyzed.

13. DOCUMENTATION

Shipping Discrepancies and/or QC issues

The airbill number is missing from all the COCs received with the shipment.

EXES SFAM01.1 Data Qualifier Sheet

Validation Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The Target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatograph/Mass Spectrometer (GC/MS).
X	The Target Pesticide or Aroclor analyte identification was not confirmed.

Region 5 ICF-ESAT Document Control Number: 00492
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on: 04/29/2022

FROM: Martin Sarmiento, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com
EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Superfund Site, St. Louis, MI

CASE NUMBER: 50011 SDG NUMBER: EXEX7

Number and Type of Samples: 1 (L/M VOA) 19 (ARO)

Sample Numbers: EXEX6-EXEX9, EXEY0-EXEY9, EXEZ0-EXEZ5

Laboratory: Chemtech Consulting Group (CHM), NJ

The following are our findings:

Case: 50011 SDG: EXEX7
Site: Velsicol Chemical Superfund Site, St. Louis, MI Laboratory: CHM

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

Nineteen (19) soil samples and one (1) water sample were identified in the table below. They were collected on 06/15/2022 and 06/16/2022. The samples were submitted to the laboratory, Chemtech Consulting Group, located in Mountainside, NJ. The samples were received on 06/17/2022 and 06/18/2022 intact and in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses
EXEX6	VCS-OU1-PD-SO-001-10.0/18.0	N3394-01	06/15/2022 09:37	2.1°C	ARO
EXEX7	VCS-OU1-PD-SO-002-7.0/15.0	N3394-02	06/15/2022 10:20	2.1°C	ARO
EXEX8	VCS-OU1-PD-SO-003-13.0/19.0	N3394-03	06/15/2022 11:15	2.1°C	ARO
EXEX9	VCS-OU1-PD-SO-004-8.0/18.0	N3394-04	06/15/2022 13:00	2.1°C	ARO
EXEY0	VCS-OU1-PD-SO-005-10.0/18.0	N3394-05	06/15/2022 14:05	2.1°C	ARO
EXEY1	VCS-OU1-PD-SO-006-5.0/10.0	N3394-06	06/15/2022 14:40	2.1°C	ARO
EXEY2	VCS-OU1-PD-SO-007-8.0/11.0	N3394-07	06/16/2022 07:45	2.1°C	ARO
EXEY3	VCS-OU1-PD-SO-008-8.0/12.0	N3394-08	06/16/2022 08:30	2.1°C	ARO
EXEY4	VCS-OU1-PD-SO-009-7.0/10.0	N3394-09	06/16/2022 09:05	2.1°C	ARO
EXEY5	VCS-OU1-PD-SO-010-8.0/15.0	N3394-10	06/16/2022 09:35	2.1°C	ARO
EXEY6	VCS-OU1-PD-SO-011-6.0/10.0	N3394-11	06/16/2022 10:15	2.1°C	ARO
EXEY7	VCS-OU1-PD-SO-012-4.0/10.0	N3394-12	06/16/2022 10:50	2.1°C	ARO
EXEY8	VCS-OU1-PD-TB-001	N3394-13	06/16/2022 12:00	2.1°C	L/M VOA
EXEY9	VCS-OU1-PD-SO-013-6.0/10.0	N3394-15	06/16/2022 12:30	2.3°C	ARO
EXEZ0	VCS-OU1-PD-SO-014-8.0/11.0	N3394-16	06/16/2022 13:20	2.3°C	ARO
EXEZ1	VCS-OU1-PD-SO-015-2.0/9.0	N3394-17	06/16/2022 13:50	2.3°C	ARO
EXEZ2	VCS-OU1-PD-SO-016-3.0/15.0	N3394-18	06/16/2022 14:20	2.3°C	ARO

EXEZ3	VCS-OU1-PD-SO-017-3.0/10.0	N3394-19	06/16/2022 14:50	2.3°C	ARO
EXEZ4	VCS-OU1-PD-SO-018-3.0/10.0	N3394-20	06/16/2022 15:30	2.3°C	ARO
EXEZ5	VCS-OU1-PD-SO-019-8.0/14.0	N3394-21	06/16/2022 16:00	2.3°C	ARO

One (1) sample was analyzed for L/M VOA. Nineteen (19) samples were analyzed for ARO. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund QAPP (Quality Assurance Project Plan), Rev 5/21/21 and November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Organic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-005-r0.

Sample EXEZ5 was designated by the samplers to be used for laboratory QC, i.e., MS/MSD analyses.

Sample EXEY8 was identified as a trip blank.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE AND SYSTEM PERFORMANCE:

NONE FOUND.

3. CALIBRATION:

Method - Volatile Organics

EXES-988
The following samples are associated with an initial calibration in which a DMC did not meet relative response factor (RRF) criteria. Detects are not qualified. Nondetects are not qualified.

EXEY8, VBLK146, VHBLK001
trans-1,3-Dichloropropene-d4

EXES-614
The following samples are associated with an opening or closing CCV with DMC RRF exceeding criteria. Detects are not qualified. Nondetects are not qualified.

EXEY8, VBLK146, VHBLK001
trans-1,3-Dichloropropene-d4

4. BLANKS

NONE FOUND.

5. DEUTERATED MONITORING COMPOUNDS / SURROGATES

Method - Aroclors

EXES-795
The following samples have surrogate percent recoveries greater than the expanded maximum criteria. Detects are qualified as estimated J+.

EXEY6
Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Aroclor-1262, Aroclor-1268

EXES-971
The following samples have surrogate percent recoveries greater than the primary maximum criteria but are less than or equal to the expanded maximum criteria. Detects are qualified as estimated J+.

Nondetects are not qualified.

EXEY1
Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Aroclor-1262, Aroclor-1268

EXES-983
The following diluted samples have surrogate percent recoveries less than the expanded minimum criteria. Detects are not qualified. Nondetects are not qualified.

EXEY1[Dilution-01]
Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Aroclor-1262, Aroclor-1268

6. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

NONE FOUND.

7. CLEANUP PROCEDURES

NONE FOUND.

8 LABORATORY CONTROL SAMPLE:

NONE FOUND.

9. INTERNAL STANDARD:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS:

Method - Aroclors

EXES-1509
The following samples have a result difference between the two columns greater than 25%. Detects are qualified as estimated J.

EXEY1[Dilution-01]
Aroclor-1254

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

ALCS729
Aroclor-1016, Aroclor-1260

11. FIELD QC SAMPLES:

Review not required under specified validation stage.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

13. DOCUMENTATION

Shipping Discrepancies and/or QC issues

The airbill number is missing from all the COCs received with the shipment. CHM had SDG EXEX7 open without assigned laboratory QC for the ARO analysis. A sample was not designated for laboratory QC, but sample EXEZ5 was received with additional volume. Per SFAM01.1, Exhibit A, Section 5.5.4.1, the laboratory noted the issue in the SDG Narrative and proceeded with the analysis of the samples.

Case: 50011 SDG: EXEX7
Site: Velsicol Chemical Superfund Site, St. Louis, MI Laboratory: CHM

EXES SFAM01.1 Data Qualifier Sheet

Validation Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The Target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatograph/Mass Spectrometer (GC/MS).
X	The Target Pesticide or Aroclor analyte identification was not confirmed.

Assembled by: Martin Sarmiento
Date: 07/21/2022

Region 5 ICF-ESAT Document Control Number: 00493
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on: 04/09/2022

FROM: Martin Sarmiento, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com
EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Superfund Site, St. Louis, MI

CASE NUMBER: 50011 SDG NUMBER: EXEZ6

Number and Type of Samples: 1 (L/M VOA) 1 (ARO)

Sample Numbers: EXEZ6, EXEZ7

Laboratory: Chemtech Consulting Group (CHM), NJ

The following are our findings:

Case: 50011 SDG: EXEZ6
Site: Velsicol Chemical Superfund Site, St. Louis, MI Laboratory: CHM

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

One (1) soil and one (1) water sample are identified in the table below. They were collected on 06/16/2022. The samples were submitted to the laboratory, Chemtech Consulting Group, located in Mountainside, NJ. The samples were received on 06/18/2022 10:40 intact and in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses
EXEZ6	VCS-OU1-PD-SO-020-10.0/15.0	N3393-01	06/16/2022 16:30	2.3°C	ARO
EXEZ7	VCS-OU1-PD-TB-002	N3393-02	06/16/2022 16:45	2.3°C	L/M VOA

One (1) sample was analyzed for ARO. One (1) sample was analyzed for L/M VOA. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund QAPP (Quality Assurance Project Plan), Rev 5/21/21 and November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Organic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-005-r0.

Sample EXEZ6 was designated by the samplers to be used for laboratory QC, i.e., MS/MSD analyses.

Sample EXEZ7 was identified as a trip blank.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

Assembled by: Martin Sarmiento
Date: 07/20/22

Case: 50011 SDG: EXEZ6
Site: Velsicol Chemical Superfund Site, St. Louis, MI Laboratory: CHM

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE AND SYSTEM PERFORMANCE:

NONE FOUND.

3. CALIBRATION:

Method - Volatile Organics

EXES-988
The following samples are associated with an initial calibration in which a DMC did not meet relative response factor (RRF) criteria. Detects are not qualified. Nondetects are not qualified.

EXEZ7, VBLK146, VHBLK001
trans-1,3-Dichloropropene-d4

EXES-614
The following samples are associated with an opening or closing CCV with DMC RRF exceeding criteria. Detects are not qualified. Nondetects are not qualified.

EXEZ7, VBLK146, VHBLK001
trans-1,3-Dichloropropene-d4

4. BLANKS

NONE FOUND.

5. DEUTERATED MONITORING COMPOUNDS / SURROGATES

NONE FOUND.

6. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Method - Aroclors

EXES-546
The relative percent difference (RPD) between the following matrix spike and matrix spike duplicate recoveries is outside criteria. Detects are qualified as estimated J. Nondetects are not qualified.

EXEZ6
Aroclor-1016

7. CLEANUP PROCEDURES

NONE FOUND.

8 LABORATORY CONTROL SAMPLE:

NONE FOUND.

9. INTERNAL STANDARD:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS:

Method - Aroclors

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

ALCS793
Aroclor-1016, Aroclor-1260

11. FIELD QC SAMPLES:

Review not required under specified validation stage.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

13. DOCUMENTATION

Shipping Discrepancies and/or QC issues

The airbill number was missing from all the COCs received with the shipment. CHM had SDG EXEZ6 open without laboratory QC assigned for the ARO analysis. No sample was designated on the COC for laboratory QC, but sample EXEZ6 was received with additional volume and CHM proceeded with this sample for laboratory QC. Per SFAM01.1, Exhibit A, Section 5.5.4.1, the laboratory noted the issue in the SDG Narrative and proceeded with the analysis of the samples.

Case: 50011 SDG: EXEZ6
Site: Velsicol Chemical Superfund Site, St. Louis, MI Laboratory: CHM

EXES SFAM01.1 Data Qualifier Sheet

Validation Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The Target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatograph/Mass Spectrometer (GC/MS).
X	The Target Pesticide or Aroclor analyte identification was not confirmed.

Assembled by: Martin Sarmiento
Date: 07/20/22

Region 5 ICF-ESAT Document Control Number: 00557
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on: 04/29/2022

FROM: Martin Sarmiento, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com
EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.Tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Superfund Site, St. Louis, MI

CASE NUMBER: 50011 SDG NUMBER: EXEZ8

Number and Type of Samples: 1 Water (L/M VOA, SVOA, PEST)

Sample Numbers: EXEZ8

Laboratory: Chemtech Consulting Group (CHM)

The following are our findings:

Case: 50011
Site: Velsicol Chemical, MI

SDG: EXEZ8
Laboratory: CHM

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

One (1) TCLP water sample, EXEZ8, identified in the table below was collected on 07/20/2022. The samples were submitted to Chemtech Consulting Group Laboratory located in Mountainside, New Jersey. The samples were received on 07/21/2022 intact and in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Receipt Temp	Analyses
EXEZ8	VCS-OU1-PD-IDW-SO-072022	N3820-01	07/20/2022 13:30	2.3°C	L/M VOA, SVOA, PEST

The sample was analyzed for TCLP L/M VOA, TCLP SVOA, and TCLP PEST. The sample was analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund Site QAPP (Quality Assurance Project Plan), Rev 5/21/21 and November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Organic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-005-r0.

No samples were designated by the samplers to be used for laboratory QC, i.e., MS/MSD analyses.

No samples were identified as trip blanks, field blanks or field duplicates.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

Assembled by: Martin Sarmiento
Date: 08/16/2022

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE AND SYSTEM PERFORMANCE:

NONE FOUND.

3. CALIBRATION:

Method - Pesticides

EXES-793
The following samples are associated with an initial calibration percent relative standard deviation (%RSD) outside criteria. Detects are qualified as estimated J. Nondetects are not qualified or qualified as estimated UJ.

EXEZ8, PBLK542, PLCS542
beta-BHC

4. BLANKS

NONE FOUND.

5. DEUTERATED MONITORING COMPOUNDS / SURROGATES

NONE FOUND.

6. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Method – Pesticides

EXES-041
The following samples are not associated with Matrix Spike sample. Detects are not qualified. Nondetects are not qualified.

EXEZ8

EXES-042
The following samples are not associated with Matrix Spike sample. Detects are not qualified. Nondetects are not qualified.

EXEZ8

7. CLEANUP PROCEDURES

NONE FOUND.

8 LABORATORY CONTROL SAMPLE:

NONE FOUND.

9. INTERNAL STANDARD:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS:

Method – Pesticides

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

PLCS542
Heptachlor, Heptachlor epoxide, Endrin, cis-Chlordane, trans-Chlordane

11. FIELD QC SAMPLES:

Review not required under specified validation stage.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

No MS/MSD was run for the sample.

13. DOCUMENTATION

No discrepancies found.

Case: 50011
Site: Velsicol Chemical, MI

SDG: EXEZ8
Laboratory: CHM

EXES SFAM01.1 Data Qualifier Sheet

Validation Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The Target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatograph/Mass Spectrometer (GC/MS).
X	The Target Pesticide or Aroclor analyte identification was not confirmed.

Assembled by: Martin Sarmiento
Date: 08/16/2022

Region 5 ICF-ESAT Document Control Number: 00556
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
SUPERFUND AND EMERGENCY MANAGEMENT DIVISION

SUBJECT: Review of Data
Received for review on: 06/30/2022

FROM: Lindsay Bippus, ICF Incorporated.
Contractor, Environmental Services Assistance Team (ESAT)

THROUGH: Michelle Kerr
Region 5 ESAT Contracting Officer's Representative

TO:

Data User:	Jacobs Inc.
Contact Person's Name:	Lindsey Xayachack
Contact email address:	lindsey.xayachack@jacobs.com
EPA Data User:	USEPA Superfund Division
Contact Person's Name:	Tom Alcamo
Contact email address:	Alcamo.Tom@epa.gov

All sample results in the attached sample delivery group (SDG) have the following label:

Stage_2B_Validation_Electronic_and_Manual (S2BVEM)

We have reviewed the data for the following case:

SITE NAME: Velsicol Chemical Superfund Site, St. Louis, MI

CASE NUMBER: 50011 SOW: SFAM01.1 SDG NUMBER: EXEZ9

Number and Type of Samples: 1 water sample (ARO/ L/M VOA), 1 soil sample (ARO)

Sample Numbers: EXEZ8-EXEZ9

Laboratory: Chemtech Consulting Group (CHM)

The following are our findings:

Case: 50011 SDG: EXEZ9
Site: Velsicol Chemical Superfund Site Laboratory: Chemtech Consulting Group

Below is a summary of the out-of-control audits and the possible effects on the data for this case:

One (1) water sample and one (1) soil sample, EXEZ8-EXEZ9, identified in the table below were collected on 07/20/2022. The samples were submitted to Chemtech Consulting Group Laboratory located in Mountainside, New Jersey. The samples were received on 07/21/2022 intact, and in good condition.

EPA Sample IDs	Sample Identifier (from COC)	Lab ID Number	Collection Date/Time	Matrix	Analyses
EXEZ8	VCS-OU1-PD-IDW-SO-072022	N3821-01	07/20/2022 13:30	Soil	ARO
EXEZ9	VCS-OU1-PD-TB-003	N3821-02	07/20/2022 13:30	Water	L/M VOA

The water sample, EXEZ9, was analyzed for L/M VOA analytes. The soil sample, EWEZ8, was analyzed for ARO analytes. All samples were analyzed using the CLP (Contract Laboratory Program) SFAM01.1 analysis procedures and reviewed according to the Velsicol Chemical Superfund Site QAPP (Quality Assurance Project Plan), November 2020 NFG (National Functional Guidelines) for SFAM01.1 and the Region 5 Organic CLP Validation SOP (STANDARD OPERATING PROCEDURE) R5-LSASD-005-r0.

No sample was designated by the samplers to be used for laboratory QC, i.e., MS/MSD analyses.

Sample EXEZ9 was identified as a trip blank.

The sample results have been reviewed for compliance with the QAPP worksheets and all non-compliances are described in Section 12. – QAPP Compliance

Assembled by: Lindsay Bippus
Date: 08/11/2022

1. HOLDING TIMES AND PRESERVATION:

NONE FOUND.

2. TUNE AND SYSTEM PERFORMANCE:

NONE FOUND.

3. CALIBRATION:

NONE FOUND.

4. BLANKS

NONE FOUND.

5. DEUTERATED MONITORING COMPOUNDS / SURROGATES

NONE FOUND.

6. MATRIX SPIKE/MATRIX SPIKE DUPLICATE

NONE FOUND.

7. CLEANUP PROCEDURES
NONE FOUND.

8 LABORATORY CONTROL SAMPLE:

NONE FOUND.

9. INTERNAL STANDARD:

NONE FOUND.

10. TARGET ANALYTE QUANTITATION AND SAMPLE ANALYSIS:

Method- Aroclors

EXES-790
The following samples have analyte results greater than or equal to detection limit (MDL) and below quantitation limit (CRQL). Detects are qualified as estimated J.

ALCS538
Aroclor-1016, Aroclor-1260

11. FIELD QC SAMPLES:

Review not required under specified validation stage.

12. QAPP COMPLIANCE:

The analytical package fulfilled the component QC requirements (of QAPP worksheets #12, #15, #19, #35 & #36).

13. DOCUMENTATION

Shipping Discrepancies and/or QC Issues:

Some samples were received without sample tags, and some were not listed on the TR/COC. These samples were noted in the SDG narrative.

Laboratory QC was scheduled for ARO analysis, but no sample was designated as the QC in the COC. The lab contacted Region 5 and obtained permission to use sample EXEZ8 as the QC since it had extra volume and the laboratory confirmed that the selected sample was not a PE, blank, or rinsate sample. Issue was noted in SDG narrative.

Case: 50011 SDG: EXEZ9
Site: Velsicol Chemical Superfund Site Laboratory: Chemtech Consulting Group

EXES SFAM01.1 Data Qualifier Sheet

Validation Data Qualifier Sheet

Qualifiers	Data Qualifier Definitions
U	The analyte was analyzed for but was not detected above the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
NJ	The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value is the estimated concentration in the sample.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
R	The data is unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
C	The Target Pesticide or Aroclor analyte identification has been confirmed by Gas Chromatograph/Mass Spectrometer (GC/MS).
X	The Target Pesticide or Aroclor analyte identification was not confirmed.

Attachment 3
Geotechnical Test Results

Velsicol GLAES RD Geotechnical Investigation Sample Summary Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/6/2022	9:55	PD-001	5-7	3	SS	VCS-OU1-GT-SO-PD001-5.0/7.0	22CV14-17
7/6/2022	10:15	PD-001	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD001-7.5/9.5	22CV14-18
7/6/2022	10:25	PD-001	10-12	5	SS	VCS-OU1-GT-SO-PD001-10.0/12.0	22CV14-19
7/6/2022	10:45	PD-001	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD001-12.5/14.5	22CV14-20
7/6/2022	11:30	PD-001	15-17	7	SS	VCS-OU1-GT-SO-PD001-15.0/17.0	22CV14-21
7/6/2022	13:00	PD-001	20-23	8	ST	VCS-OU1-GT-SO-PD001-20.0/23.0	22CV14-22
7/6/2022	13:15	PD-001	23-25	9	SS	VCS-OU1-GT-SO-PD001-23.0/25.0	22CV14-23
7/6/2022	15:13	PD-001	25-28	10	ST	VCS-OU1-GT-SO-PD001-25.0/28.0	22CV14-24
7/6/2022	15:30	PD-001	28-30	11	SS	VCS-OU1-GT-SO-PD001-28.0/30.0	22CV14-25
7/6/2022	16:15	PD-001	30-33	12	ST	VCS-OU1-GT-SO-PD001-30.0/33.0	22CV14-26
7/6/2022	16:50	PD-001	33-35	13	SS	VCS-OU1-GT-SO-PD001-33.0/35.0	22CV14-27
7/6/2022	17:20	PD-001	35-38	14	ST	VCS-OU1-GT-SO-PD001-35.0/38.0	22CV14-28
7/6/2022	17:30	PD-001	38-40	15	SS	VCS-OU1-GT-SO-PD001-38.0/40.0	22CV14-29

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/7/2022	9:49	PD-002	0-2	1	SS	VCS-OU1-GT-SO-PD002-0.0/2.0	22CV14-30
7/7/2022	9:55	PD-002	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD002-2.5/4.5	22CV14-31
7/7/2022	10:50	PD-002	5-7	3	SS	VCS-OU1-GT-SO-PD002-5.0/7.0	22CV14-32
7/7/2022	11:00	PD-002	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD002-7.5/9.5	22CV14-33
7/7/2022	11:10	PD-002	10-12	5	SS	VCS-OU1-GT-SO-PD002-10.0/12.0	22CV14-34
7/7/2022	11:15	PD-002	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD002-12.5/14.5	22CV14-35
7/7/2022	11:25	PD-002	15-17	7	SS	VCS-OU1-GT-SO-PD002-15.0/17.0	22CV14-36
7/7/2022	12:15	PD-002	20-23	8	ST	VCS-OU1-GT-SO-PD002-20.0/23.0	22CV14-37
7/7/2022	12:25	PD-002	23-25	9	SS	VCS-OU1-GT-SO-PD002-23.0/25.0	22CV14-38
7/7/2022	NA	PD-002	25-28	10	ST (No Recovery)	NA	NA
7/7/2022	14:30	PD-002	28-30	11	SS	VCS-OU1-GT-SO-PD002-28.0/30.0	22CV14-39
7/7/2022	15:00	PD-002	30-33	12	ST	VCS-OU1-GT-SO-PD002-30.0/33.0	22CV14-40
7/7/2022	15:25	PD-002	33-35	13	SS	VCS-OU1-GT-SO-PD002-33.0/35.0	22CV14-41
7/7/2022	16:10	PD-002	35-38	14	ST	VCS-OU1-GT-SO-PD002-35.0/38.0	22CV14-42
7/7/2022	16:20	PD-002	38-40	15	SS	VCS-OU1-GT-SO-PD002-38.0/40.0	22CV14-43

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/8/2022	8:45	PD-003	0-2	1	SS	VCS-OU1-GT-SO-PD003-0.0/2.0	22CV14-44
7/8/2022	8:50	PD-003	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD003-2.5/4.5	22CV14-45
7/8/2022	10:30	PD-003	5-7	3	SS	VCS-OU1-GT-SO-PD003-5.0/7.0	22CV14-46
7/8/2022	10:45	PD-003	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD003-7.5/9.5	22CV14-47
7/8/2022	10:55	PD-003	10-12	5	SS	VCS-OU1-GT-SO-PD003-10.0/12.0	22CV14-48
7/8/2022	11:05	PD-003	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD003-12.5/14.5	22CV14-49
7/8/2022	11:15	PD-003	15-17	7	SS	VCS-OU1-GT-SO-PD003-15.0/17.0	22CV14-50
7/8/2022	11:50	PD-003	20-23	8	ST	VCS-OU1-GT-SO-PD003-20.0/23.0	22CV14-51
7/8/2022	13:05	PD-003	23-25	9	SS	VCS-OU1-GT-SO-PD003-23.0/25.0	22CV14-52
7/8/2022	13:50	PD-003	25-28	10	ST	VCS-OU1-GT-SO-PD003-25.0/28.0	22CV14-53
7/8/2022	14:00	PD-003	28-30	11	SS	VCS-OU1-GT-SO-PD003-28.0/30.0	22CV14-54
7/9/2022	9:28	PD-003	33-35	12	SS	VCS-OU1-GT-SO-PD003-33.0/35.0	22CV14-55
7/9/2022	10:00	PD-003	38-40	13	SS	VCS-OU1-GT-SO-PD003-38.0/40.0	22CV14-56
Note: No Shelby Tubes from 30'-33' bgs and from 35'-38' bgs due to Pitcher Sampler failure							

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/13/2022	16:30	PD-006	0-2	1	SS	VCS-OU1-GT-SO-PD006-0.0/2.0	22CV14-96
7/13/2022	16:40	PD-006	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD006-2.5/4.5	22CV14-97
7/14/2022	8:00	PD-006	5-7	3	SS	VCS-OU1-GT-SO-PD006-5.0/7.0	22CV14-98
7/14/2022	8:05	PD-006	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD006-7.5/9.5	22CV14-99
7/14/2022	8:20	PD-006	10-12	5	SS	VCS-OU1-GT-SO-PD006-10.0/12.0	22CV15-01
7/14/2022	8:30	PD-006	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD006-12.5/14.5	22CV15-02
7/14/2022	8:45	PD-006	15-17	7	SS	VCS-OU1-GT-SO-PD006-15.0/17.0	22CV15-03
7/14/2022	9:40	PD-006	20-23	8	ST	VCS-OU1-GT-SO-PD006-20.0/23.0	22CV15-04
7/14/2022	9:50	PD-006	23-25	9	SS	VCS-OU1-GT-SO-PD006-23.0/25.0	22CV15-05
7/14/2022	11:50	PD-006	25-28	10	ST	VCS-OU1-GT-SO-PD006-25.0/28.0	22CV15-06
7/14/2022	12:10	PD-006	28-30	11	SS	VCS-OU1-GT-SO-PD006-28.0/30.0	22CV15-07
7/14/2022	13:10	PD-006	30-33	12	ST	VCS-OU1-GT-SO-PD006-30.0/33.0	22CV15-08
7/14/2022	13:20	PD-006	33-35	13	SS	VCS-OU1-GT-SO-PD006-33.0/35.0	22CV15-09
7/14/2022	14:10	PD-006	35-38	14	ST	VCS-OU1-GT-SO-PD006-35.0/38.0	22CV15-10
7/14/2022	14:40	PD-006	38-40	15	SS	VCS-OU1-GT-SO-PD006-38.0/40.0	22CV15-11

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/12/2022	8:20	PD-008	0-2	1	SS	VCS-OU1-GT-SO-PD008-0.0/2.0	22CV14-68
7/12/2022	8:25	PD-008	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD008-2.5/4.5	22CV14-69
7/12/2022	9:20	PD-008	5-7	3	SS	VCS-OU1-GT-SO-PD008-5.0/7.0	22CV14-70
7/12/2022	9:30	PD-008	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD008-7.5/9.5	22CV14-71
7/12/2022	9:40	PD-008	10-12	5	SS	VCS-OU1-GT-SO-PD008-10.0/12.0	22CV14-72
7/12/2022	9:55	PD-008	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD008-12.5/14.5	22CV14-73
7/12/2022	10:10	PD-008	15-17	7	SS	VCS-OU1-GT-SO-PD008-15.0/17.0	22CV14-74
7/12/2022	10:35	PD-008	20-22	8	SS	VCS-OU1-GT-SO-PD008-20.0/22.0	22CV14-75
7/12/2022	11:00	PD-008	28-30	9	SS	VCS-OU1-GT-SO-PD008-28.0/30.0	22CV14-76
7/12/2022	12:15	PD-008	30-33	10	ST	VCS-OU1-GT-SO-PD008-30.0/33.0	22CV14-77
7/12/2022	12:30	PD-008	33-35	11	SS	VCS-OU1-GT-SO-PD008-33.0/35.0	22CV14-78
7/12/2022	13:15	PD-008	35-38	12	ST	VCS-OU1-GT-SO-PD008-35.0/38.0	22CV14-79
7/12/2022	13:25	PD-008	38-40	13	SS	VCS-OU1-GT-SO-PD008-38.0/40.0	22CV14-80
Note: No Shelby Tubes from 20'-23' bgs and from 25'-28' due to Pitcher Sampler failure							

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/12/2022	16:30	PD-009	0-2	1	SS	VCS-OU1-GT-SO-PD009-0.0/2.0	22CV14-81
7/12/2022	16:45	PD-009	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD009-2.5/4.5	22CV14-82
7/12/2022	17:25	PD-009	5-7	3	SS	VCS-OU1-GT-SO-PD009-5.0/7.0	22CV14-83
7/12/2022	17:35	PD-009	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD009-7.5/9.5	22CV14-84
7/12/2022	17:45	PD-009	10-12	5	SS	VCS-OU1-GT-SO-PD009-10.0/12.0	22CV14-85
7/12/2022	17:50	PD-009	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD009-12.5/14.5	22CV14-86
7/12/2022	18:00	PD-009	15-17	7	SS	VCS-OU1-GT-SO-PD009-15.0/17.0	22CV14-87
7/13/2022	9:15	PD-009	20-23	8	ST	VCS-OU1-GT-SO-PD009-20.0/23.0	22CV14-88
7/13/2022	9:20	PD-009	23-25	9	SS	VCS-OU1-GT-SO-PD009-23.0/25.0	22CV14-89
7/13/2022	10:10	PD-009	25-28	10	ST	VCS-OU1-GT-SO-PD009-25.0/28.0	22CV14-90
7/13/2022	10:15	PD-009	28-30	11	SS	VCS-OU1-GT-SO-PD009-28.0/30.0	22CV14-91
7/13/2022	11:15	PD-009	30-33	12	ST	VCS-OU1-GT-SO-PD009-30.0/33.0	22CV14-92
7/13/2022	12:50	PD-009	33-35	13	SS	VCS-OU1-GT-SO-PD009-33.0/35.0	22CV14-93
7/13/2022	13:45	PD-009	35-38	14	ST	VCS-OU1-GT-SO-PD009-35.0/38.0	22CV14-94
7/13/2022	14:00	PD-009	38-40	15	SS	VCS-OU1-GT-SO-PD009-38.0/40.0	22CV14-95

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/11/2022	10:20	PD-010	0-2	1	SS	VCS-OU1-GT-SO-PD010-0.0/2.0	22CV14-57
7/11/2022	10:30	PD-010	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD010-2.5/4.5	22CV14-58
7/11/2022	11:18	PD-010	5-7	3	SS	VCS-OU1-GT-SO-PD010-5.0/7.0	22CV14-59
7/11/2022	11:30	PD-010	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD010-7.5/9.5	22CV14-60
7/11/2022	11:50	PD-010	10-12	5	SS	VCS-OU1-GT-SO-PD010-10.0/12.0	22CV14-61
7/11/2022	12:05	PD-010	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD010-12.5/14.5	22CV14-62
7/11/2022	12:20	PD-010	18-20	7	SS	VCS-OU1-GT-SO-PD010-18.0/20.0	22CV14-63
7/11/2022	12:40	PD-010	23-25	8	SS	VCS-OU1-GT-SO-PD010-23.0/25.0	22CV14-64
7/11/2022	13:15	PD-010	28-30	9	SS	VCS-OU1-GT-SO-PD010-28.0/30.0	22CV14-65
7/11/2022	14:00	PD-010	33-35	10	SS	VCS-OU1-GT-SO-PD010-33.0/35.0	22CV14-66
7/11/2022	14:10	PD-010	38-40	11	SS	VCS-OU1-GT-SO-PD010-38.0/40.0	22CV14-67

No Shelby Tubes were collected due to broken Pitcher Sampler

Laboratory Testing Summary

Boring Number	Sample Number	Depth (Feet)	Soil Classification Based on Laboratory Test Results	Particle Size			Atterberg Limits			Moisture Content	Triaxial Shear
				Percent Gravel	Percent Sand	Percent Fines	LL	PL	PI		CU (tsf)
PD-001	ST (A)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	7.7	7.86
	ST (B)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	7.8	14.32
	ST (C)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	6.8	11.51
	15	38-40	(CL) Lean clay with sand	6.5	41.2	52.3	17	10	7	9.8	
PD-002	7	15-17	(CL) Lean clay, some sand, grayish brown	0.2	11.2	88.6					
	13	33-35	(CL-ML) Silty clay, with sand, trace gravel	7.0	42.5	50.5	16	10	6	8.0	
PD-003	7	15-17	(CL) Sandy lean clay, trace gravel, grayish brown	2.7	46.6	50.7					
	ST (A)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	10.9	5.64
	ST (B)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	10.7	6.89
	ST (C)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	11.2	10.32
	12	33-35	(CL-ML) Silty clay with sand	5.4	43.8	50.8	16	10	6	7.9	
PD-006	6	12.5-14.5	(ML) Silt, some sand, trace gravel, light brown	5.9	10.6	83.6					
	ST (A)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	11.4	5.03
	ST (B)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	12.6	5.60
	ST (C)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	12.3	5.44
	13	33-35	(SM) Silty sand, fine to medium, some gravel	11.0	52.6	36.4	NP	NP	NP	8.4	
PD-008	11	33-35	(SM) Silty sand, fine	5.9	49.5	44.6	12	11	1	8.3	
PD-009	6	12.5-14.5	(ML) Sandy silt, light grayish brown	0.7	19.9	79.4					
	ST (A)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.4	4.38
	ST (B)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.4	5.28
	ST (C)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.6	6.85
	13	33-35	(CL) Lean clay, some sand	0.1	7.9	92.0	22	14	8	18.4	
PD-010	6	12.5-14.5	(SM) Silty sand, fine, light grayish brown	0.0	71.4	28.6					
	8	23-25	(CL) Sandy lean clay	0.4	38.9	60.7	19	11	8	9.8	

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay with sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-001
Sample No.: 15
Depth: 38'-40'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	11.1	4.2	95.8
4M	4.76	6.2	2.3	93.5
10M	2.00	11.0	4.1	89.4
20M	0.85	2.86	4.9	95.1 / 85.0
40M	0.42	3.20	5.5	89.6 / 80.1
60M	0.25	5.60	9.7	79.9 / 71.4
100M	0.149	6.76	11.7	68.2 / 61.0
140M	0.106	2.91	5.0	63.2 / 56.5
200M	0.074	2.71	4.7	58.5 / 52.3
LBW		33.77	58.4	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 57.88 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: R. Edlebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-001

Soil Description: (CL) Lean clay with sand

Sample No.: 15

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 38'-40'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 1

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.4 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.67 g	57.88 g

Starting Date: 8/17/22 Starting Time: 7:12:00 Sedimentation Cylinder No.: HYD 20

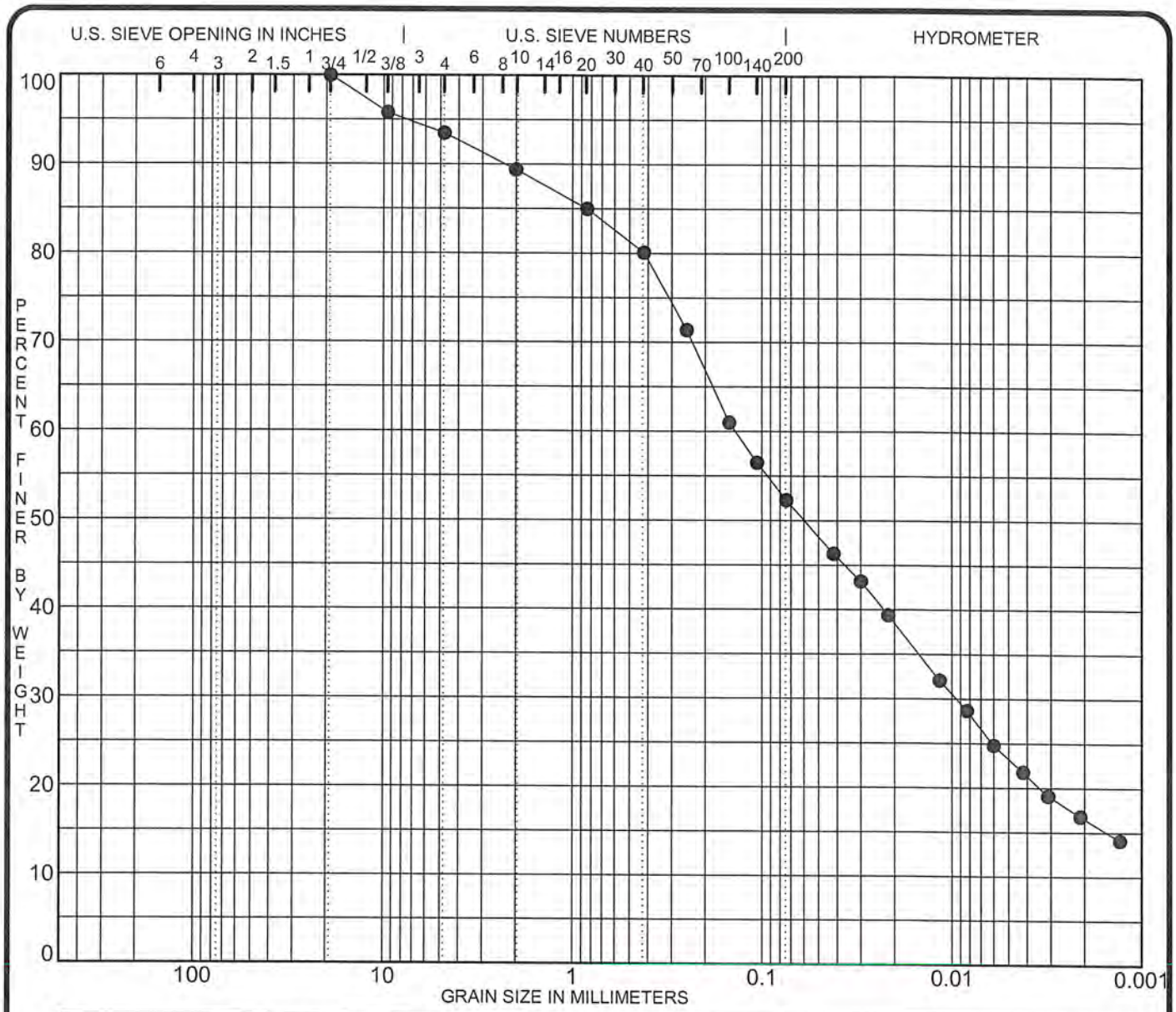
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:13:00	1.0	36.50	23.5	6.25	30.25	51.7	0.01297	10.4	0.0418	46.3
7:14:00	2.0	34.50	23.5	6.25	28.25	48.3	0.01297	10.7	0.0300	43.2
7:16:00	4.0	32.00	23.5	6.25	25.75	44.0	0.01297	11.1	0.0216	39.4
7:27:00	15.0	27.25	23.5	6.25	21.00	35.9	0.01297	11.9	0.0116	32.1
7:42:00	30.0	25.00	23.5	6.25	18.75	32.1	0.01297	12.2	0.0083	28.7
8:12:00	60.0	22.50	23.5	6.25	16.25	27.8	0.01297	12.7	0.0060	24.8
9:16:00	124.0	20.50	23.5	6.25	14.25	24.4	0.01297	13.0	0.0042	21.8
11:12:00	240.0	18.75	23.5	6.25	12.50	21.4	0.01297	13.3	0.0031	19.1
15:12:00	480.0	17.25	24.0	6.25	11.00	18.8	0.01282	13.5	0.0021	16.8
7:12:00	1440.0	15.50	24.0	6.25	9.25	15.8	0.01282	13.8	0.0013	14.1

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: N. Ellebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-001 #15 38'-40'	(CL) LEAN CLAY WITH SAND						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-001 #15 38'-40'	19.10	0.14	0.059	0.009		6.5	41.2	29.0	23.3

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
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COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE • IRON MOUNTAIN, MI 49801 • PHONE: 906-774-3440
200 EAST AYER STREET • IRONWOOD, MI 49938 • PHONE: 906-932-5048
120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay, some sand, grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-002
Sample No.: 7
Depth: 15'-17'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5	0.00	0.0	100.0
4M	4.76	0.22	0.2	99.8
10M	2.00	0.57	0.6	99.2
20M	0.85	0.36	0.6	99.4 / 98.6
40M	0.42	0.69	1.2	98.2 / 97.4
60M	0.25	1.20	2.1	96.1 / 95.3
100M	0.149	1.43	2.5	93.6 / 92.9
140M	0.106	0.78	1.4	92.2 / 91.5
200M	0.074	1.64	2.9	89.3 / 88.6
LBW		49.66	88.6	
Pan		0.41	0.7	

Wet weight = - gm
Dry Initial weight = 56.17 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/8/2022
Laboratory: Iron Mountain
Submitted By: N. Ellebeck
Date: 8/27/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-002

Soil Description: (CL) Lean clay, some sand, grayish brown

Sample No.: 7

Prior Testing: [ ] No [X] Yes Type: Moisture

Depth: 15'-17'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 8

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	99.2 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.92 g	56.17 g

Starting Date: 8/4/22 Starting Time: 7:00:00 Sedimentation Cylinder No.: HYD 11

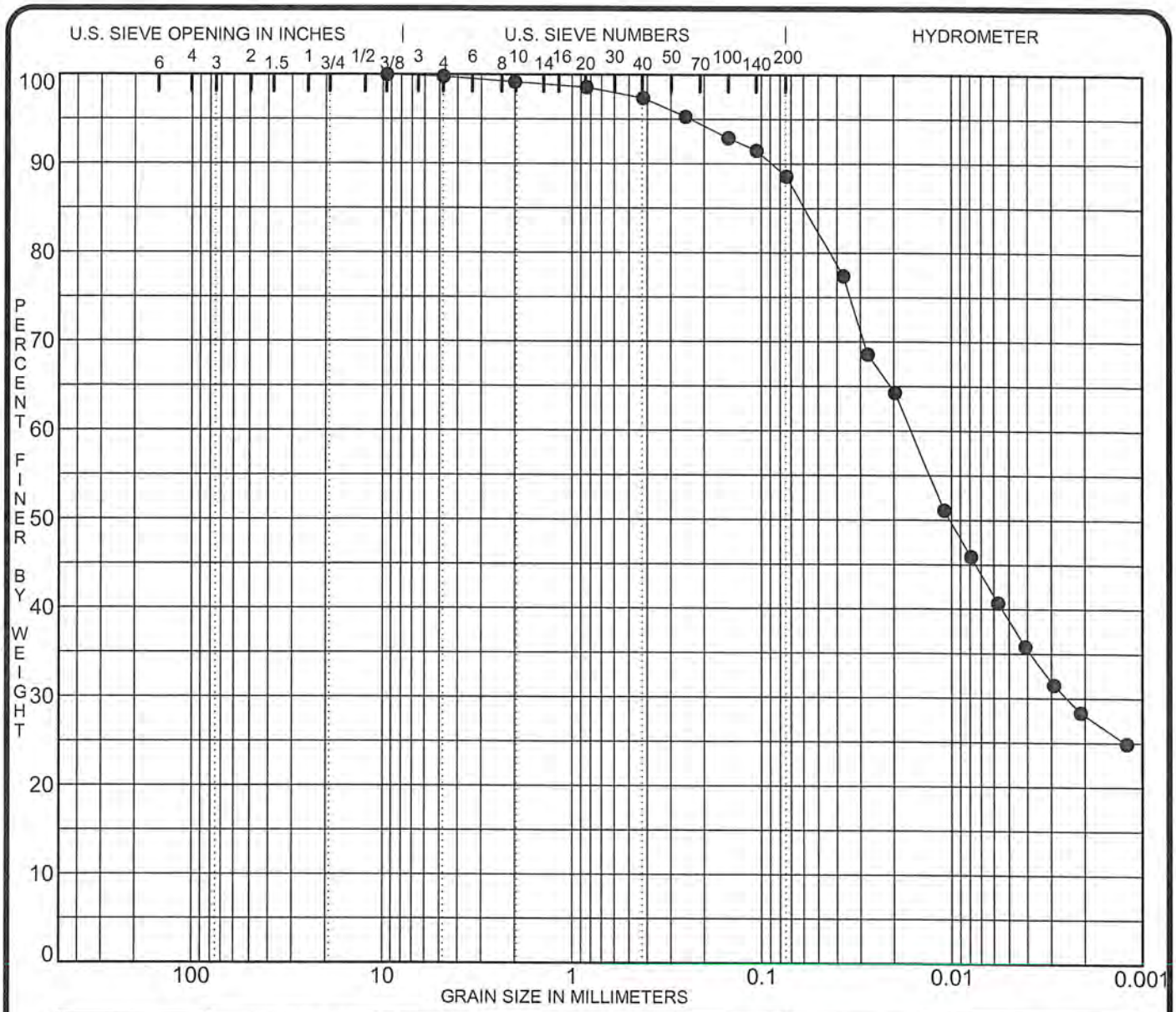
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:01:00	1.0	50.50	23.5	6.25	44.25	78.0	0.01297	8.1	0.0369	77.4
7:02:00	2.0	45.50	23.5	6.25	39.25	69.2	0.01297	8.9	0.0274	68.6
7:04:00	4.0	43.00	23.5	6.25	36.75	64.8	0.01297	9.2	0.0197	64.3
7:15:00	15.0	35.50	23.5	6.25	29.25	51.6	0.01297	10.6	0.0109	51.1
7:30:00	30.0	32.50	23.5	6.25	26.25	46.3	0.01297	11.1	0.0079	45.9
8:00:00	60.0	29.50	23.5	6.25	23.25	41.0	0.01297	11.5	0.0057	40.7
9:00:00	120.0	26.75	23.5	6.25	20.50	36.1	0.01297	12.0	0.0041	35.8
11:00:00	240.0	24.25	23.5	6.25	18.00	31.7	0.01297	12.4	0.0029	31.5
15:00:00	480.0	22.50	24.0	6.25	16.25	28.6	0.01282	12.7	0.0021	28.4
7:00:00	1440.0	20.50	24.0	6.25	14.25	25.1	0.01282	13.0	0.0012	24.9

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-002 #7 15'-17'**	**(CL) LEAN CLAY, some sand, grayish brown**						

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-002 #7 15'-17'**	**9.50**	**0.02**	**0.010**	**0.002**		**0.2**	**11.2**	**50.0**	**38.6**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL-ML) Silty clay, with sand, trace gravel
Remarks:

Job No.: GL 191059F2
Boring No.: PD-002
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	13.0	5.5	94.5
4M	4.76	3.5	1.5	93.0
10M	2.00	7.9	3.3	89.7
20M	0.85	2.23	4.1	95.9 / 86.0
40M	0.42	3.03	5.5	90.4 / 81.1
60M	0.25	5.74	10.4	80.0 / 71.8
100M	0.149	7.10	12.9	67.1 / 60.2
140M	0.106	3.06	5.6	61.5 / 55.2
200M	0.074	2.86	5.2	56.3 / 50.5
LBW		30.96	56.2	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 55.05 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: W. Ellebest
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-002

Soil Description: (CL-ML) Silty clay, with sand, trace gravel

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 7

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	55.86 g	55.05 g

Starting Date: 8/17/22 Starting Time: 7:06:00 Sedimentation Cylinder No.: HYD 21

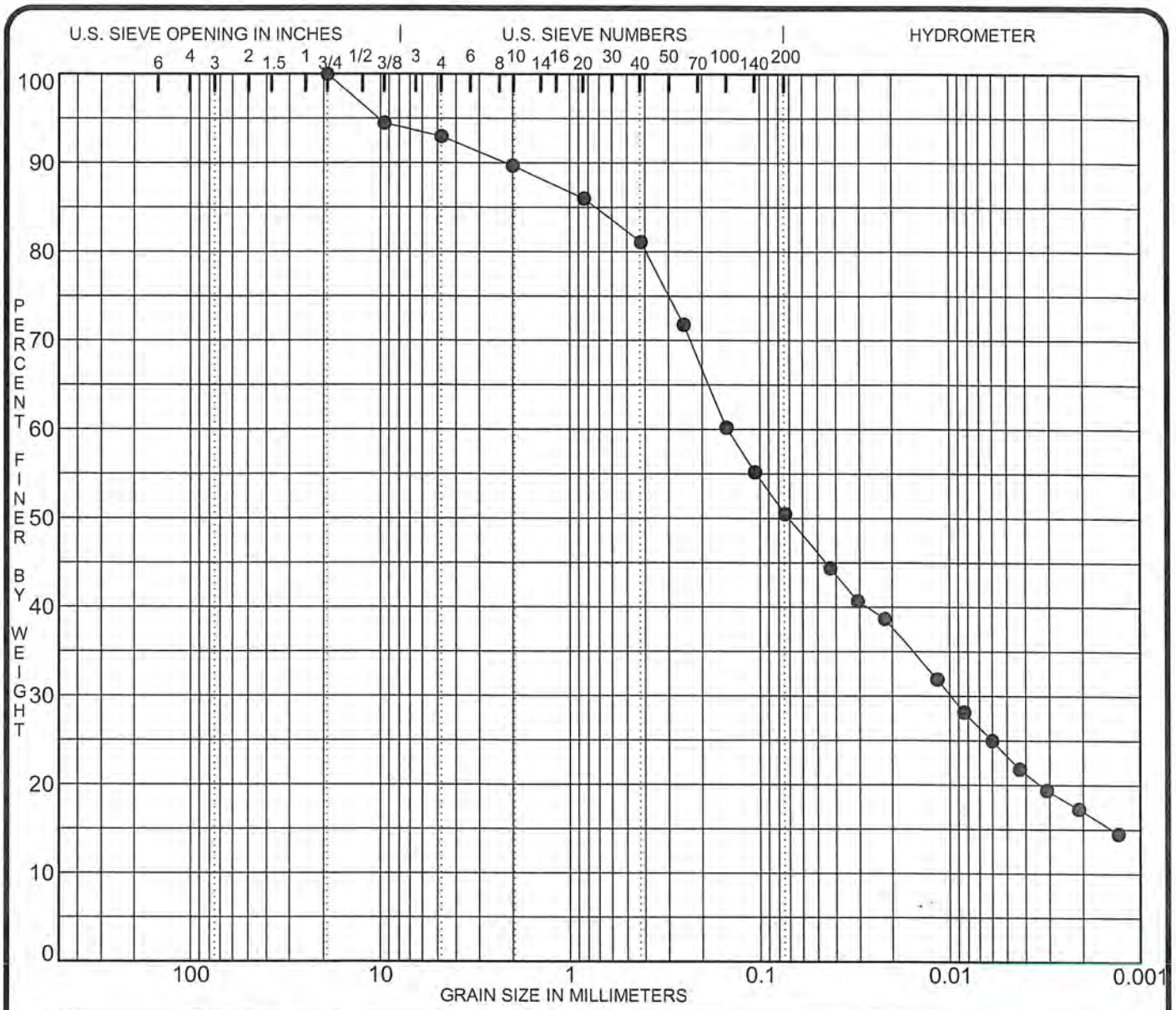
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:07:00	1.0	33.75	23.5	6.25	27.50	49.5	0.01297	10.9	0.0428	44.4
7:08:00	2.0	31.50	23.5	6.25	25.25	45.4	0.01297	11.2	0.0307	40.7
7:10:00	4.0	30.25	23.5	6.25	24.00	43.2	0.01297	11.4	0.0219	38.7
7:21:00	15.0	26.00	23.5	6.25	19.75	35.5	0.01297	12.0	0.0116	31.9
7:36:00	30.0	23.75	23.5	6.25	17.50	31.5	0.01297	12.5	0.0084	28.2
8:06:00	60.0	21.75	23.5	6.25	15.50	27.9	0.01297	12.9	0.0060	25.0
9:06:00	120.0	19.75	23.5	6.25	13.50	24.3	0.01297	13.2	0.0043	21.8
11:06:00	240.0	18.25	23.5	6.25	12.00	21.6	0.01297	13.3	0.0031	19.4
15:06:00	480.0	17.00	24.0	6.25	10.75	19.3	0.01282	13.5	0.0021	17.3
7:06:00	1440.0	15.25	24.0	6.25	9.00	16.2	0.01282	13.8	0.0013	14.5

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: Dr Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **PD-002 #13 33'-35'**	**(CL-ML) SILTY CLAY, with sand, trace gravel**						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **PD-002 #13 33'-35'**	**19.10**	**0.15**	**0.071**	**0.010**		**7.0**	**42.5**	**27.4**	**23.1**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Sandy lean clay, trace gravel, grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-003
Sample No.: 7
Depth: 15'-17'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.00	0.0	100.0
3/8"	9.5	1.42	1.5	98.5
4M	4.76	1.14	1.2	97.3
10M	2.00	2.54	2.7	94.6
20M	0.85	2.14	4.0	96.0 / 90.8
40M	0.42	2.78	5.1	90.9 / 86.0
60M	0.25	6.03	11.1	79.8 / 75.5
100M	0.149	7.58	14.0	65.8 / 62.2
140M	0.106	3.51	6.5	59.3 / 56.1
200M	0.074	3.06	5.7	53.6 / 50.1
LBW		27.94	51.6	
Pan		1.09	2.0	

Wet weight = - gm
Dry Initial weight = 54.13 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: W. Edebert

Date: 8/8/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-003

Soil Description: (CL) Sandy lean clay, trace gravel, grayish brown

Sample No.: 7

Prior Testing: [X] No [ ] Yes Type:

Depth: 15'-17'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 11

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	94.6 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	54.60 g	54.13 g

Starting Date: 8/4/22 Starting Time: 7:06:00 Sedimentation Cylinder No.: HYD 13

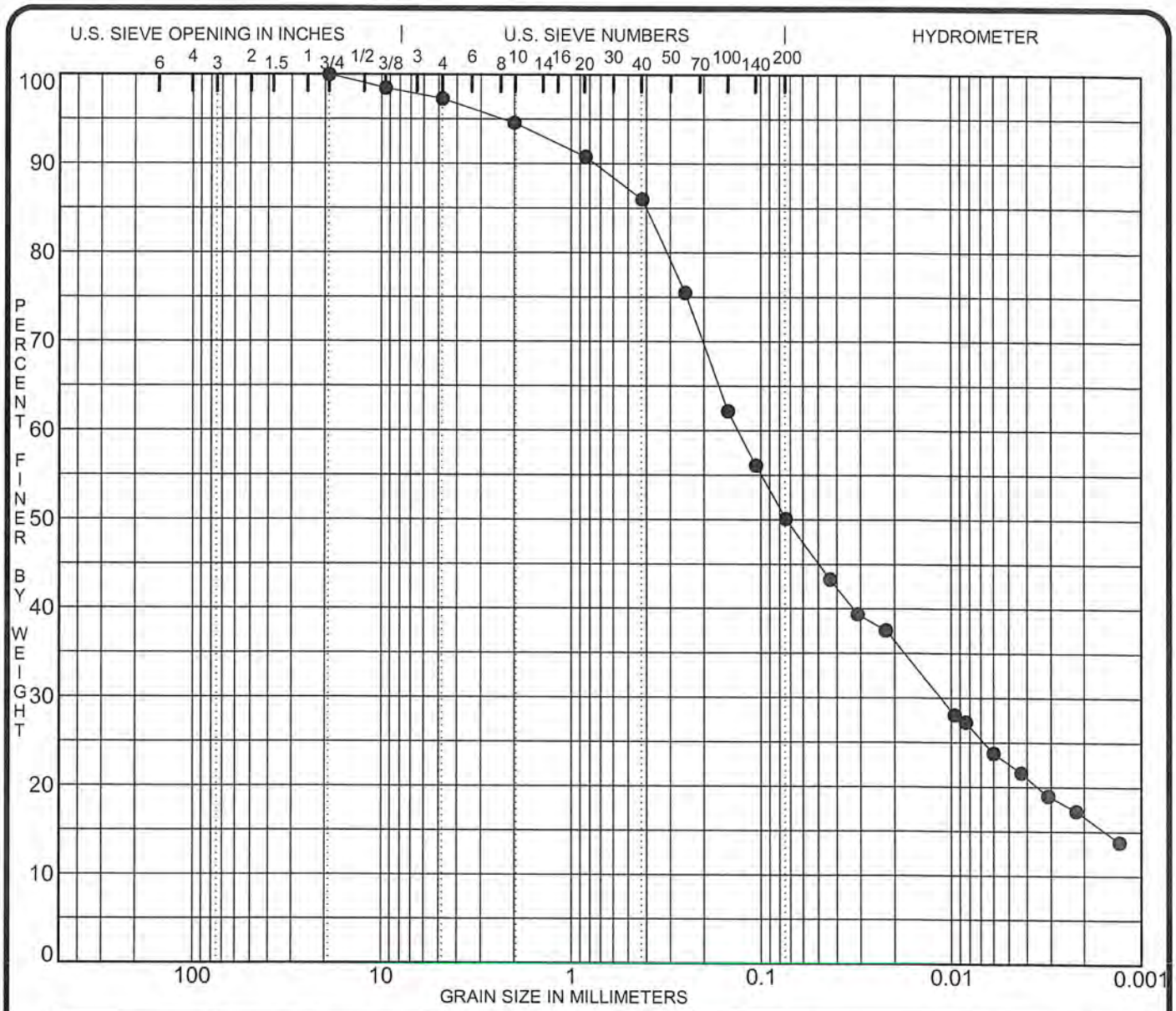
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:07:00	1.0	31.25	23.5	6.25	25.00	45.7	0.01297	11.2	0.0434	43.3
7:08:00	2.0	29.00	23.5	6.25	22.75	41.6	0.01297	11.5	0.0311	39.4
7:10:00	4.0	28.00	23.5	6.25	21.75	39.8	0.01297	11.7	0.0222	37.6
7:29:00	23.0	22.50	23.5	6.25	16.25	29.7	0.01297	12.7	0.0096	28.1
7:36:00	30.0	22.00	23.5	6.25	15.75	28.8	0.01297	12.7	0.0084	27.3
8:06:00	60.0	20.00	23.5	6.25	13.75	25.1	0.01297	13.0	0.0060	23.8
9:06:00	120.0	18.75	23.5	6.25	12.50	22.9	0.01297	13.3	0.0043	21.6
11:06:00	240.0	17.25	23.5	6.25	11.00	20.1	0.01297	13.5	0.0031	19.0
15:06:00	480.0	16.25	24.0	6.25	10.00	18.3	0.01282	13.7	0.0022	17.3
7:06:00	1440.0	14.25	24.0	6.25	8.00	14.6	0.01282	14.0	0.0013	13.8

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: W. Edlebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-003 #7 15'-17'	(CL) SANDY LEAN CLAY, trace gravel, grayish brown						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-003 #7 15'-17'	19.10	0.13	0.073	0.011		2.7	47.2	27.5	22.6

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL-ML) Silty clay with sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-003
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	6.5	2.9	97.1
4M	4.76	5.5	2.5	94.6
10M	2.00	8.5	3.8	90.8
20M	0.85	2.41	4.1	95.9 / 87.1
40M	0.42	3.36	5.7	90.2 / 81.9
60M	0.25	6.59	11.1	79.1 / 71.8
100M	0.149	7.65	12.8	66.3 / 60.2
140M	0.106	3.13	5.3	61.0 / 55.4
200M	0.074	2.97	5.0	56.0 / 50.8
LBW		33.08	55.8	
Pan		0.1	0.2	

Wet weight = - gm
Dry Initial weight = 59.29 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: N. Ellebest
Date: 8/27/22

COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-003

Soil Description: (CL-ML) Silty clay with sand

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 11

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	90.8 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	60.16 g	59.29 g

Starting Date: 8/17/22 Starting Time: 7:18:00 Sedimentation Cylinder No.: HYD 24

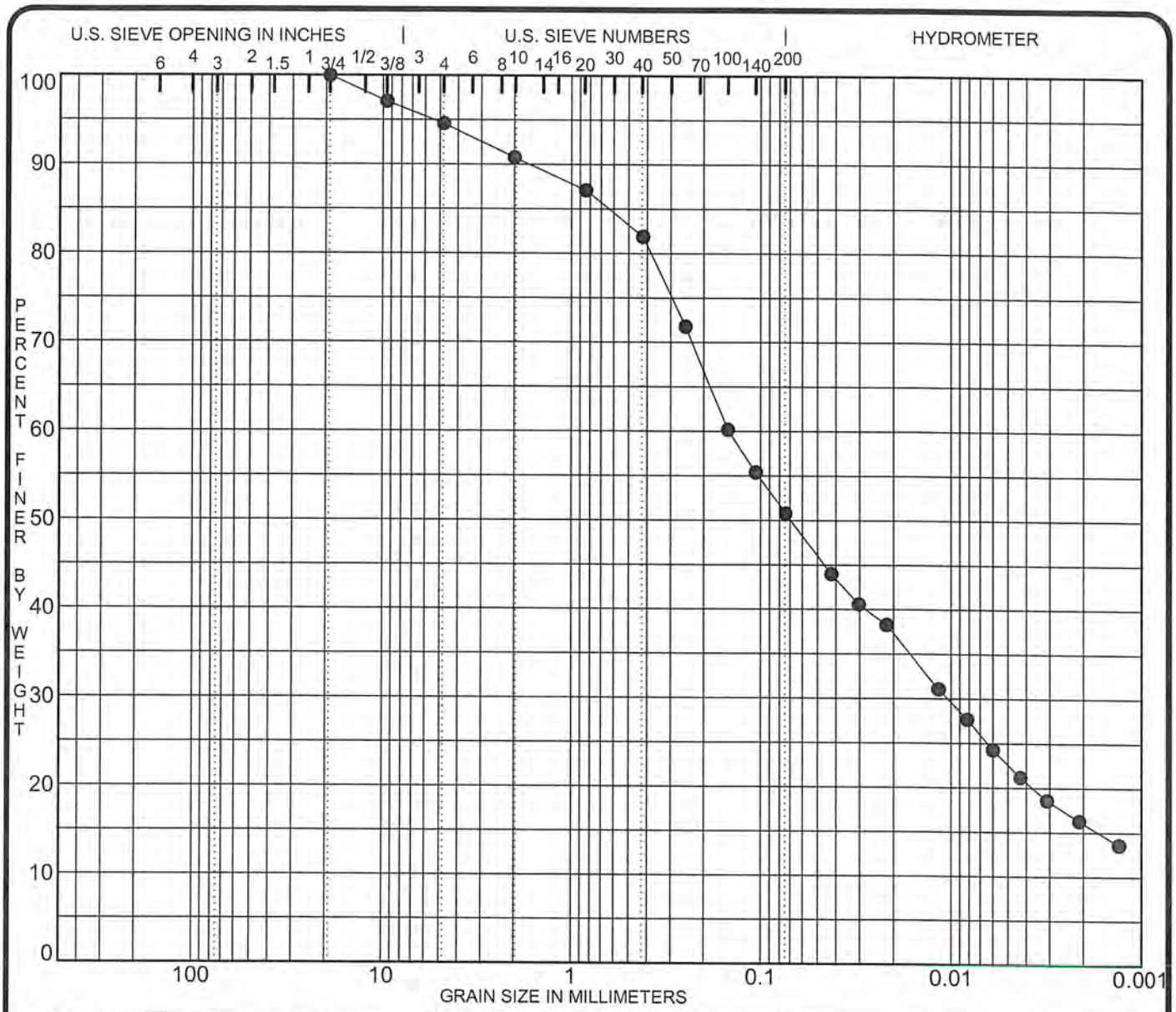
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:19:00	1.0	35.25	23.5	6.25	29.00	48.4	0.01297	10.6	0.0422	44.0
7:20:00	2.0	33.00	23.5	6.25	26.75	44.7	0.01297	10.9	0.0303	40.6
7:22:00	4.0	31.50	23.5	6.25	25.25	42.2	0.01297	11.2	0.0217	38.3
7:33:00	15.0	26.75	23.5	6.25	20.50	34.2	0.01297	12.0	0.0116	31.1
7:49:00	31.0	24.50	23.5	6.25	18.25	30.5	0.01297	12.4	0.0082	27.7
8:18:00	60.0	22.25	23.5	6.25	16.00	26.7	0.01297	12.7	0.0060	24.3
9:18:00	120.0	20.25	23.5	6.25	14.00	23.4	0.01297	13.0	0.0043	21.2
11:18:00	240.0	18.50	23.5	6.25	12.25	20.5	0.01297	13.3	0.0031	18.6
15:18:00	480.0	17.00	24.0	6.25	10.75	17.9	0.01282	13.5	0.0021	16.3
7:18:00	1440.0	15.25	24.0	6.25	9.00	15.0	0.01282	13.8	0.0013	13.6

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-003 #13 33'-35'	(CL-ML) SILTY CLAY WITH SAND						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-003 #13 33'-35'	19.10	0.15	0.069	0.010		5.4	43.8	28.2	22.6

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
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COLEMAN ENGINEERING COMPANY
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120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (ML) Silt, some sand, trace gravel, light brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-006
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.00	0.0	100.0
3/8"	9.5	7.02	5.9	94.1
4M	4.76	0.00	0.0	94.1
10M	2.00	0.34	0.3	93.8
20M	0.85	0.14	0.3	99.7 / 93.5
40M	0.42	0.26	0.5	99.2 / 93.0
60M	0.25	0.85	1.5	97.7 / 91.6
100M	0.149	1.85	3.3	94.4 / 88.5
140M	0.106	1.48	2.7	91.7 / 86.0
200M	0.074	1.44	2.6	89.1 / 83.6
LBW		49.23	88.4	
Pan		0.38	0.7	

Wet weight = - gm
Dry Initial weight = 55.63 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/8/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-006

Soil Description: (ML) Silt, some sand, trace gravel, light brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 10

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	93.8 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.58 g	55.63 g

Starting Date: 8/4/22 Starting Time: 7:12:00 Sedimentation Cylinder No.: HYD 10

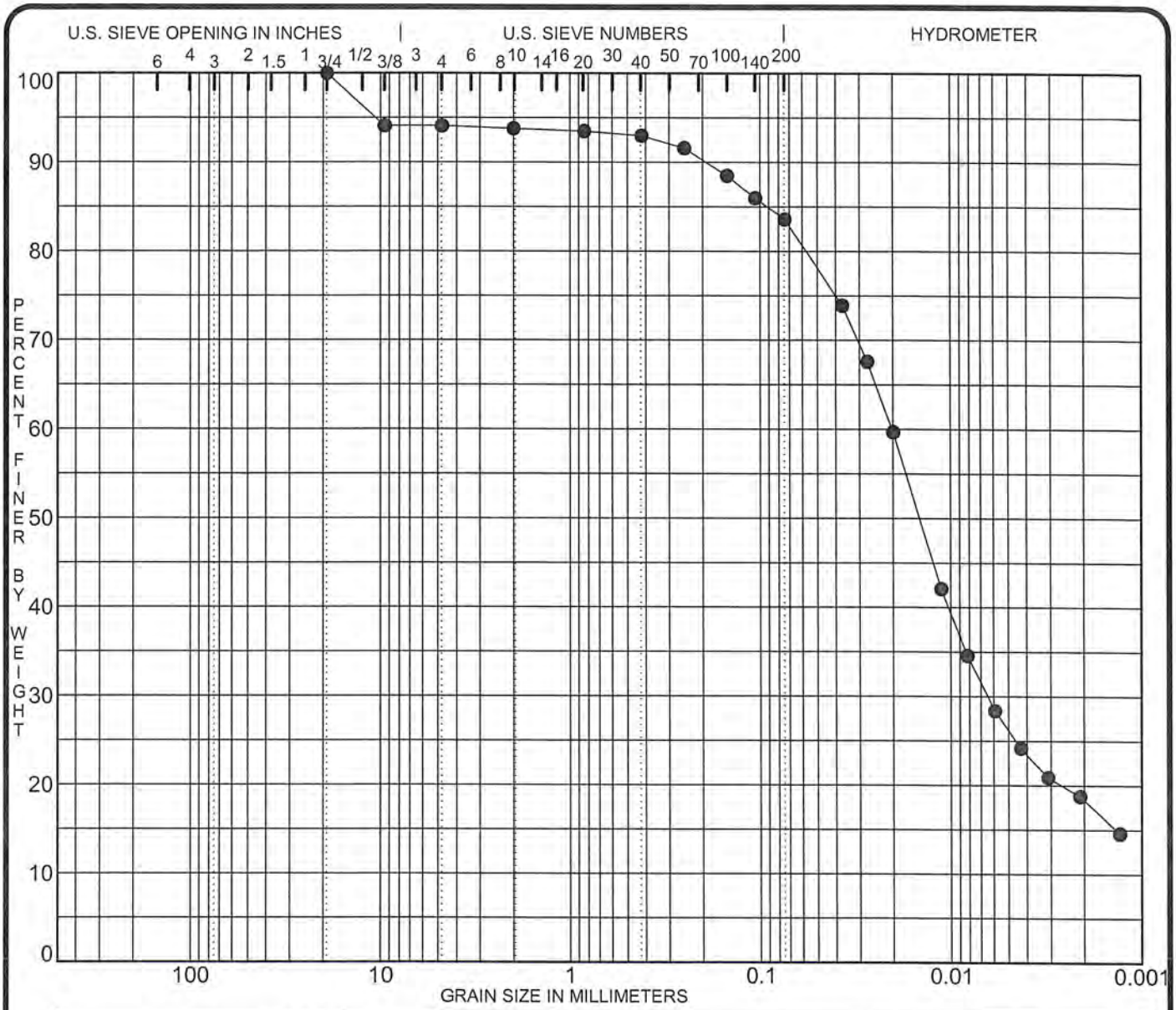
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:13:00	1.0	50.50	23.5	6.25	44.25	78.7	0.01297	8.1	0.0369	73.9
7:14:00	2.0	46.75	23.5	6.25	40.50	72.1	0.01297	8.8	0.0272	67.6
7:16:00	4.0	42.00	23.5	6.25	35.75	63.6	0.01297	9.4	0.0199	59.7
7:27:00	15.0	31.50	23.5	6.25	25.25	44.9	0.01297	11.2	0.0112	42.1
7:42:00	30.0	27.00	23.5	6.25	20.75	36.9	0.01297	11.9	0.0082	34.6
8:12:00	60.0	23.25	23.5	6.25	17.00	30.3	0.01297	12.5	0.0059	28.4
9:12:00	120.0	20.75	23.5	6.25	14.50	25.8	0.01297	13.0	0.0043	24.2
11:12:00	240.0	18.75	23.5	6.25	12.50	22.2	0.01297	13.3	0.0031	20.9
15:12:00	480.0	17.50	24.0	6.25	11.25	20.0	0.01282	13.5	0.0021	18.8
7:12:00	1440.0	15.00	24.0	6.25	8.75	15.6	0.01282	13.8	0.0013	14.6

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: N. Edlebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-006 #6 12.5'-14.5'	(ML) SILT, some sand, trace gravel, light brown						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-006 #6 12.5'-14.5'	19.10	0.02	0.014	0.006		5.9	10.5	57.4	26.2

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine to medium, some gravel
Remarks:

Job No.: GL 191059F2
Boring No.: PD-006
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	10.1	3.9	96.1
4M	4.76	18.5	7.1	89.0
10M	2.00	21.6	8.3	80.7
20M	0.85	4.16	7.2	92.8 / 74.9
40M	0.42	5.27	9.1	83.7 / 67.5
60M	0.25	7.62	13.2	70.5 / 56.9
100M	0.149	8.04	13.8	56.7 / 45.8
140M	0.106	3.38	5.8	50.9 / 41.1
200M	0.074	3.34	5.8	45.1 / 36.4
LBW		26.02	44.9	
Pan		0.1	0.2	

Wet weight = - gm
Dry Initial weight = 57.93 gm
Moisture Content _____ %

Tested By: Jeanne Johnson / Taylor Follrath
Laboratory: Iron Mountain
Submitted By: R. Edlebeck

Date: 8/22/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-006

Soil Description: (SM) Silty sand, fine to medium, some gravel

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 3

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	80.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.25 g	57.93 g

Starting Date: 8/17/22 Starting Time: 7:00:00 Sedimentation Cylinder No.: HYD 1

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:01:00	1.0	27.50	23.5	6.25	21.25	36.3	0.01297	11.9	0.0447	29.3
7:02:00	2.0	25.25	23.5	6.25	19.00	32.5	0.01297	12.2	0.0320	26.2
7:04:00	4.0	25.00	23.5	6.25	18.75	32.0	0.01297	12.2	0.0227	25.9
7:15:00	15.0	24.75	23.5	6.25	18.50	31.6	0.01297	12.4	0.0118	25.5
7:30:00	30.0	18.00	23.5	6.25	11.75	20.1	0.01297	13.3	0.0086	16.2
8:00:00	60.0	16.25	23.5	6.25	10.00	17.1	0.01297	13.7	0.0062	13.8
9:00:00	120.0	15.00	23.5	6.25	8.75	15.0	0.01297	13.8	0.0044	12.1
11:00:00	240.0	13.50	23.5	6.25	7.25	12.4	0.01297	14.2	0.0032	10.0
15:00:00	480.0	13.00	24.0	6.25	6.75	11.5	0.01282	14.2	0.0022	9.3
7:00:00	1440.0	12.00	24.0	6.25	5.75	9.8	0.01282	14.3	0.0013	7.9

Remarks:

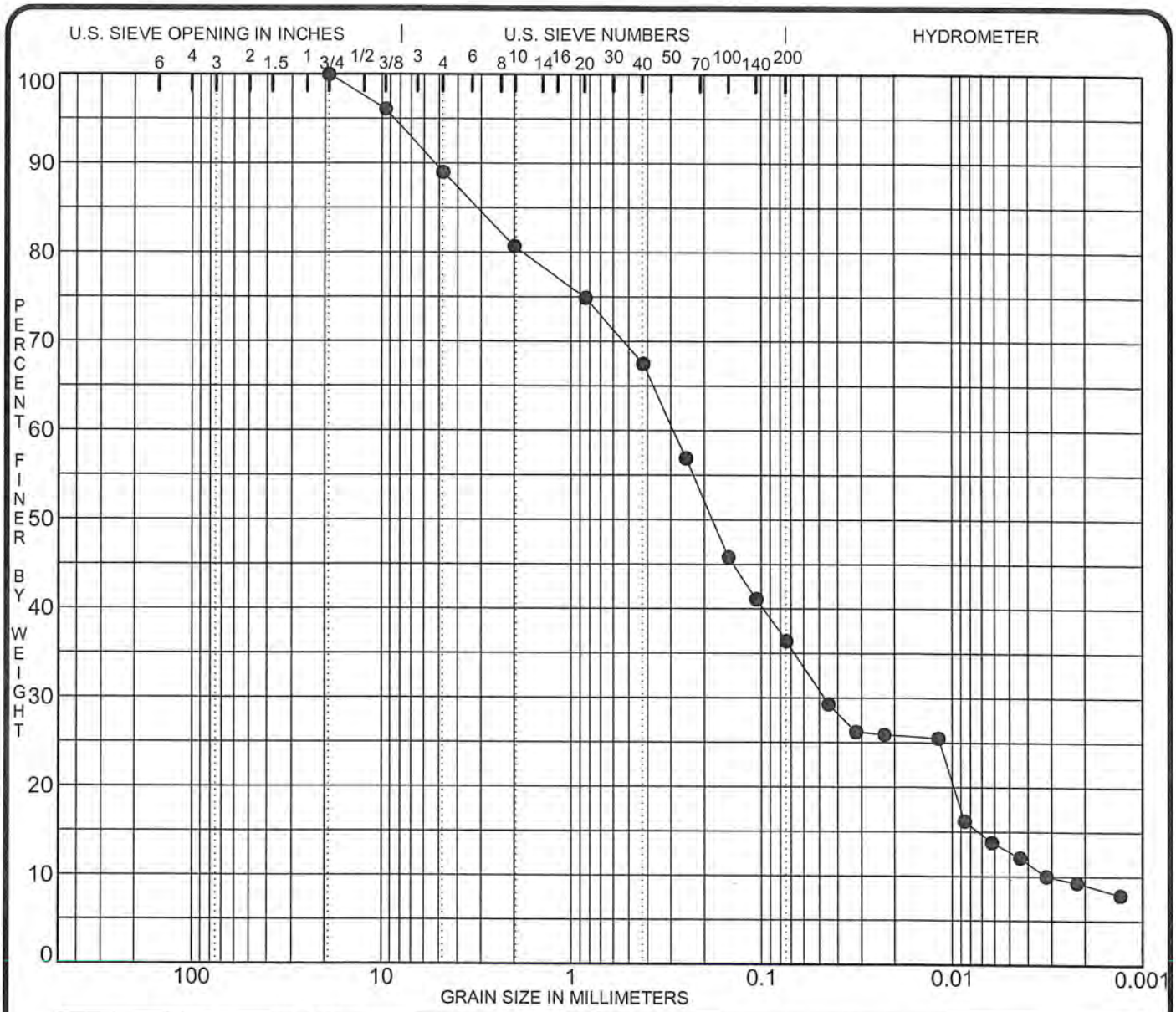
Tested By: Jeanne Johnson

Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck

Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-006 #13 33'-35'**	**(SM) SILTY SAND, fine to medium, some gravel**					**2.37**	**90.9**

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-006 #13 33'-35'**	**19.10**	**0.29**	**0.181**	**0.047**	**0.0032**	**11.0**	**52.6**	**23.7**	**12.7**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine
Remarks:

Job No.: GL 191059F2
Boring No.: PD-008
Sample No.: 11
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	6.3	2.7	97.3
4M	4.76	7.6	3.2	94.1
10M	2.00	11.4	4.8	89.3
20M	0.85	2.86	4.9	95.1 / 84.9
40M	0.42	4.02	6.9	88.2 / 78.8
60M	0.25	7.58	13.0	75.2 / 67.2
100M	0.149	8.31	14.3	60.9 / 54.4
140M	0.106	3.27	5.6	55.3 / 49.4
200M	0.074	3.08	5.3	50.0 / 44.6
LBW		29.15	49.9	
Pan		0.06	0.1	

Wet weight = - gm
Dry Initial weight = 58.33 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/22/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-008

Soil Description: (SM) Silty sand, fine

Sample No.: 11

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 10

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.3 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.63 g	58.33 g

Starting Date: 8/19/22 Starting Time: 7:30:00 Sedimentation Cylinder No.: HYD 11

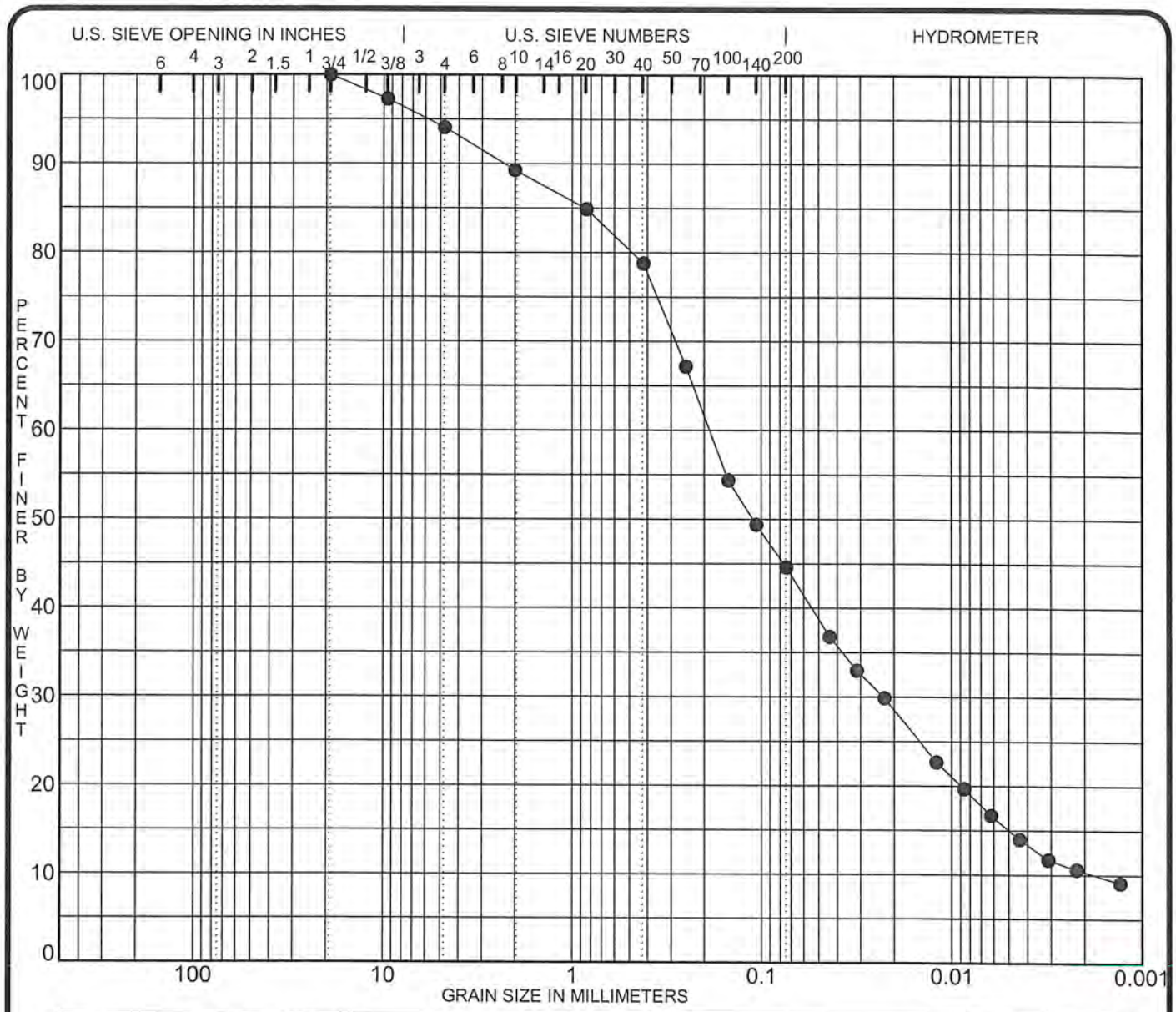
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:31:00	1.0	30.50	23.5	6.25	24.25	41.2	0.01297	11.4	0.0438	36.8
7:32:00	2.0	28.00	23.5	6.25	21.75	36.9	0.01297	11.7	0.0314	33.0
7:34:00	4.0	26.00	23.5	6.25	19.75	33.5	0.01297	12.0	0.0225	29.9
7:45:00	15.0	21.25	23.5	6.25	15.00	25.5	0.01297	12.9	0.0120	22.7
8:00:00	30.0	19.25	23.5	6.25	13.00	22.1	0.01297	13.2	0.0086	19.7
8:30:00	60.0	17.25	23.5	6.25	11.00	18.7	0.01297	13.5	0.0062	16.7
9:30:00	120.0	15.50	23.5	6.25	9.25	15.7	0.01297	13.8	0.0044	14.0
11:30:00	240.0	14.00	24.0	6.25	7.75	13.2	0.01282	14.0	0.0031	11.7
15:30:00	480.0	13.25	24.0	6.25	7.00	11.9	0.01282	14.2	0.0022	10.6
7:30:00	1440.0	12.25	23.5	6.25	6.00	10.2	0.01297	14.3	0.0013	9.1

Remarks:

Tested By: Jeanne Johnson Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-008 #11 33'-35'	(SM) SILTY SAND, fine					1.55	104.8

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-008 #11 33'-35'	19.10	0.19	0.110	0.023	0.0018	5.9	49.5	29.6	15.0

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (ML) Sandy silt, light grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-009
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5	0.00	0.0	100.0
4M	4.76	0.67	0.7	99.3
10M	2.00	1.97	2.1	97.2
20M	0.85	1.45	2.6	97.4 / 94.7
40M	0.42	2.01	3.6	93.8 / 91.2
60M	0.25	2.60	4.6	89.2 / 86.7
100M	0.149	1.35	2.4	86.8 / 84.4
140M	0.106	0.61	1.1	85.7 / 83.3
200M	0.074	2.24	4.0	81.7 / 79.4
LBW		43.79	78.1	
Pan		2.03	3.6	

Wet weight = - gm
Dry Initial weight = 56.08 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/8/2022
Laboratory: Iron Mountain
Submitted By: D. Edlebeck
Date: 8/27/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-009

Soil Description: (ML) Sandy silt, light grayish brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 3

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	97.2 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.41 g	56.08 g

Starting Date: 8/4/22 Starting Time: 7:24:00 Sedimentation Cylinder No.: HYD 2

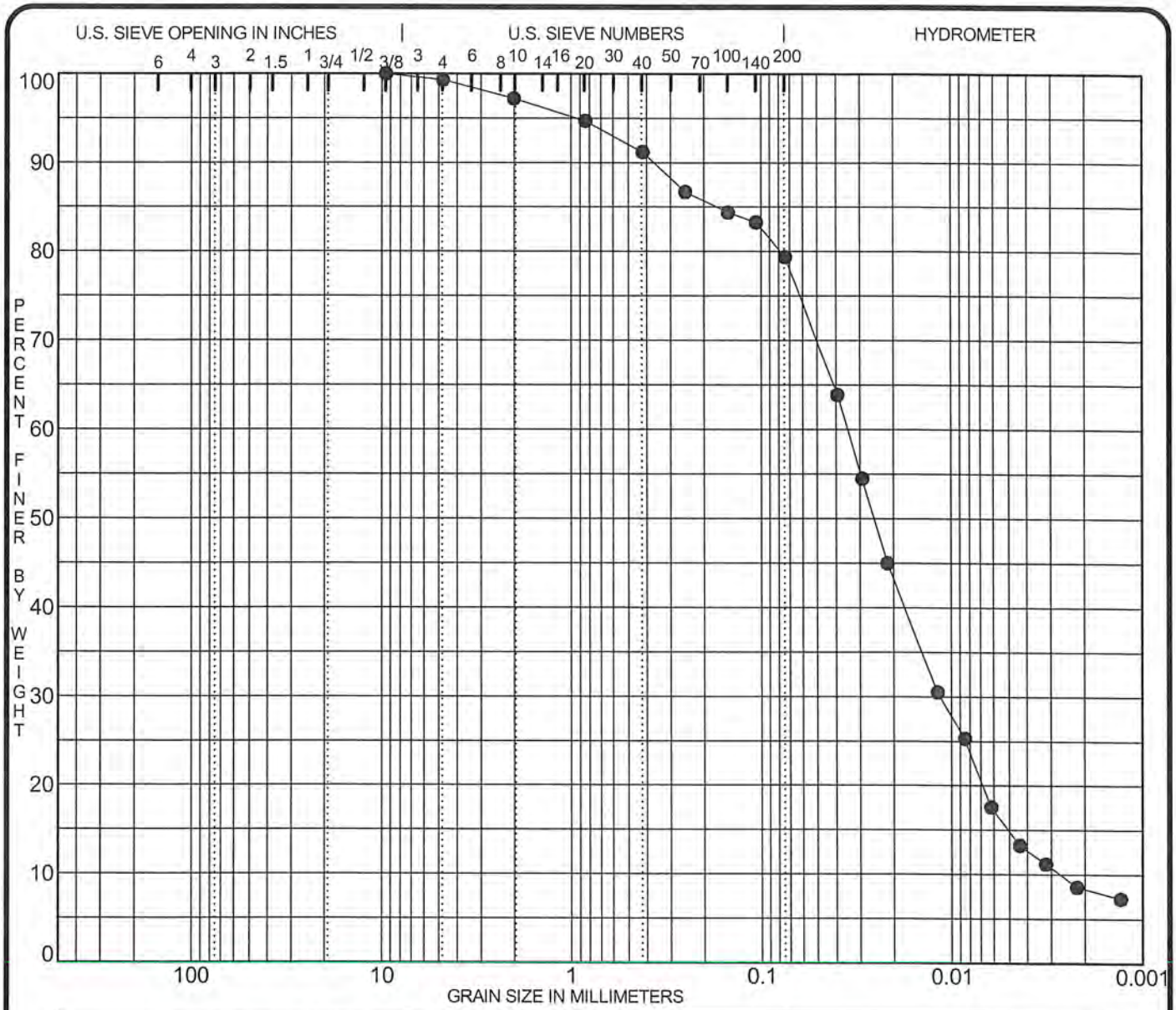
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:25:00	1.0	43.50	23.5	6.25	37.25	65.8	0.01297	9.2	0.0393	63.9
7:26:00	2.0	38.00	23.5	6.25	31.75	56.0	0.01297	10.1	0.0291	54.5
7:28:00	4.0	32.50	23.5	6.25	26.25	46.3	0.01297	11.1	0.0216	45.0
7:39:00	15.0	24.00	23.5	6.25	17.75	31.3	0.01297	12.4	0.0118	30.5
7:54:00	30.0	21.00	23.5	6.25	14.75	26.0	0.01297	12.9	0.0085	25.3
8:24:00	60.0	16.50	23.5	6.25	10.25	18.1	0.01297	13.7	0.0062	17.6
9:24:00	120.0	14.00	23.5	6.25	7.75	13.7	0.01297	14.0	0.0044	13.3
11:24:00	240.0	12.75	23.5	6.25	6.50	11.5	0.01297	14.3	0.0032	11.2
15:24:00	480.0	11.25	24.0	6.25	5.00	8.8	0.01282	14.7	0.0022	8.6
7:24:00	1440.0	10.50	24.0	6.25	4.25	7.5	0.01282	14.7	0.0013	7.3

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: D. Ellebed Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-009 #6 12.5'-14.5'**	**(ML) SANDY SILT, light grayish brown**					**1.40**	**12.9**

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-009 #6 12.5'-14.5'**	**9.50**	**0.03**	**0.025**	**0.011**	**0.0027**	**0.7**	**19.9**	**64.5**	**14.9**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE • IRON MOUNTAIN, MI 49801 • PHONE: 906-774-3440
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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay, some sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-009
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	0.0	0.0	100.0
4M	4.76	0.2	0.1	99.9
10M	2.00	0.4	0.2	99.7
20M	0.85	0.15	0.3	99.7 / 99.4
40M	0.42	0.33	0.6	99.1 / 98.8
60M	0.25	0.59	1.1	98.0 / 97.7
100M	0.149	0.71	1.3	96.7 / 96.4
140M	0.106	0.38	0.7	96.0 / 95.7
200M	0.074	2.08	3.7	92.3 / 92.0
LBW		51.38	91.9	
Pan		0.20	0.4	

Wet weight = - gm
Dry Initial weight = 55.82 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: D. Ellebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-009

Soil Description: (CL) Lean clay, some sand

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 8

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	99.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.59 g	55.82 g

Starting Date: 8/19/22 Starting Time: 7:42:00 Sedimentation Cylinder No.: HYD 10

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:43:00	1.0	48.00	24.0	6.25	41.75	74.0	0.01282	8.4	0.0372	73.8
7:44:00	2.0	44.25	24.0	6.25	38.00	67.4	0.01282	9.1	0.0273	67.2
7:46:00	4.0	41.25	24.0	6.25	35.00	62.1	0.01282	9.6	0.0199	61.9
7:57:00	15.0	34.75	24.0	6.25	28.50	50.5	0.01282	10.7	0.0108	50.4
8:12:00	30.0	31.00	24.0	6.25	24.75	43.9	0.01282	11.2	0.0078	43.8
8:42:00	60.0	28.00	24.0	6.25	21.75	38.6	0.01282	11.7	0.0057	38.5
9:42:00	120.0	25.50	24.0	6.25	19.25	34.1	0.01282	12.2	0.0041	34.0
11:42:00	240.0	23.25	24.0	6.25	17.00	30.2	0.01282	12.5	0.0029	30.1
15:42:00	480.0	21.50	24.0	6.25	15.25	27.0	0.01282	12.9	0.0021	27.0
7:42:00	1440.0	19.00	23.5	6.25	12.75	22.6	0.01297	13.2	0.0012	22.5

Remarks:

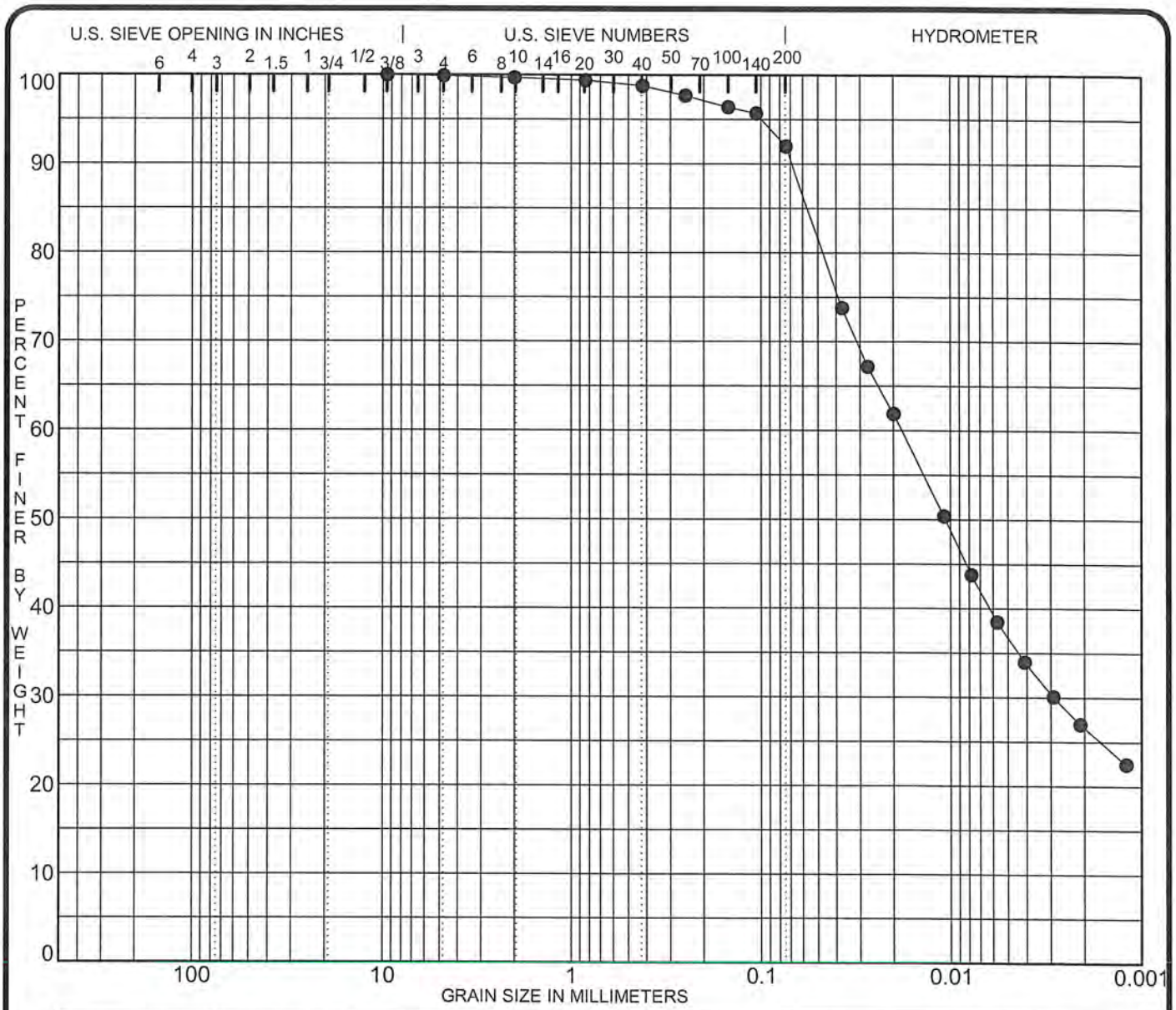
Tested By: Jeanne Johnson

Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: W. Edlebeck

Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-009 #13 33'-35'	(CL) LEAN CLAY, some sand						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-009 #13 33'-35'	9.50	0.02	0.011	0.003		0.1	7.9	55.3	36.7

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
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COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine, light grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-010
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5			
4M	4.76			
10M	2.00			
20M	0.85	0.01	0.0	100.0
40M	0.42	0.09	0.2	99.8
60M	0.25	1.19	2.1	97.7
100M	0.149	15.94	27.5	70.2
140M	0.106	12.62	21.8	48.4
200M	0.074	11.45	19.8	28.6
LBW		11.77	20.4	
Pan		4.71	8.2	

Wet weight = - gm
Dry Initial weight = 57.78 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/8/2022
Date: 8/27/22

Form D6913 Revised 3/17/22

COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-010

Soil Description: (SM) Silty sand, fine, light grayish brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 5

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	100.0 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	57.95 g	57.78 g

Starting Date: 8/4/22 Starting Time: 7:18:00 Sedimentation Cylinder No.: HYD 4

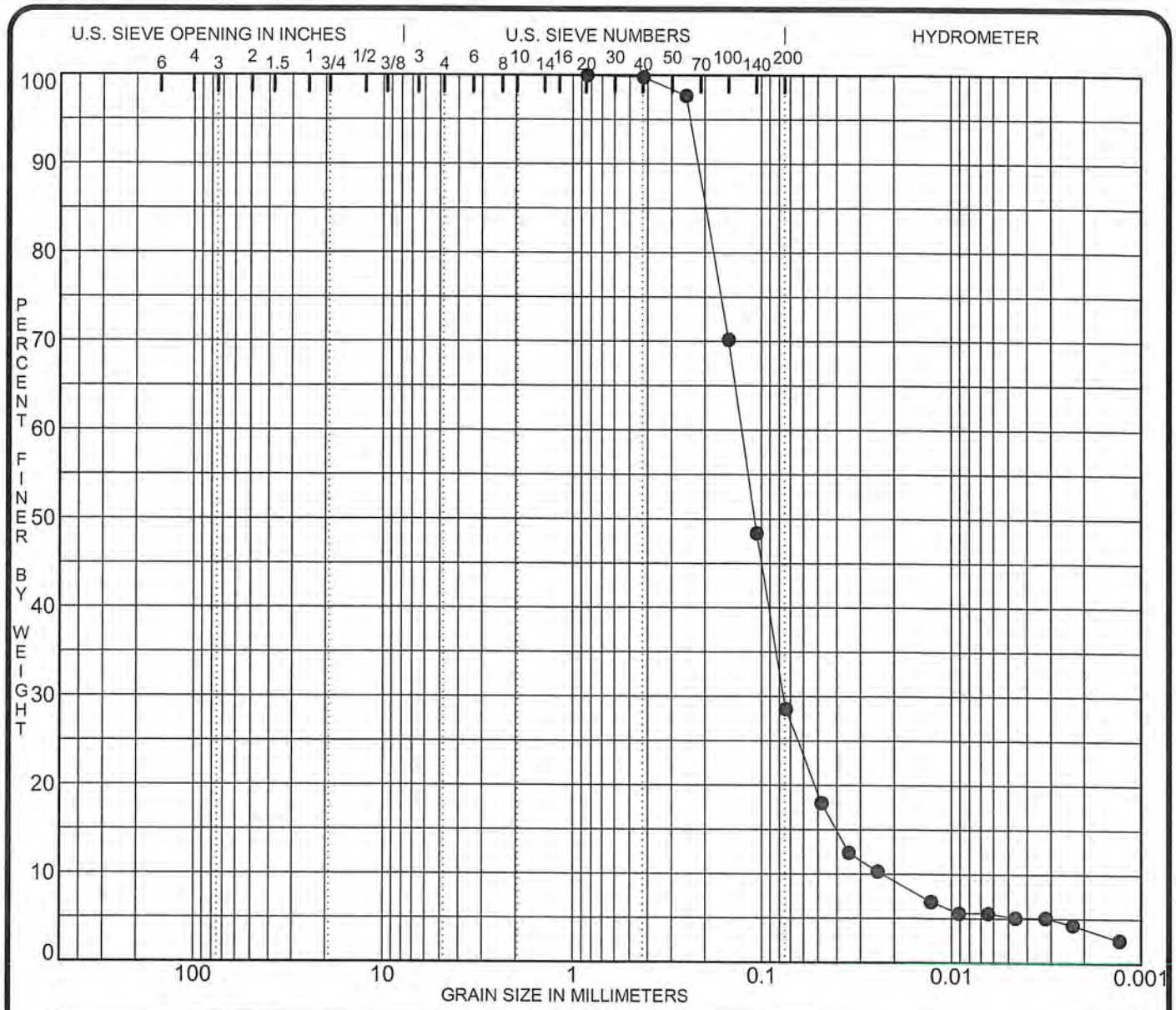
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:19:00	1.0	16.75	23.5	6.25	10.50	18.0	0.01297	13.7	0.0480	18.0
7:20:00	2.0	13.50	23.5	6.25	7.25	12.4	0.01297	14.2	0.0346	12.4
7:22:00	4.0	12.25	23.5	6.25	6.00	10.3	0.01297	14.3	0.0245	10.3
7:33:00	15.0	10.25	23.5	6.25	4.00	6.9	0.01297	14.7	0.0128	6.9
7:48:00	30.0	9.50	23.5	6.25	3.25	5.6	0.01297	14.8	0.0091	5.6
8:18:00	60.0	9.50	23.5	6.25	3.25	5.6	0.01297	14.8	0.0064	5.6
9:18:00	120.0	9.25	23.5	6.25	3.00	5.1	0.01297	14.8	0.0046	5.1
11:18:00	240.0	9.25	23.5	6.25	3.00	5.1	0.01297	14.8	0.0032	5.1
15:18:00	480.0	8.75	24.0	6.25	2.50	4.3	0.01282	15.0	0.0023	4.3
7:18:00	1440.0	7.75	24.0	6.25	1.50	2.6	0.01282	15.2	0.0013	2.6

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: W. Ellebedi Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-010 #6 12.5'-14.5'	(SM) SILTY SAND, fine, light grayish brown					1.96	5.5

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-010 #6 12.5'-14.5'	0.84	0.13	0.109	0.076	0.0231	0.0	71.4	23.4	5.2

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
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COLEMAN ENGINEERING COMPANY
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120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Sandy lean clay
Remarks:

Job No.: GL 191059F2
Boring No.: PD-010
Sample No.: 8
Depth: 23'-25'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	0.0	0.0	100.0
4M	4.76	1.0	0.4	99.6
10M	2.00	6.0	2.3	97.3
20M	0.85	1.48	2.7	97.3 / 94.7
40M	0.42	2.45	4.5	92.8 / 90.3
60M	0.25	5.27	9.6	83.2 / 81.0
100M	0.149	6.40	11.7	71.5 / 69.6
140M	0.106	2.63	4.8	66.7 / 64.9
200M	0.074	2.35	4.3	62.4 / 60.7
LBW		34.07	62.3	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 54.72 gm
Moisture Content - %

Tested By: Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: N. Edlebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-010

Soil Description: (CL) Sandy lean clay

Sample No.: 8

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 23'-25'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Foam Inhibitor Used: [ ] Yes [X] No

Specimen-mixing Container ID: HB 5

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	97.3 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	55.17 g	54.72 g

Starting Date: 8/19/22 Starting Time: 7:36:00 Sedimentation Cylinder No.: HYD 2

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:37:00	1.0	38.00	23.5	6.25	31.75	57.4	0.01297	10.1	0.0412	55.9
7:38:00	2.0	35.50	23.5	6.25	29.25	52.9	0.01297	10.6	0.0299	51.5
7:40:00	4.0	34.50	23.5	6.25	28.25	51.1	0.01297	10.7	0.0212	49.7
7:51:00	15.0	30.50	23.5	6.25	24.25	43.9	0.01297	11.4	0.0113	42.7
8:06:00	30.0	28.00	23.5	6.25	21.75	39.4	0.01297	11.7	0.0081	38.3
8:36:00	60.0	25.75	23.5	6.25	19.25	34.8	0.01297	12.2	0.0058	33.9
9:36:00	120.0	23.25	23.5	6.25	17.00	30.8	0.01297	12.5	0.0042	29.9
11:36:00	240.0	21.00	24.0	6.25	14.75	26.7	0.01282	12.9	0.0030	26.0
15:36:00	480.0	20.00	24.0	6.25	13.75	24.9	0.01282	13.0	0.0021	24.2
7:36:00	1440.0	17.00	23.5	6.25	10.75	19.4	0.01297	13.5	0.0013	18.9

Remarks:

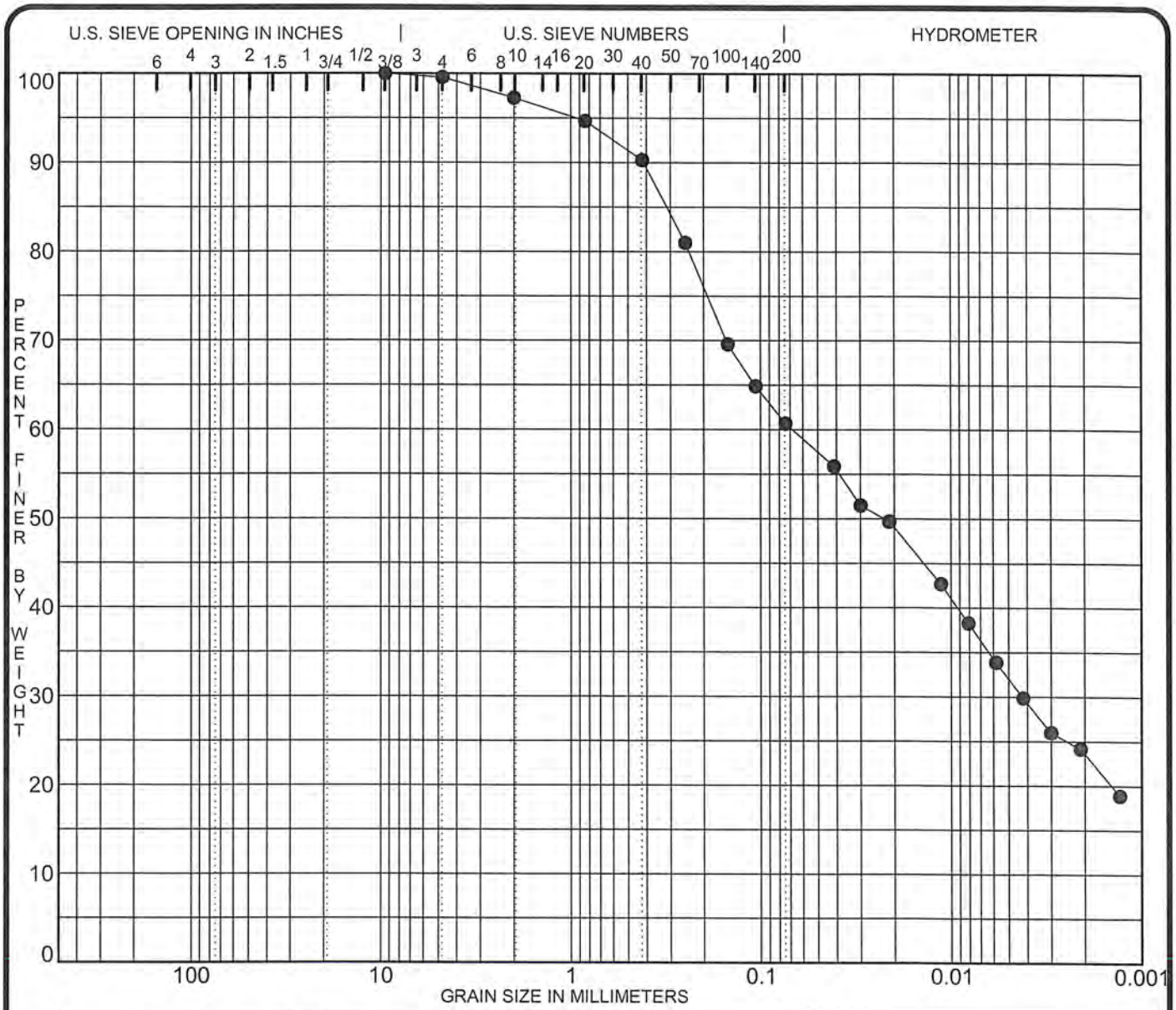
Tested By: Jeanne Johnson

Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: R. Edlebrock

Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **PD-010 #8 23'-25'**	(CL) **SANDY LEAN CLAY**						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **PD-010 #8 23'-25'**	**9.50**	**0.07**	**0.022**	**0.004**		**0.4**	**38.9**	**28.6**	**32.1**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

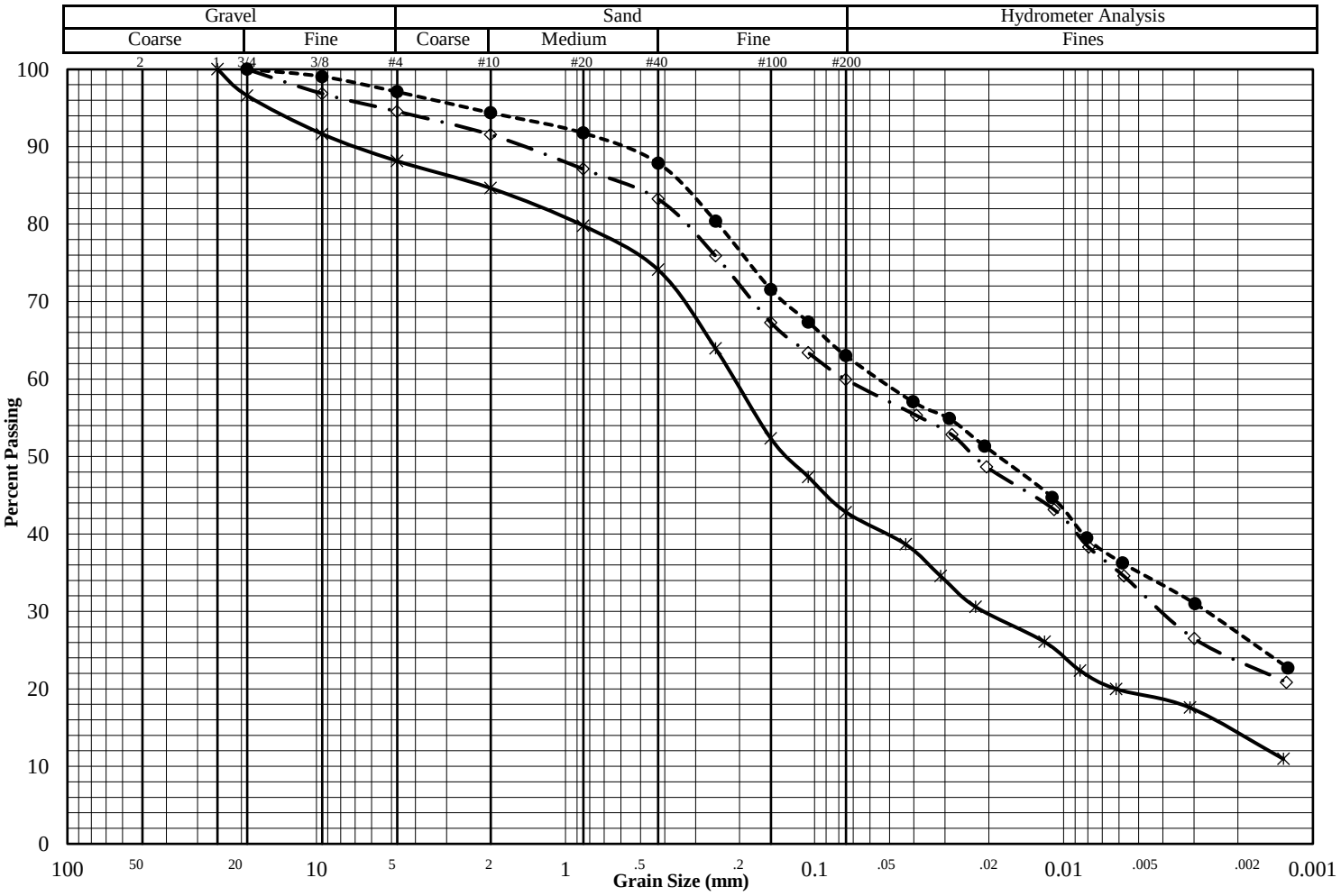
COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/3/22
Reported To:	Coleman Engineering Co.	Report Date:	8/8/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	PD-001		30-33	TWT	Silty Clayey Sand w/a little gravel (SC-SM)
●	PD-003		25-28	TWT	Sandy Lean Clay w/a trace of gravel (CL)
◇	PD-006		25-28	TWT	Sandy Lean Clay w/a little gravel (CL)



Additional Results	∗	●	◇
Liquid Limit	16	21	21
Plastic Limit	10	10	11
Plasticity Index ASTM:D4316	6	11	10
Water Content ASTM:D2216			
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854	2.68*	2.68*	2.68*
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing (Single Set)

	∗	●	◇
Mass (g)	470.9	350.5	303.9
1"	100.0		
3/4"	96.6	100.0	100.0
3/8"	91.6	99.1	96.9
#4	88.2	97.1	94.6
#10	84.7	94.4	91.6
#20	79.8	91.8	87.1
#40	74.1	87.9	83.2
#60	64.0	80.4	75.9
#100	52.3	71.6	67.3
#140	47.4	67.4	63.4
#200	42.8	63.0	60.0

**Sieves larger than 1" reported on page 2

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/3/22
Reported To:	Coleman Engineering Co.	Report Date:	8/8/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	PD-001		30-33	TWT	Silty Clayey Sand w/a little gravel (SC-SM)
Spec 2	PD-003		25-28	TWT	Sandy Lean Clay w/a trace of gravel (CL)
Spec 3	PD-006		25-28	TWT	Sandy Lean Clay w/a little gravel (CL)

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
3"		3"		3"	
2"		2"		2"	
1 1/2"		1 1/2"		1 1/2"	
1"	100.0	1"		1"	
3/4"	96.6	3/4"	100.0	3/4"	100.0
3/8"	91.6	3/8"	99.1	3/8"	96.9
#4	88.2	#4	97.1	#4	94.6
#10	84.7	#10	94.4	#10	91.6
#20	79.8	#20	91.8	#20	87.1
#40	74.1	#40	87.9	#40	83.2
#60	64.0	#60	80.4	#60	75.9
#100	52.3	#100	71.6	#100	67.3
#140	47.4	#140	67.4	#140	63.4
#200	42.8	#200	63.0	#200	60.0

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.043	38.7	0.040	57.1	0.039	55.3
0.031	34.6	0.029	54.9	0.028	52.8
0.023	30.6	0.021	51.4	0.020	48.7
0.012	26.1	0.011	44.7	0.011	43.1
0.009	22.4	0.008	39.5	0.008	38.3
0.006	20.0	0.006	36.2	0.006	34.6
0.003	17.6	0.003	31.0	0.003	26.5
0.001	11.0	0.001	22.7	0.001	20.8

Remarks

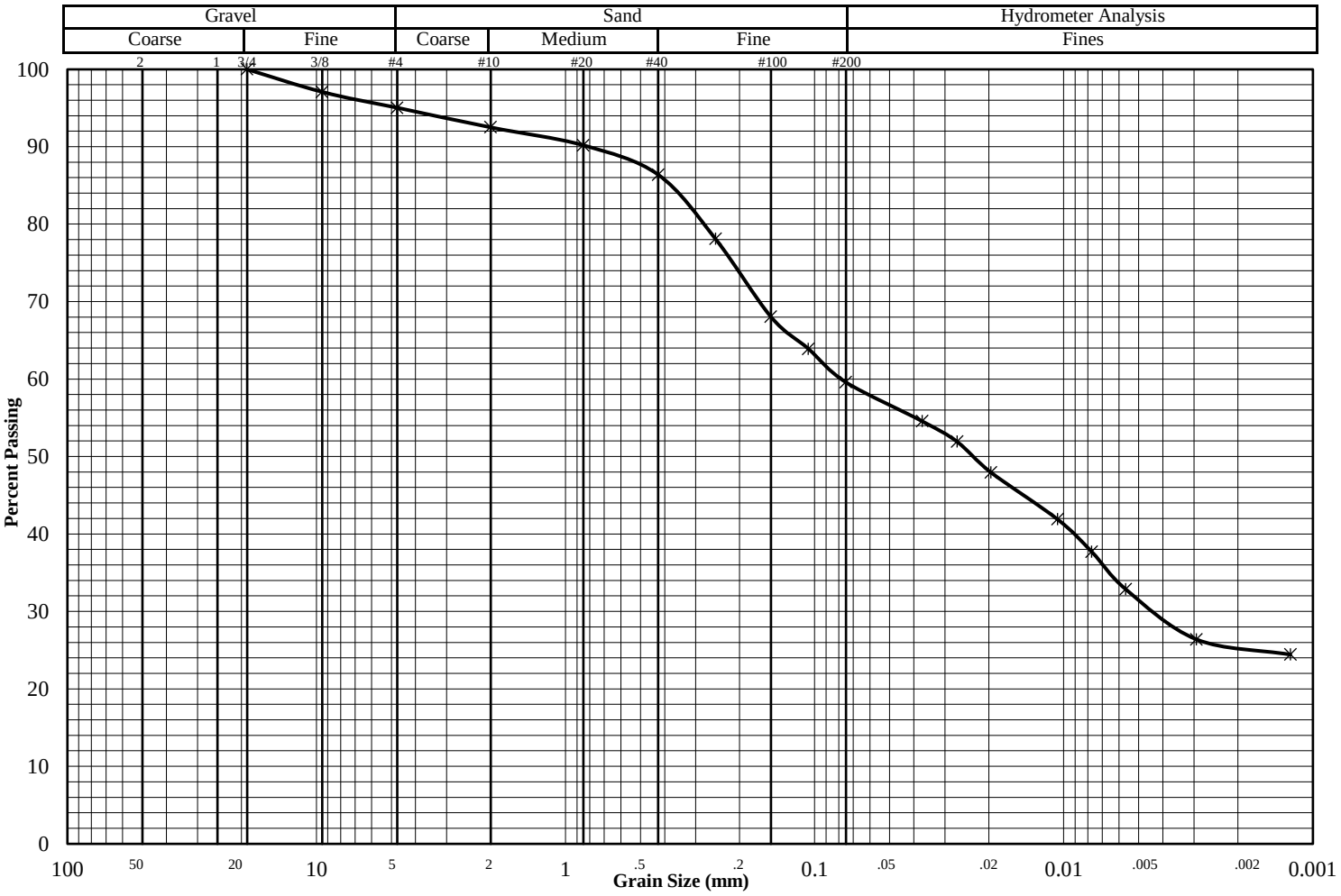
Specimen 1	Specimen 2	Specimen 3

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/10/22
Reported To:	Coleman Engineering Co.	Report Date:	8/12/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	PD-009		30-33	TWT	Sandy Lean Clay w/a little gravel (CL)
●					
◇					



Additional Results	∗	●	◇
Liquid Limit	20		
Plastic Limit	11		
Plasticity Index ASTM:D4316	9		
Water Content ASTM:D2216			
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854	2.68*		
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing (Single Set)

	∗	●	◇
Mass (g)	313.1		
1"			
3/4"	100.0		
3/8"	97.1		
#4	95.0		
#10	92.5		
#20	90.2		
#40	86.4		
#60	78.1		
#100	68.1		
#140	63.9		
#200	59.6		

**Sieves larger than 1" reported on page 2

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/10/22
Reported To:	Coleman Engineering Co.	Report Date:	8/12/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	PD-009		30-33	TWT	Sandy Lean Clay w/a little gravel (CL)
Spec 2					
Spec 3					

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
3"		3"		3"	
2"		2"		2"	
1 1/2"		1 1/2"		1 1/2"	
1"		1"		1"	
3/4"	100.0	3/4"		3/4"	
3/8"	97.1	3/8"		3/8"	
#4	95.0	#4		#4	
#10	92.5	#10		#10	
#20	90.2	#20		#20	
#40	86.4	#40		#40	
#60	78.1	#60		#60	
#100	68.1	#100		#100	
#140	63.9	#140		#140	
#200	59.6	#200		#200	

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.037	54.6				
0.027	51.9				
0.020	47.9				
0.011	41.9				
0.008	37.7				
0.006	32.9				
0.003	26.4				
0.001	24.4				

Remarks

Specimen 1	Specimen 2	Specimen 3

9530 James Ave South

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Bloomington, MN 55431

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

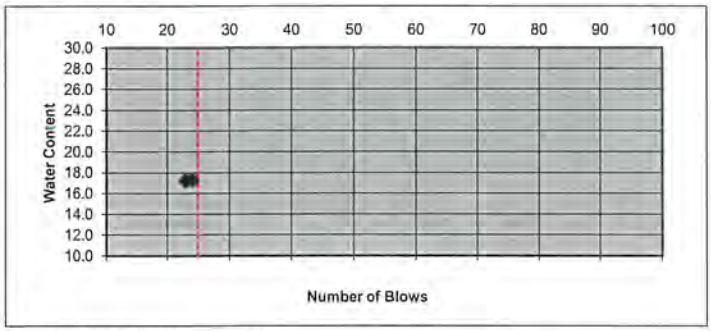
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Lean clay with sand

Job No.: GL-191059F2
Boring No.: PD-001
Sample No.: 15
Depth: 38'-40'

Liquid Limit Determination

Can No.	5	23				
Wt. of wet soil +can (g)	30.61	30.51				
Wt. of dry soil + can (g)	28.43	28.38				
Wt. of can (g)	15.82	16.01				
Wt of dry soil (g)	12.61	12.37				
Wt of moisture (g)	2.18	2.13				
* No of blows, N	**24**	**23**				
Water content, *w* %	**17.3**	**17.2**				
K Values and Corrected Average	**K=0.995 17.2**	**K=0.990 17.0**	**Avg = 17.1**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 17
Plastic limit = 10
Plasticity index I_p = 7

Plastic Limit Determination

Can no.	30	38				
Wt. of wet soil + can (g)	28.37	27.20				
Wt. of dry soil + can (g)	27.22	26.16				
Wt. of can (g)	16.15	16.00				
Wt. of dry soil (g)	11.07	10.16				
Wt. of moisture (g)	1.15	1.04				
Water content, $w\% = w_p$	10.4	10.2	Avg = 10.3			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: W. Edlebeck
Date: 8/27/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

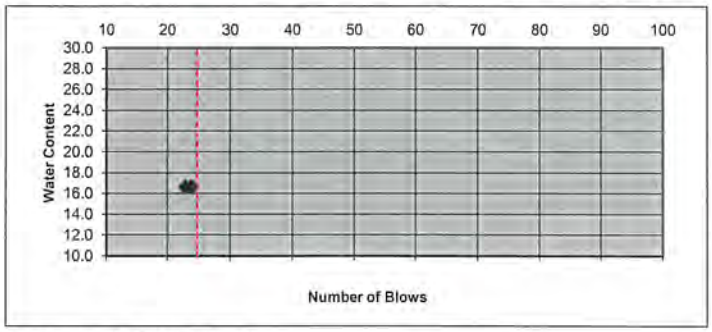
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL-ML) Silty clay, with sand, trace gravel

Job No.: GL-191059F2
Boring No.: PD-002
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	42	36				
Wt. of wet soil +can (g)	34.03	32.30				
Wt. of dry soil + can (g)	31.47	29.96				
Wt. of can (g)	16.04	15.89				
Wt of dry soil (g)	15.43	14.07				
Wt of moisture (g)	2.56	2.34				
* No of blows, N	**23**	**24**				
Water content, *w* %	**16.6**	**16.6**				
K Values and Corrected Average	**K=0.990 16.4**	**K=0.995 16.5**	**Avg = 16.4**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 16
Plastic limit = 10
Plasticity index I_p = 6

Plastic Limit Determination

Can no.	44	26				
Wt. of wet soil + can (g)	26.01	29.66				
Wt. of dry soil + can (g)	25.10	28.41				
Wt. of can (g)	15.91	16.11				
Wt. of dry soil (g)	9.19	12.30				
Wt. of moisture (g)	0.91	1.25				
Water content, w % = w_p	9.9	10.2	Avg = 10.0			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: N. Ellabes
Date: 8/27/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

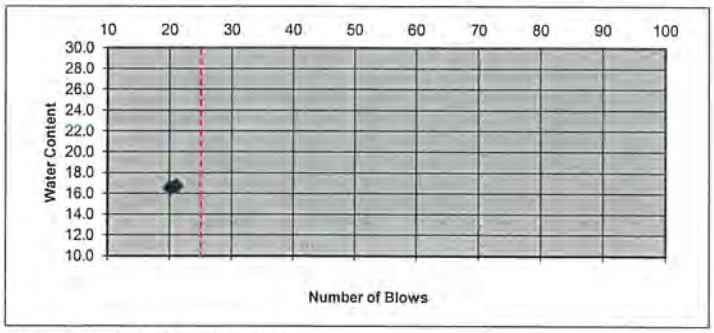
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL-ML) Silty clay with sand

Job No.: GL-191059F2
Boring No.: PD-003
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	33	37				
Wt. of wet soil +can (g)	31.65	31.00				
Wt. of dry soil + can (g)	29.41	28.87				
Wt. of can (g)	15.97	15.99				
Wt of dry soil (g)	13.44	12.88				
Wt of moisture (g)	2.24	2.13				
* No of blows, N	**21**	**20**				
Water content, *w* %	**16.7**	**16.5**				
K Values and Corrected Average	**K=0.979 16.3**	**K=0.973 16.1**	**Avg = 16.2**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 16
Plastic limit = 10
Plasticity index I_p = 6

Plastic Limit Determination

Can no.	40	45				
Wt. of wet soil + can (g)	29.23	28.85				
Wt. of dry soil + can (g)	27.96	27.67				
Wt. of can (g)	15.81	15.94				
Wt. of dry soil (g)	12.15	11.73				
Wt. of moisture (g)	1.27	1.18				
Water content, $w\% = w_p$	10.5	10.1	Avg = 10.3			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/17/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

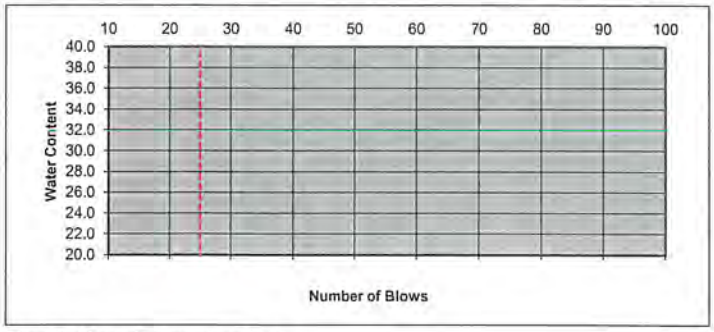
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (SM) Silty sand, fine to medium, some gravel

Job No.: GL-191059F2
Boring No.: PD-006
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.						
Wt. of wet soil +can (g)						
Wt. of dry soil + can (g)						
Wt. of can (g)						
Wt of dry soil (g)						
Wt of moisture (g)						
* No of blows, N						
Water content, *w* %						
K Values and Corrected Average						

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit =
Plastic limit =
Plasticity index I_p =

***Non Plastic**
Sample could not be rolled to 1/8 inch thread

Plastic Limit Determination

Can no.						
Wt. of wet soil + can (g)						
Wt. of dry soil + can (g)						
Wt. of can (g)						
Wt. of dry soil (g)						
Wt. of moisture (g)						
Water content, $w\,\% = w_p$						

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: N. Edlebeck
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

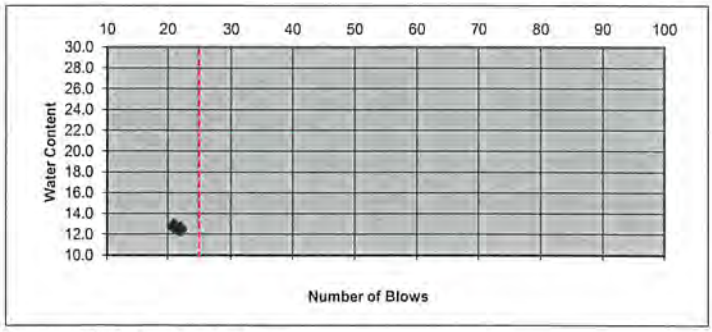
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (SM) Silty sand, fine

Job No.: GL-191059F2
Boring No.: PD-008
Sample No.: 11
Depth: 33'-35'

Liquid Limit Determination

Can No.	37	40				
Wt. of wet soil +can (g)	39.56	39.71				
Wt. of dry soil + can (g)	36.88	37.05				
Wt. of can (g)	16.01	15.82				
Wt of dry soil (g)	20.87	21.23				
Wt of moisture (g)	2.68	2.66				
* No of blows, N	**21**	**22**				
Water content, *w* %	**12.8**	**12.5**				
K Values and Corrected Average	**K=0.979 12.6**	**K=0.985 12.3**	**Avg = 12.4**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 12
Plastic limit = 11
Plasticity index I_p = 1

Plastic Limit Determination

Can no.	33	45				
Wt. of wet soil + can (g)	28.12	28.18				
Wt. of dry soil + can (g)	26.97	27.00				
Wt. of can (g)	15.97	15.92				
Wt. of dry soil (g)	11.00	11.08				
Wt. of moisture (g)	1.15	1.18				
Water content, w % = w_p	10.5	10.6	Avg = 10.6			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/18/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

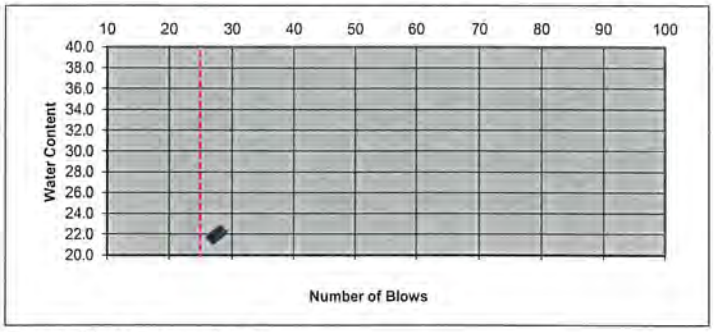
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Lean clay, some sand

Job No.: GL-191059F2
Boring No.: PD-009
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	42	44				
Wt. of wet soil +can (g)	29.41	29.31				
Wt. of dry soil + can (g)	26.98	26.92				
Wt. of can (g)	16.03	15.89				
Wt of dry soil (g)	10.95	11.03				
Wt of moisture (g)	2.43	2.39				
* No of blows, N	**28**	**27**				
Water content, *w* %	**22.2**	**21.7**				
K Values and Corrected Average	**K=1.014 22.5**	**K=1.009 21.9**	**Avg = 22.2**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 22
Plastic limit = 14
Plasticity index I_p = 8

Plastic Limit Determination

Can no.	5	23				
Wt. of wet soil + can (g)	26.02	26.42				
Wt. of dry soil + can (g)	24.80	25.19				
Wt. of can (g)	15.82	16.03				
Wt. of dry soil (g)	8.98	9.16				
Wt. of moisture (g)	1.22	1.23				
Water content, $w\% = w_p$	13.6	13.4	Avg = 13.5			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/18/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

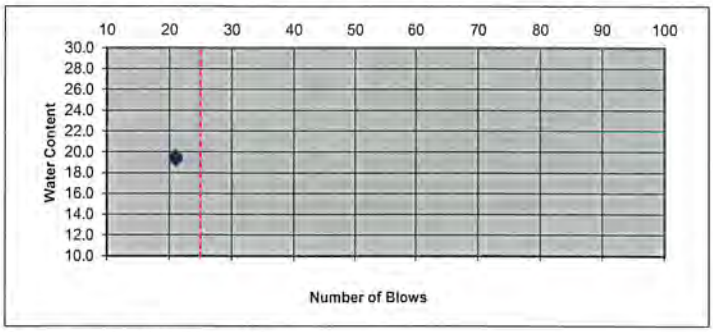
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Sandy lean clay

Job No.: GL-191059F2
Boring No.: PD-010
Sample No.: 8
Depth: 23'-25'

Liquid Limit Determination

Can No.	30	36				
Wt. of wet soil +can (g)	29.98	31.87				
Wt. of dry soil + can (g)	27.72	29.28				
Wt. of can (g)	16.15	15.88				
Wt of dry soil (g)	11.57	13.40				
Wt of moisture (g)	2.26	2.59				
* No of blows, N	**21**	**21**				
Water content, *w* %	**19.5**	**19.3**				
K Values and Corrected Average	**K=0.979 19.1**	**K=0.979 18.9**	**Avg = 19.0**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 19
Plastic limit = 11
Plasticity index I_p = 8

Plastic Limit Determination

Can no.	26	43				
Wt. of wet soil + can (g)	25.52	26.51				
Wt. of dry soil + can (g)	24.62	25.52				
Wt. of can (g)	16.10	16.19				
Wt. of dry soil (g)	8.52	9.33				
Wt. of moisture (g)	0.90	0.99				
Water content, $w\% = w_p$	10.6	10.6	Avg = 10.6			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Eddebed

Date: 8/18/2022
Date: 8/27/22

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MOISTURE CONTENT DETERMINATION

ASTM D2216

Project: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.	PD-001	PD-002	PD-003	PD-006	PD-008
Sample No.	15	13	13	13	11
Depth (ft.)	38-40	33-35	33-35	33-35	33-35
Pan No.	66	50	54	29	64
Weight-Wet Sample & Tare (g)	408.62	379.83	391.26	386.89	372.58
Weight-Dry Sample & Tare (g)	402.68	376.98	387.67	383.29	370.23
Weight of Moisture (g)	5.94	2.85	3.59	3.60	2.35
Weight of Tare (g)	341.83	341.52	342.46	340.24	341.76
Weight of Dry Soil (g)	60.85	35.46	45.21	43.05	28.47
Moisture Content (%)	9.8	8.0	7.9	8.4	8.3

Boring No.	PD-009	PD-010			
Sample No.	13	8			
Depth (ft.)	33-35	23-25			
Pan No.	59	62			
Weight-Wet Sample & Tare (g)	389.30	378.73			
Weight-Dry Sample & Tare (g)	381.90	375.35			
Weight of Moisture (g)	7.40	3.38			
Weight of Tare (g)	341.70	340.94			
Weight of Dry Soil (g)	40.20	34.41			
Moisture Content (%)	18.4	9.8			

Equipment Used: Scale: Ohaus 1124011084

Remarks:

Tested By: Dave Edlebeck

Date: 8/13/2022

Laboratory: Iron Mountain

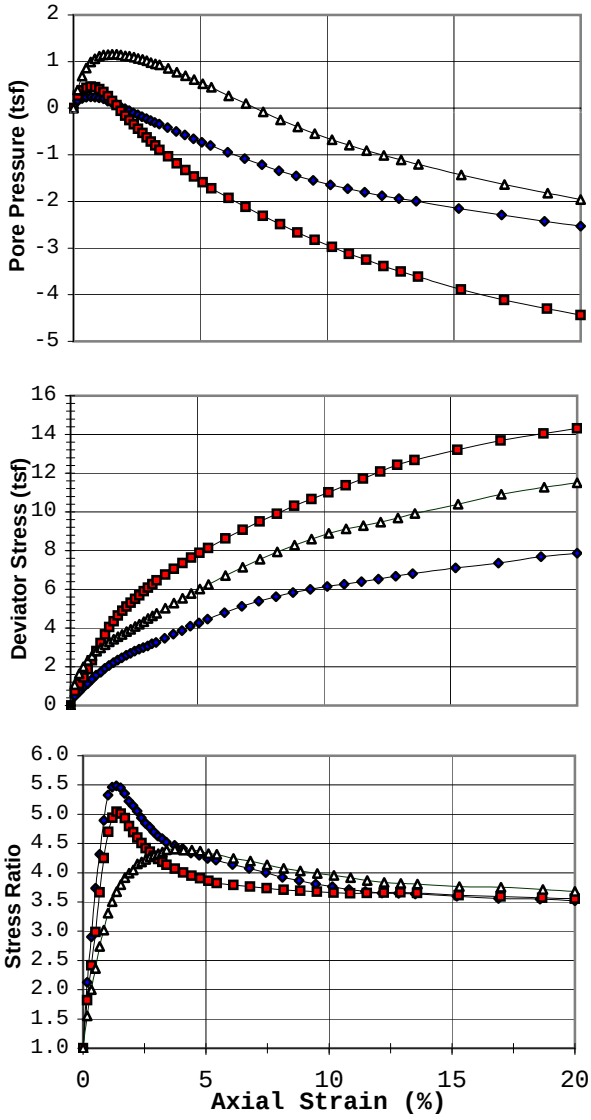
Submitted By: D. Edlebeck

Date: 8/22/22

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



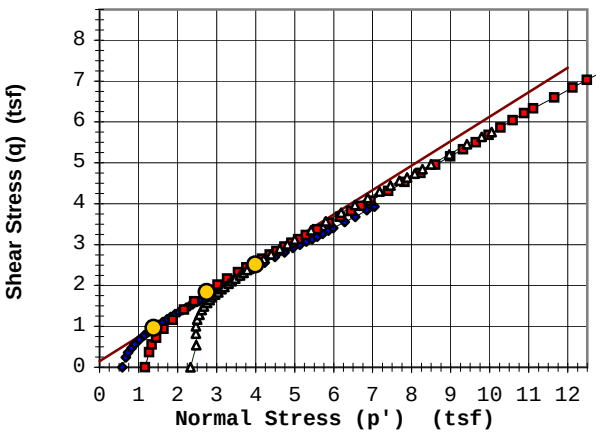
Failure Criterion:	**Max. Stress Ratio**
Angle of internal friction, **ϕ' =**	**36.7 °**
Apparent Cohesion, **c' =**	**0.19 (tsf)**

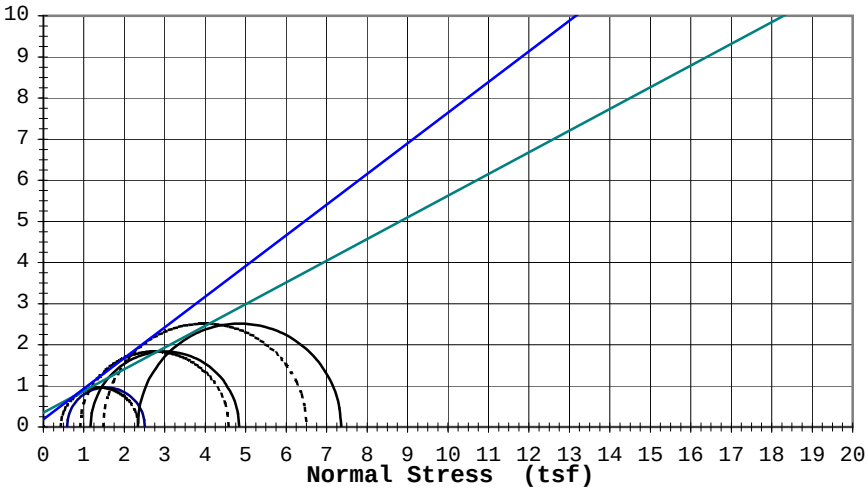
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	1.92	3.67	5.03		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.4	3.7		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 30.9 °	a = 0.2 (tsf)

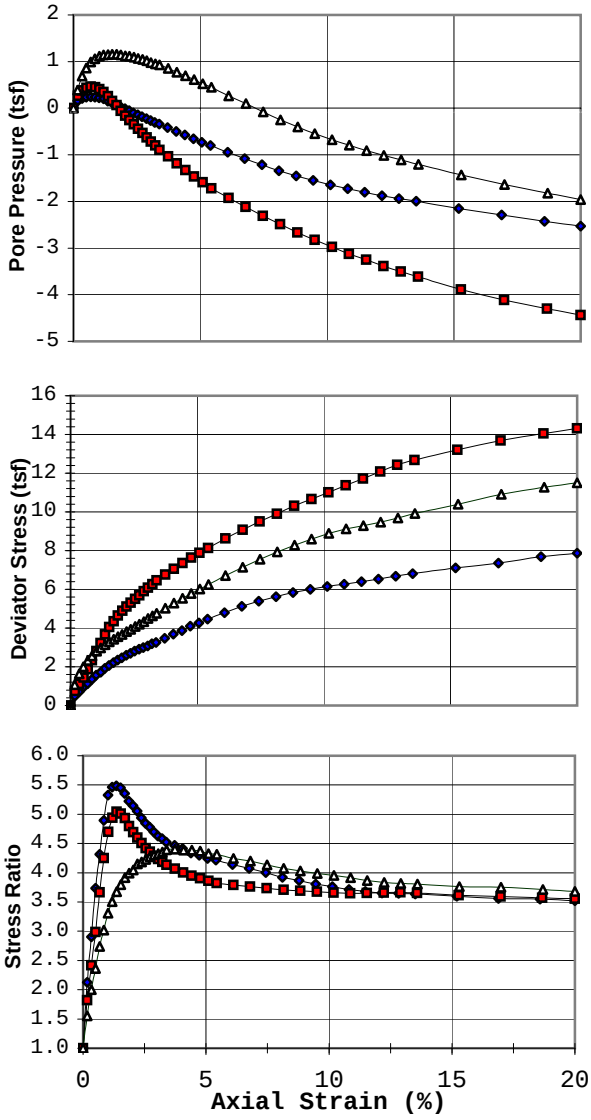
----------	Effective ϕ': 36.7 °	c'=	0.19 (tsf)
_____	Total ϕ: 27.8 °	c=	0.35 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



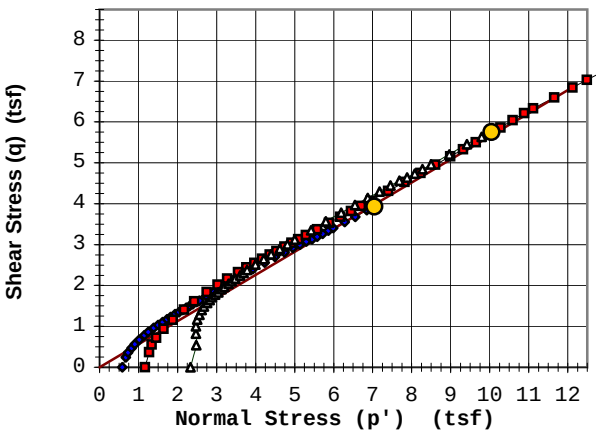
Failure Criterion:	Max. Deviator Stress
Angle of internal friction, ϕ' =	34.4 °
Apparent Cohesion, c' =	0.00 (tsf)

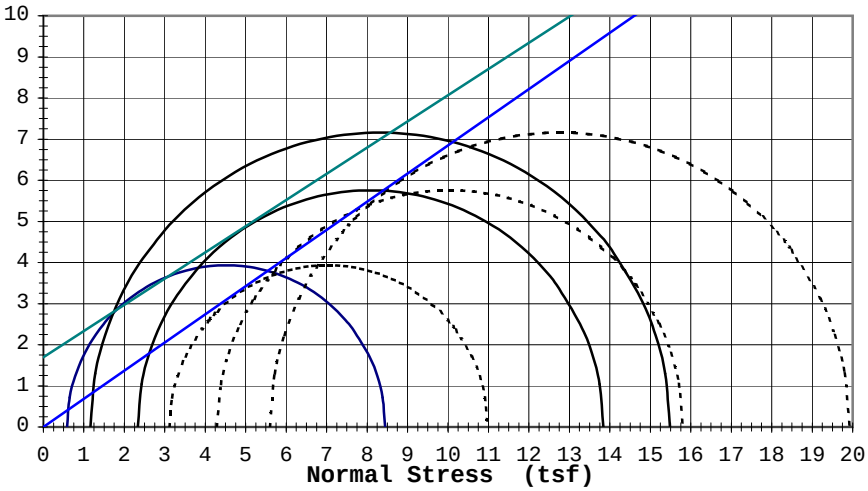
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	7.86	14.32	11.51		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	20.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress. Specimen B was not used in total friction angle determination





Rupture Envelope at Failure	
α = 29.5 °	a = 0.0 (tsf)

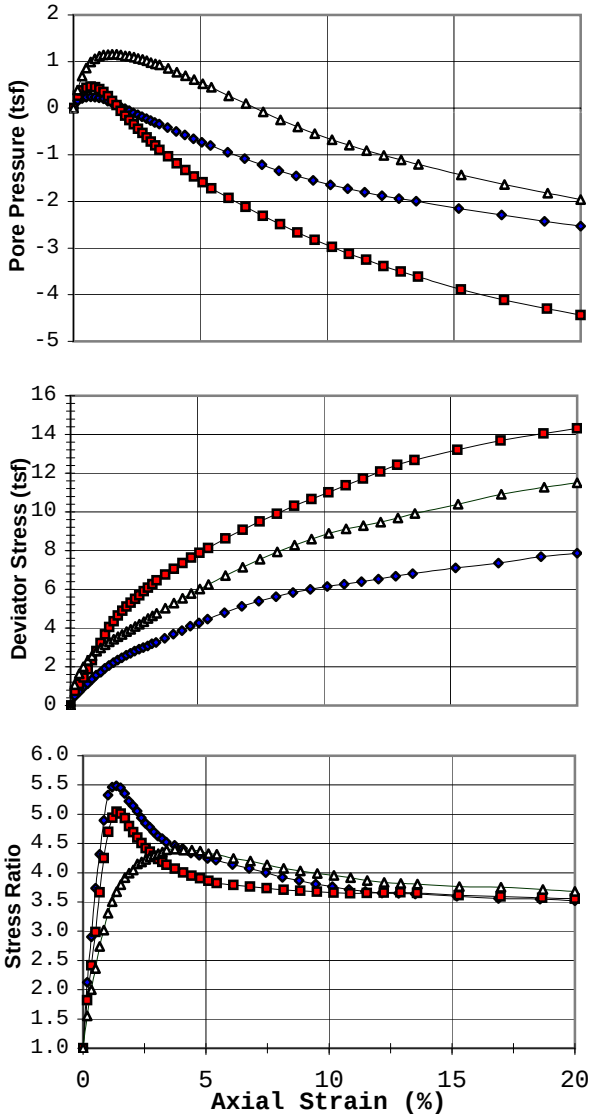
----------	Effective ϕ': 34.4 °	c'=	0.00 (tsf)
_____	Total ϕ: 32.5 °	c=	1.70 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



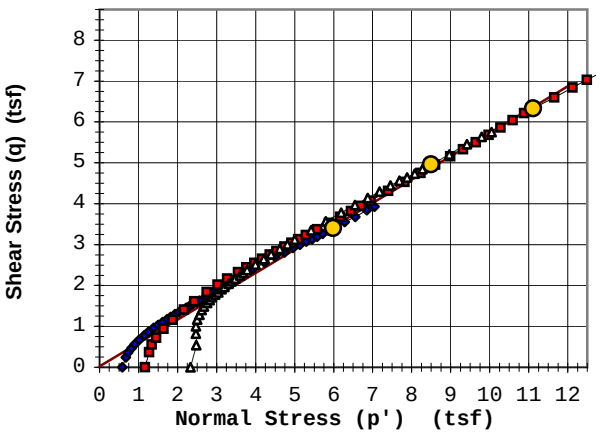
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	34.8 °
Apparent Cohesion, c' =	0.03 (tsf)

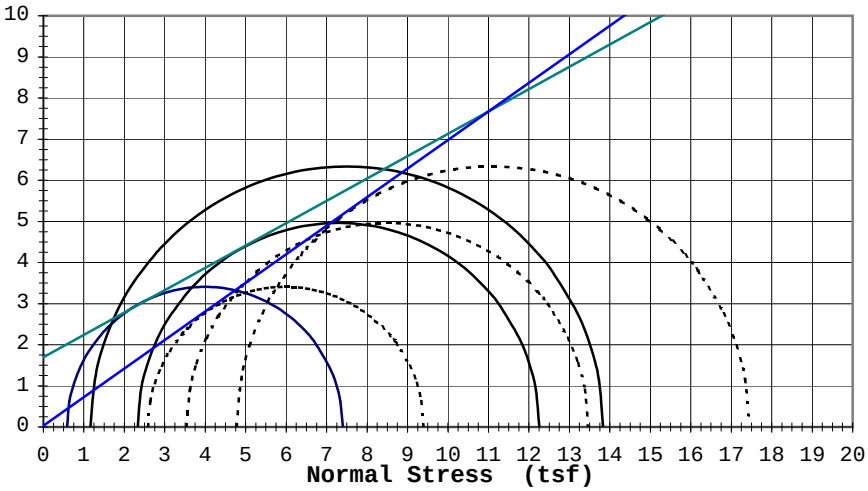
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	6.81	12.67	9.92		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress. Specimen B was not used in total friction angle determination





Rupture Envelope at Failure	
α = 29.7 °	a = 0.0 (tsf)

----------	Effective ϕ': 34.8 °	c'=	0.03 (tsf)
_____	Total ϕ: 28.5 °	c=	1.70 (tsf)

Triaxial Data

Job: **13945**

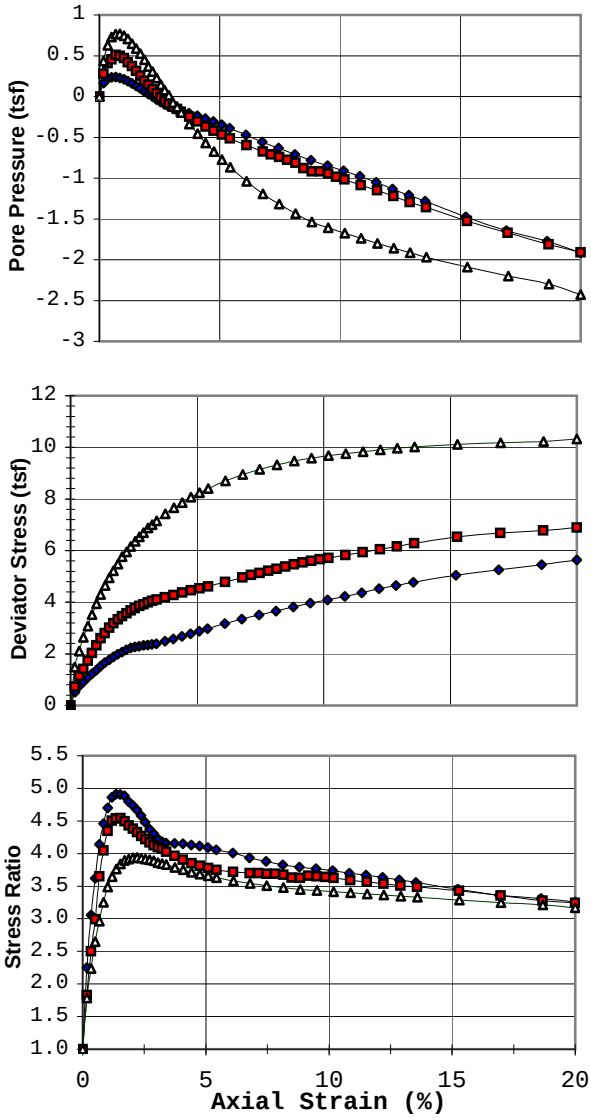
Boring: PD-001 Sample: Depth: 30-33 Date: 8/17/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.48	0.16	0.17	0.74	0.26	0.17	1.07	0.39						
0.34	0.71	0.21	0.34	1.11	0.38	0.34	1.64	0.69						
0.51	0.95	0.24	0.51	1.45	0.44	0.51	2.00	0.86						
0.68	1.13	0.24	0.68	1.87	0.46	0.68	2.33	0.99						
0.84	1.35	0.24	0.85	2.32	0.45	0.85	2.57	1.06						
1.01	1.57	0.22	1.02	2.81	0.40	1.02	2.80	1.11						
1.18	1.72	0.20	1.19	3.22	0.35	1.19	2.97	1.14						
1.35	1.92	0.16	1.36	3.67	0.26	1.36	3.15	1.15						
1.52	2.07	0.12	1.53	4.04	0.16	1.53	3.29	1.15						
1.69	2.21	0.08	1.70	4.34	0.06	1.70	3.42	1.16						
1.86	2.35	0.03	1.87	4.65	-0.06	1.87	3.55	1.14						
2.03	2.46	-0.01	2.04	4.89	-0.16	2.04	3.67	1.12						
2.20	2.59	-0.05	2.21	5.11	-0.25	2.21	3.82	1.12						
2.36	2.69	-0.10	2.38	5.31	-0.35	2.38	3.93	1.10						
2.53	2.80	-0.14	2.55	5.50	-0.44	2.55	4.08	1.07						
2.70	2.91	-0.18	2.72	5.69	-0.53	2.72	4.20	1.04						
2.87	2.99	-0.22	2.89	5.90	-0.63	2.89	4.34	1.02						
3.04	3.08	-0.26	3.06	6.08	-0.72	3.06	4.49	0.98						
3.21	3.19	-0.30	3.23	6.26	-0.80	3.23	4.62	0.95						
3.38	3.26	-0.34	3.40	6.46	-0.89	3.40	4.76	0.93						
3.72	3.47	-0.42	3.74	6.75	-1.04	3.74	5.03	0.85						
4.05	3.69	-0.50	4.08	7.06	-1.19	4.08	5.29	0.77						
4.39	3.87	-0.57	4.42	7.35	-1.33	4.42	5.53	0.70						
4.73	4.09	-0.66	4.76	7.64	-1.46	4.76	5.79	0.61						
5.07	4.27	-0.73	5.10	7.89	-1.59	5.10	6.01	0.52						
5.40	4.46	-0.80	5.44	8.13	-1.72	5.44	6.24	0.45						
6.08	4.80	-0.94	6.12	8.62	-1.92	6.12	6.70	0.26						
6.75	5.13	-1.08	6.79	9.07	-2.12	6.80	7.13	0.10						
7.43	5.39	-1.21	7.47	9.51	-2.31	7.48	7.55	-0.08						
8.11	5.63	-1.34	8.15	9.90	-2.49	8.16	7.93	-0.25						
8.78	5.84	-1.45	8.83	10.32	-2.66	8.84	8.28	-0.40						
9.46	6.00	-1.55	9.51	10.66	-2.82	9.52	8.60	-0.55						
10.13	6.15	-1.64	10.19	11.01	-2.98	10.20	8.89	-0.68						
10.81	6.27	-1.73	10.87	11.37	-3.13	10.88	9.12	-0.80						
11.48	6.39	-1.80	11.55	11.72	-3.25	11.56	9.29	-0.91						
12.16	6.52	-1.87	12.23	12.09	-3.38	12.24	9.47	-1.01						
12.83	6.68	-1.94	12.91	12.43	-3.50	12.92	9.69	-1.11						
13.51	6.81	-2.00	13.58	12.67	-3.61	13.60	9.92	-1.21						
15.20	7.10	-2.15	15.28	13.20	-3.89	15.30	10.40	-1.43						
16.89	7.36	-2.29	16.98	13.69	-4.12	17.00	10.91	-1.64						
18.58	7.68	-2.43	18.68	14.05	-4.30	18.70	11.27	-1.83						
20.00	7.86	-2.53	20.00	14.32	-4.44	20.00	11.51	-1.96						

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**



Failure Criterion: **Max. Stress Ratio**

Angle of internal friction, **ϕ' = 34.7 °**

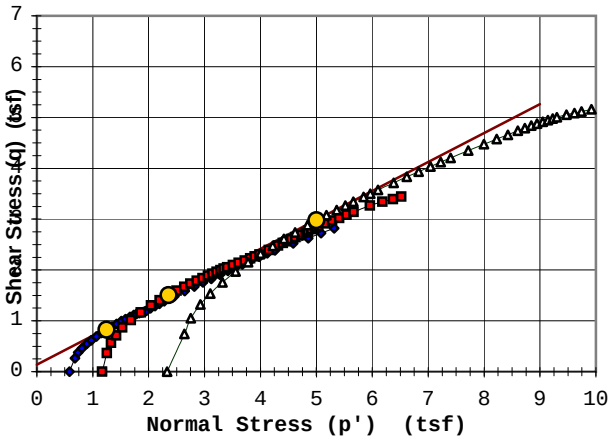
Apparent Cohesion, **c' = 0.16 (tsf)**

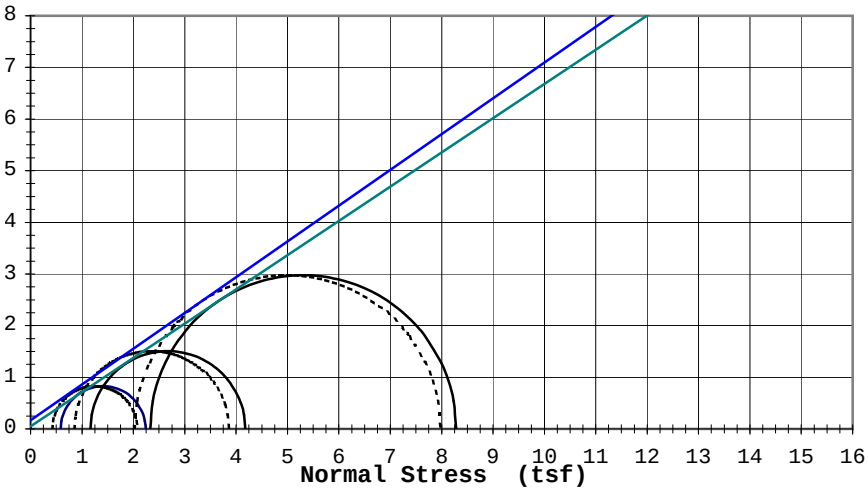
Test Date:	8/2/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	11
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	1.66	3.01	5.95		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.5	2.2		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure
α = 29.7 ° a = 0.1 (tsf)

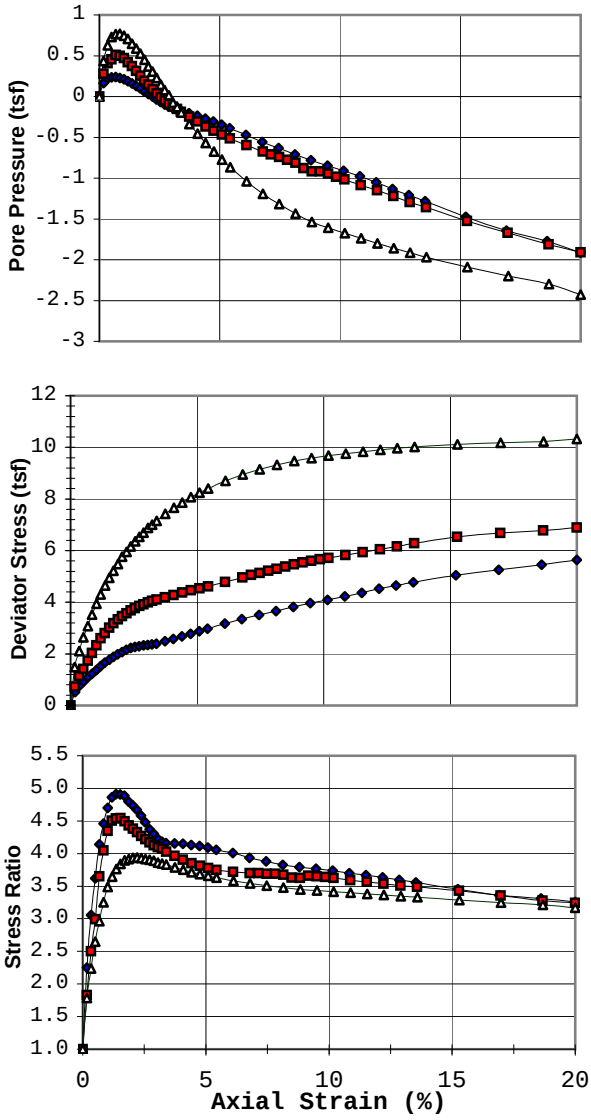
----------	Effective ϕ': 34.7 °	c'=	0.16 (tsf)
_____	Total ϕ: 33.5 °	c=	0.05 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

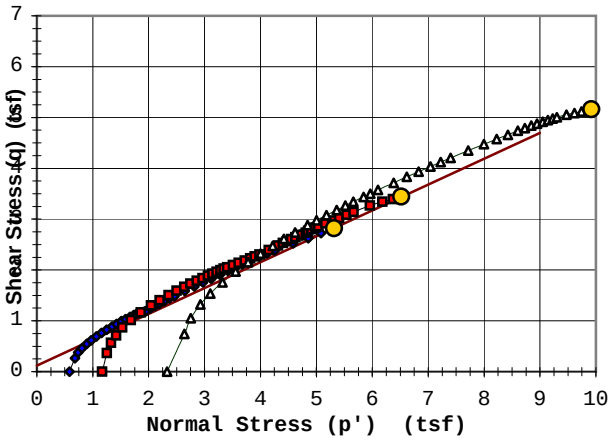
Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**

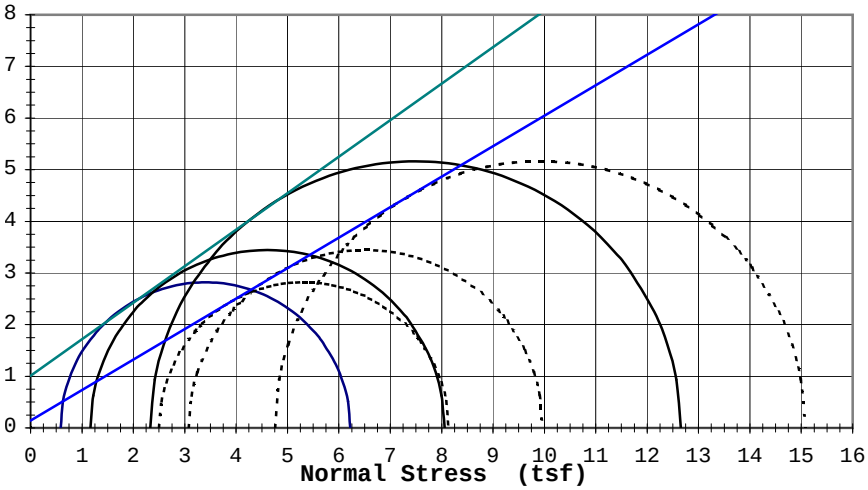


Failure Criterion:	**Max. Deviator Stress**				
Angle of internal friction, **ϕ' =**	**30.6 °**				
Apparent Cohesion, **c' =**	**0.14 (tsf)**				
Test Date: 8/2/22	Liquid Limit: 21				
Test Type: CU w/pp	Plastic Limit: 10				
Strain Rate (in/min): 0.00074	Plasticity Index: 11				
Strain Rate (%/min): 0.025	Spec. Gravity (Assumed): 2.68				
Initial Conditions	**A**	**B**	**C**	**D**	**E**
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	5.64	6.89	10.32		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	20.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.0 °	a = 0.1 (tsf)

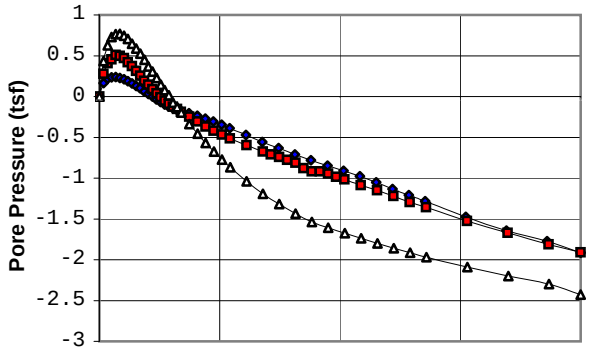
----------	Effective ϕ': 30.6 °	c'=	0.14 (tsf)
_____	Total ϕ: 35.3 °	c=	1.01 (tsf)

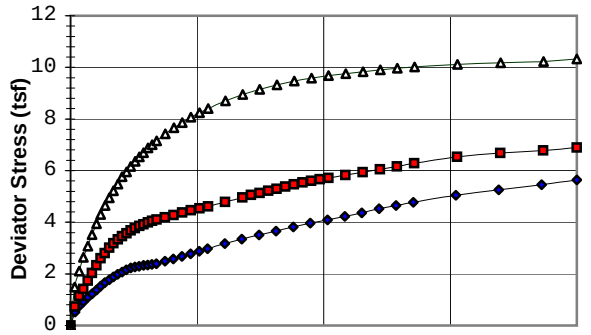
9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

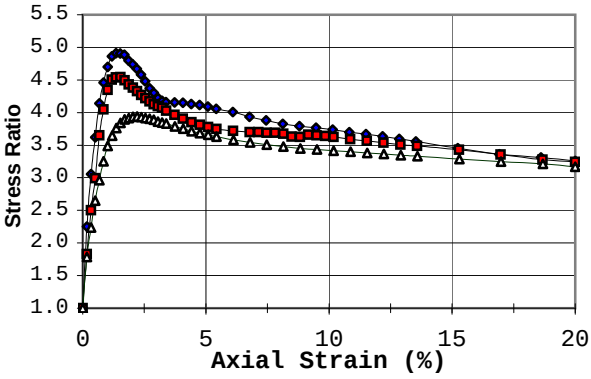
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**







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X

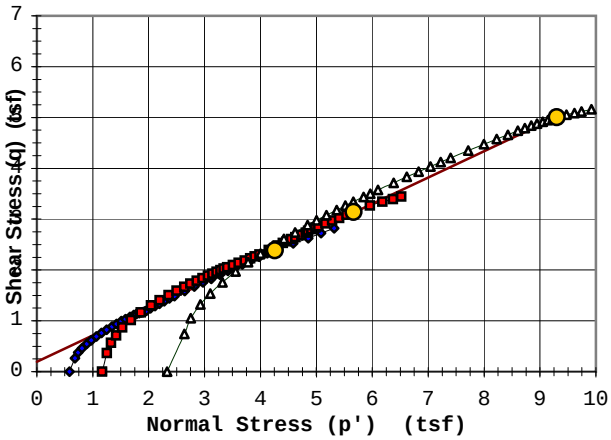
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	31.2 °
Apparent Cohesion, c' =	0.23 (tsf)

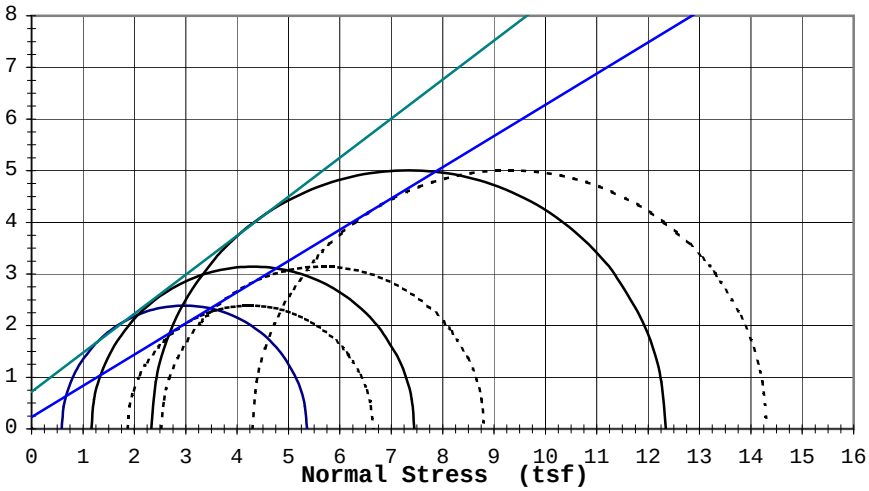
Test Date:	8/2/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	11
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	4.78	6.28	10.01		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.4 °	a = 0.2 (tsf)

----------	Effective ϕ':	31.2 °	c'=	0.23 (tsf)
_____	Total ϕ:	37.1 °	c=	0.72 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

Triaxial Data

Job: **13945**

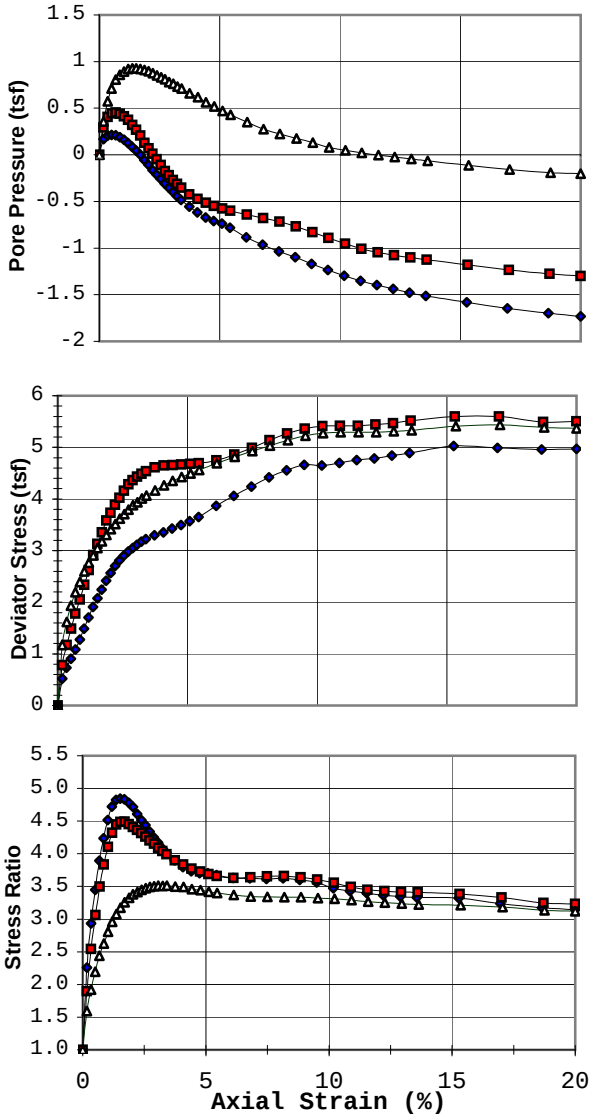
Boring: PD-003 Sample: Depth: 25-28 Date: 8/16/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.53	0.16	0.17	0.73	0.28	0.17	1.49	0.44						
0.34	0.75	0.22	0.34	1.14	0.41	0.34	2.11	0.63						
0.51	0.91	0.24	0.51	1.42	0.45	0.51	2.64	0.73						
0.68	1.09	0.24	0.68	1.74	0.51	0.68	3.07	0.77						
0.85	1.23	0.23	0.85	2.03	0.50	0.85	3.52	0.77						
1.02	1.38	0.21	1.02	2.33	0.47	1.02	3.94	0.75						
1.19	1.53	0.19	1.19	2.61	0.42	1.19	4.30	0.70						
1.36	1.66	0.16	1.36	2.81	0.37	1.36	4.64	0.65						
1.53	1.78	0.13	1.53	3.01	0.31	1.53	4.95	0.59						
1.69	1.88	0.10	1.70	3.18	0.25	1.70	5.23	0.52						
1.86	1.98	0.06	1.87	3.33	0.19	1.87	5.48	0.45						
2.03	2.07	0.03	2.04	3.46	0.14	2.04	5.76	0.37						
2.20	2.15	0.00	2.21	3.57	0.09	2.21	5.95	0.30						
2.37	2.23	-0.04	2.38	3.68	0.04	2.38	6.16	0.23						
2.54	2.26	-0.07	2.55	3.77	-0.01	2.55	6.36	0.15						
2.71	2.30	-0.10	2.72	3.86	-0.05	2.72	6.53	0.08						
2.88	2.33	-0.12	2.89	3.92	-0.09	2.89	6.69	0.01						
3.05	2.35	-0.14	3.06	4.00	-0.13	3.06	6.88	-0.07						
3.22	2.37	-0.16	3.23	4.05	-0.15	3.23	7.01	-0.13						
3.38	2.39	-0.17	3.39	4.10	-0.19	3.40	7.16	-0.20						
3.72	2.49	-0.20	3.73	4.19	-0.25	3.74	7.43	-0.34						
4.06	2.58	-0.23	4.07	4.28	-0.31	4.08	7.66	-0.45						
4.40	2.67	-0.27	4.42	4.37	-0.37	4.42	7.87	-0.57						
4.74	2.77	-0.31	4.75	4.46	-0.42	4.76	8.07	-0.68						
5.08	2.88	-0.35	5.09	4.54	-0.47	5.10	8.25	-0.77						
5.42	2.98	-0.39	5.43	4.61	-0.51	5.44	8.41	-0.87						
6.09	3.17	-0.47	6.11	4.78	-0.59	6.12	8.70	-1.04						
6.77	3.35	-0.56	6.79	4.96	-0.67	6.80	8.95	-1.19						
7.45	3.51	-0.63	7.13	5.06	-0.71	7.48	9.15	-1.32						
8.12	3.66	-0.71	7.47	5.13	-0.74	8.15	9.32	-1.43						
8.80	3.82	-0.78	7.81	5.22	-0.78	8.83	9.48	-1.54						
9.48	3.97	-0.85	8.15	5.29	-0.81	9.51	9.58	-1.61						
10.15	4.09	-0.91	8.49	5.38	-0.88	10.19	9.68	-1.67						
10.83	4.22	-0.98	8.83	5.46	-0.92	10.87	9.76	-1.74						
11.50	4.37	-1.05	9.17	5.54	-0.92	11.55	9.84	-1.80						
12.18	4.53	-1.13	9.51	5.60	-0.95	12.23	9.90	-1.86						
12.86	4.65	-1.21	9.84	5.67	-0.98	12.91	9.96	-1.91						
13.53	4.78	-1.28	10.19	5.72	-1.01	13.59	10.01	-1.97						
15.23	5.05	-1.48	10.86	5.83	-1.09	15.29	10.11	-2.09						
16.92	5.25	-1.64	11.54	5.94	-1.15	16.99	10.17	-2.20						
18.61	5.45	-1.77	12.22	6.05	-1.22	18.69	10.23	-2.30						
20.00	5.64	-1.91	12.90	6.17	-1.29	20.00	10.32	-2.43						
			13.58	6.28	-1.36									
			15.28	6.54	-1.53									
			16.97	6.69	-1.67									
			18.67	6.79	-1.81									
			20.00	6.89	-1.91									

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



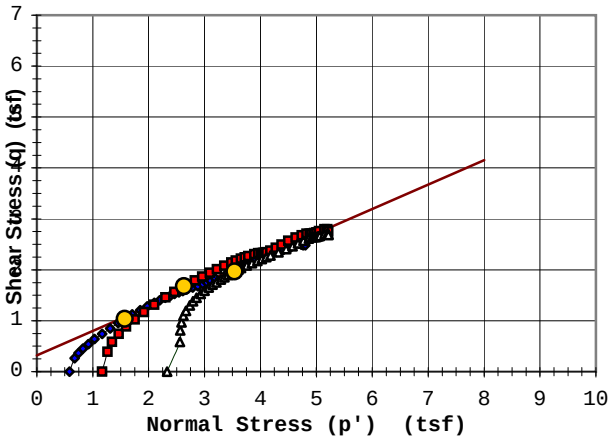
Failure Criterion:	**Max. Stress Ratio**
Angle of internal friction, **ϕ' =**	**28.6 °**
Apparent Cohesion, **c' =**	**0.37 (tsf)**

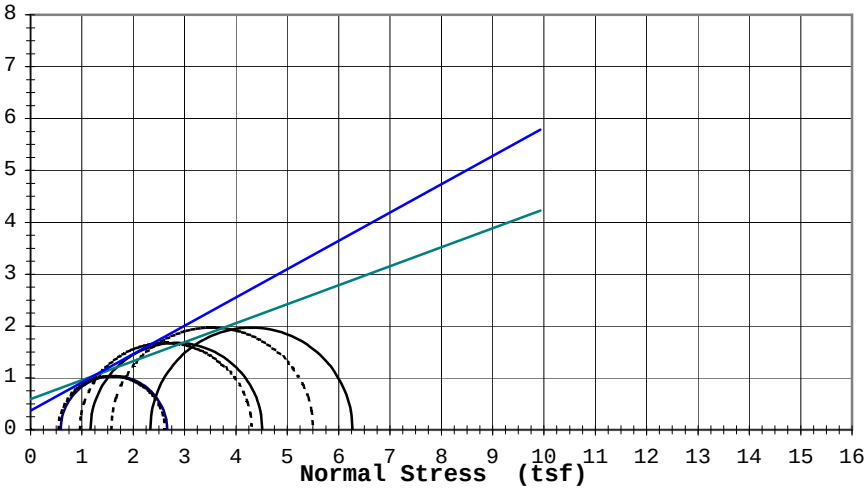
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	2.07	3.35	3.94		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.5	1.7	3.1		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





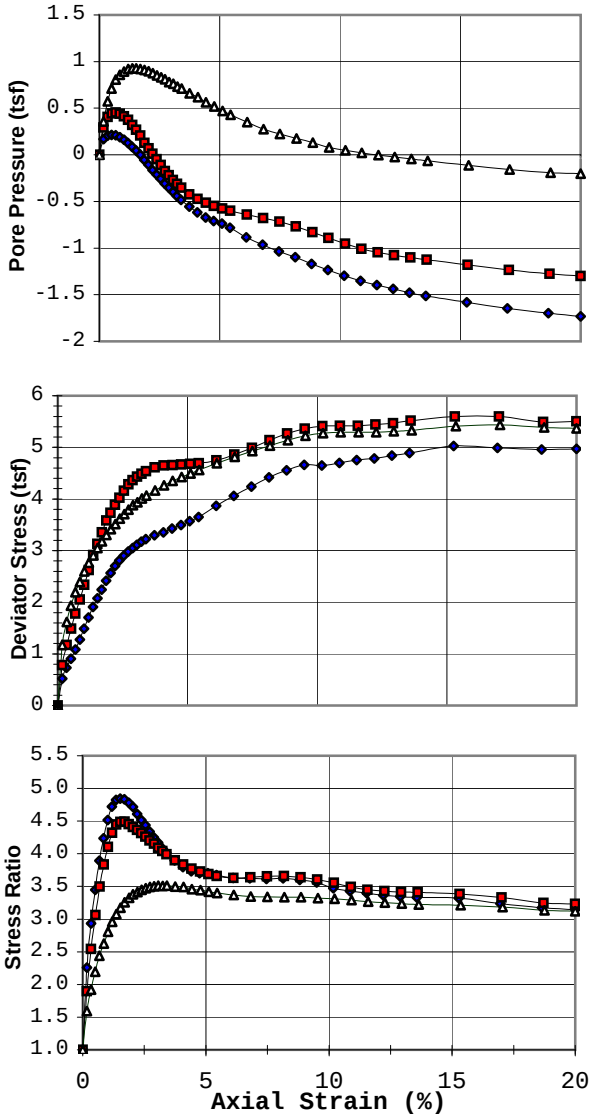
Rupture Envelope at Failure	
α = 25.6 °	a = 0.3 (tsf)

----------	Effective ϕ': 28.6 °	c'=	0.37 (tsf)
_____	Total ϕ: 20.1 °	c=	0.59 (tsf)

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



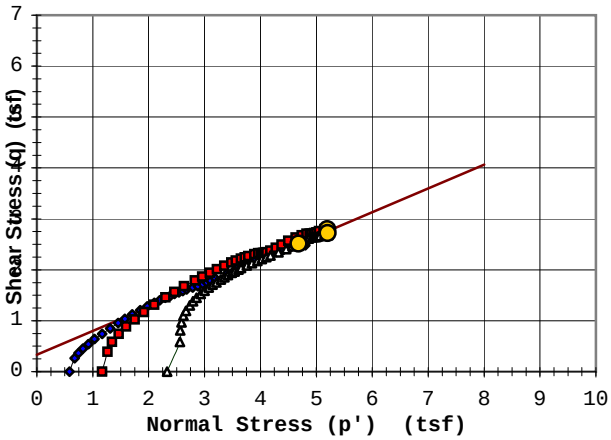
Failure Criterion:	**Max. Deviator Stress**
Angle of internal friction, **ϕ' =**	**27.8 °**
Apparent Cohesion, **c' =**	**0.37 (tsf)**

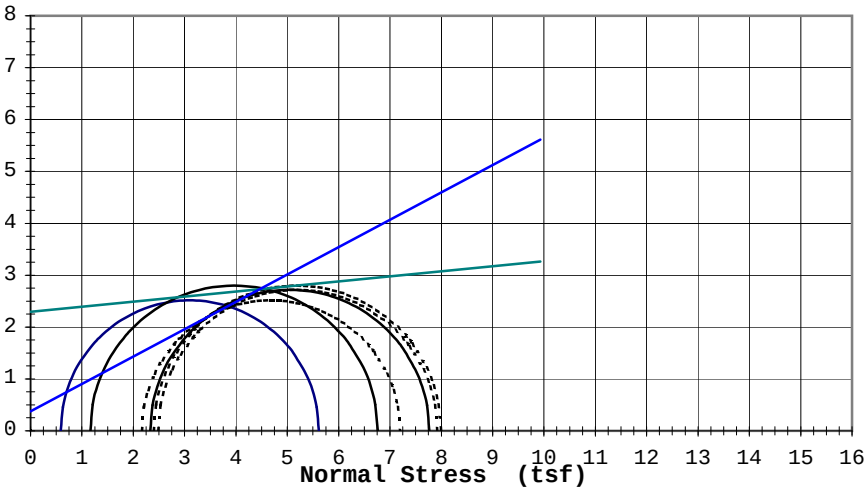
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	5.03	5.60	5.44		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.3	17.0	17.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 25.0 °	a = 0.3 (tsf)

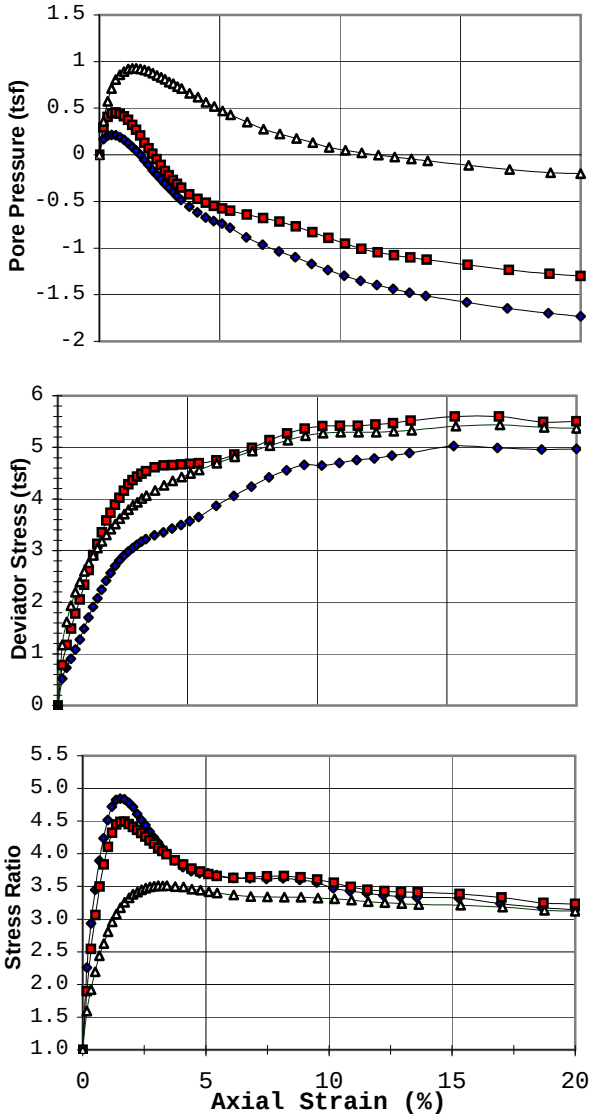
----------	Effective ϕ': 27.8 °	c'=	0.37 (tsf)
_____	Total ϕ: 5.5 °	c=	2.30 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



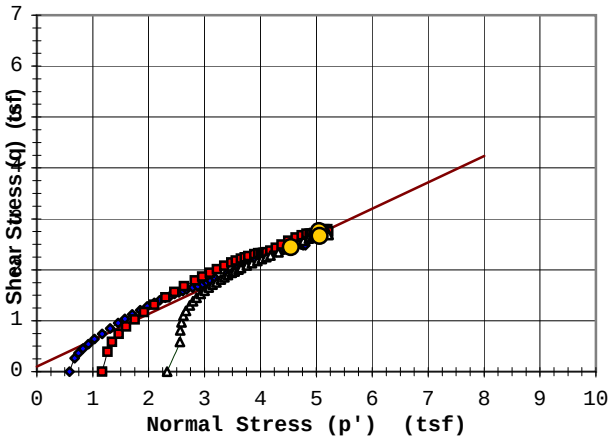
Failure Criterion:	**Given Strain of: 15%**
Angle of internal friction, **ϕ' =**	**31.1 °**
Apparent Cohesion, **c' =**	**0.11 (tsf)**

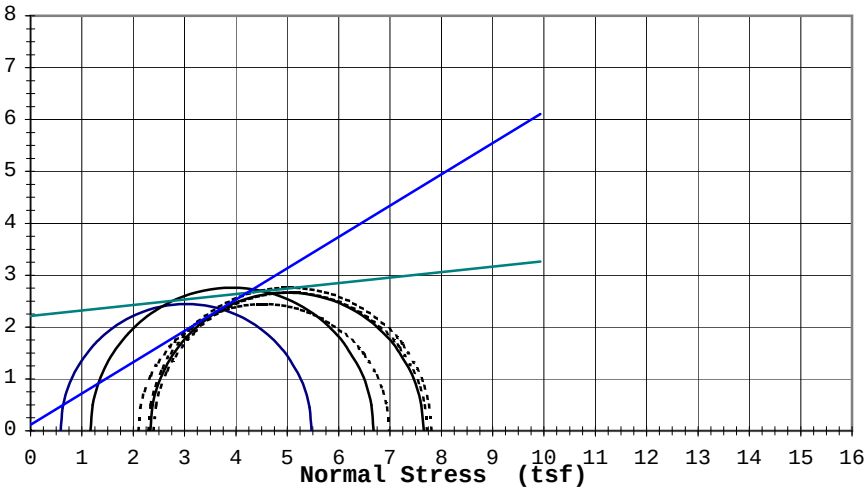
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	4.89	5.52	5.33		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.3 °	a = 0.1 (tsf)

----------	Effective ϕ': 31.1 °	c'=	0.11 (tsf)
_____	Total ϕ: 6.0 °	c=	2.22 (tsf)

Triaxial Data

Job: **13945**

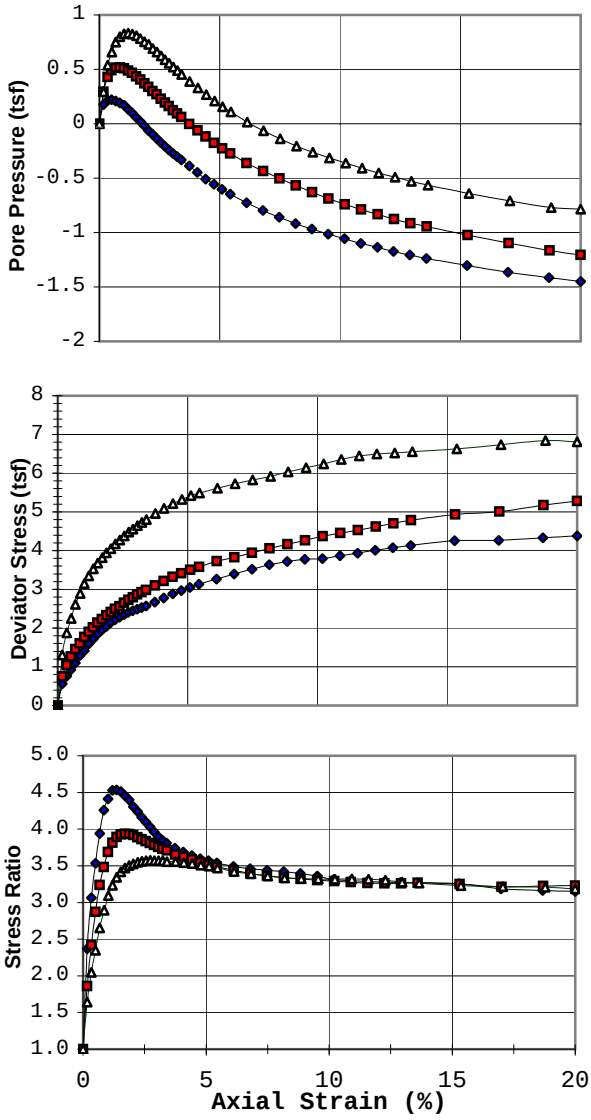
Boring: PD-006 Sample: Depth: 25-28 Date: 8/16/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.52	0.17	0.17	0.78	0.29	0.17	1.17	0.36						
0.34	0.73	0.21	0.34	1.17	0.41	0.34	1.62	0.57						
0.51	0.91	0.21	0.51	1.48	0.44	0.51	1.94	0.71						
0.68	1.09	0.21	0.68	1.78	0.45	0.68	2.19	0.81						
0.85	1.28	0.19	0.85	2.05	0.44	0.86	2.39	0.86						
1.02	1.49	0.16	1.02	2.34	0.41	1.03	2.60	0.89						
1.19	1.70	0.13	1.19	2.62	0.37	1.19	2.77	0.92						
1.36	1.91	0.09	1.36	2.91	0.32	1.36	2.91	0.93						
1.53	2.07	0.05	1.53	3.13	0.27	1.53	3.05	0.93						
1.70	2.24	0.00	1.70	3.35	0.21	1.71	3.18	0.92						
1.87	2.42	-0.05	1.87	3.58	0.13	1.88	3.30	0.91						
2.03	2.57	-0.11	2.04	3.73	0.07	2.05	3.41	0.90						
2.20	2.70	-0.16	2.21	3.89	0.01	2.22	3.51	0.88						
2.37	2.81	-0.21	2.38	4.02	-0.05	2.39	3.62	0.85						
2.54	2.90	-0.26	2.55	4.16	-0.11	2.56	3.71	0.83						
2.71	2.98	-0.31	2.72	4.28	-0.17	2.73	3.79	0.81						
2.88	3.05	-0.35	2.89	4.36	-0.22	2.90	3.88	0.78						
3.05	3.11	-0.40	3.06	4.43	-0.27	3.07	3.94	0.76						
3.22	3.17	-0.44	3.23	4.49	-0.31	3.24	4.01	0.73						
3.39	3.22	-0.48	3.40	4.54	-0.35	3.41	4.07	0.71						
3.73	3.30	-0.55	3.74	4.61	-0.42	3.75	4.17	0.66						
4.07	3.36	-0.62	4.08	4.65	-0.47	4.09	4.27	0.62						
4.41	3.43	-0.67	4.42	4.65	-0.52	4.43	4.35	0.56						
4.75	3.50	-0.71	4.76	4.67	-0.55	4.78	4.42	0.52						
5.09	3.57	-0.74	5.10	4.68	-0.57	5.11	4.49	0.47						
5.43	3.65	-0.78	5.44	4.69	-0.60	5.46	4.56	0.43						
6.10	3.87	-0.89	6.12	4.75	-0.64	6.14	4.69	0.35						
6.78	4.06	-0.96	6.81	4.86	-0.68	6.82	4.81	0.28						
7.46	4.24	-1.04	7.49	4.99	-0.72	7.50	4.93	0.22						
8.14	4.42	-1.10	8.17	5.14	-0.77	8.19	5.03	0.17						
8.82	4.56	-1.17	8.85	5.27	-0.83	8.87	5.14	0.13						
9.49	4.66	-1.23	9.53	5.36	-0.89	9.55	5.23	0.08						
10.17	4.65	-1.30	10.21	5.41	-0.95	10.23	5.28	0.05						
10.85	4.70	-1.35	10.89	5.42	-1.01	10.91	5.30	0.02						
11.53	4.75	-1.40	11.57	5.42	-1.05	11.59	5.29	0.00						
12.21	4.79	-1.44	12.25	5.44	-1.08	12.27	5.30	-0.02						
12.89	4.84	-1.48	12.93	5.47	-1.10	12.96	5.31	-0.05						
13.56	4.89	-1.51	13.61	5.52	-1.13	13.64	5.33	-0.07						
15.26	5.03	-1.58	15.31	5.60	-1.18	15.35	5.41	-0.11						
16.96	4.99	-1.65	17.02	5.60	-1.23	17.05	5.44	-0.16						
18.65	4.96	-1.70	18.71	5.49	-1.28	18.75	5.39	-0.19						
20.00	4.97	-1.73	20.00	5.50	-1.30	20.00	5.37	-0.20						

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



Failure Criterion: **Max. Stress Ratio**

Angle of internal friction, **ϕ' = 31.8 °**

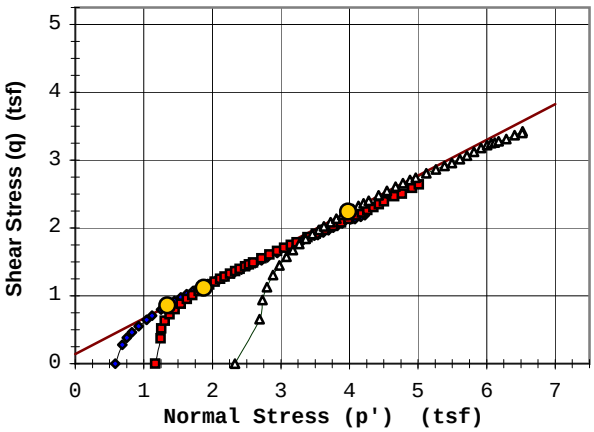
Apparent Cohesion, **c' = 0.17 (tsf)**

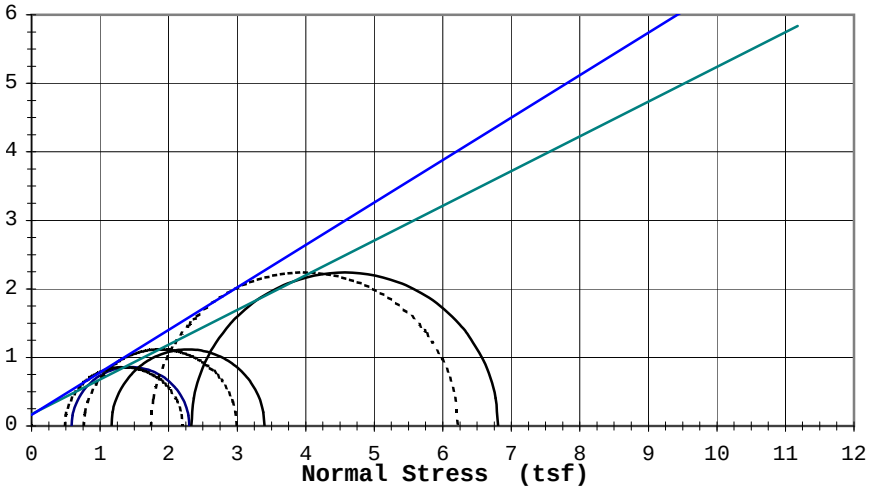
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	1.72	2.23	4.48		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.7	2.7		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





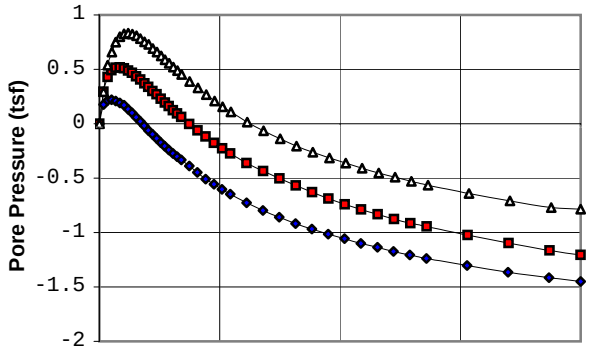
Rupture Envelope at Failure
α = 27.8 ° a = 0.1 (tsf)

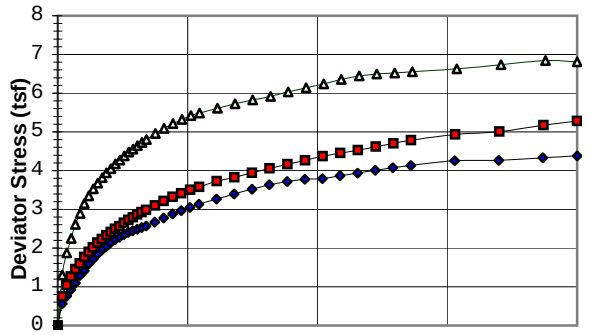
---------- Effective ϕ': 31.8 ° c'= 0.17 (tsf)
_____ Total ϕ: 26.9 ° c= 0.17 (tsf)

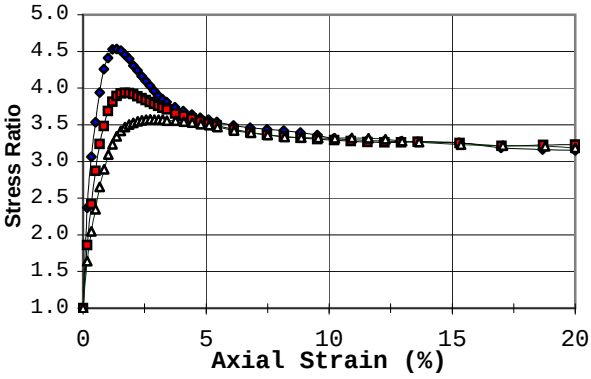
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**







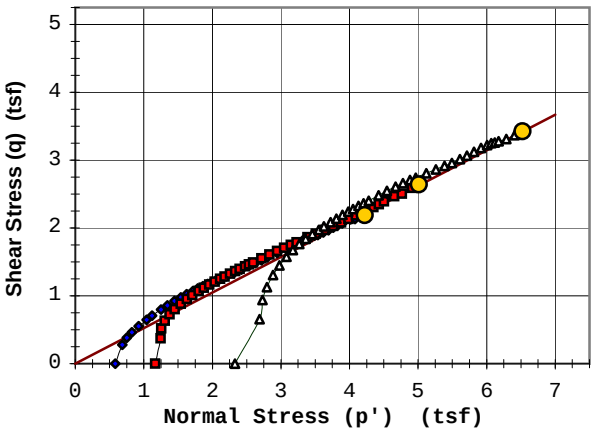
Failure Criterion:	Max. Deviator Stress
Angle of internal friction, ϕ' =	31.6 °
Apparent Cohesion, c' =	0.00 (tsf)

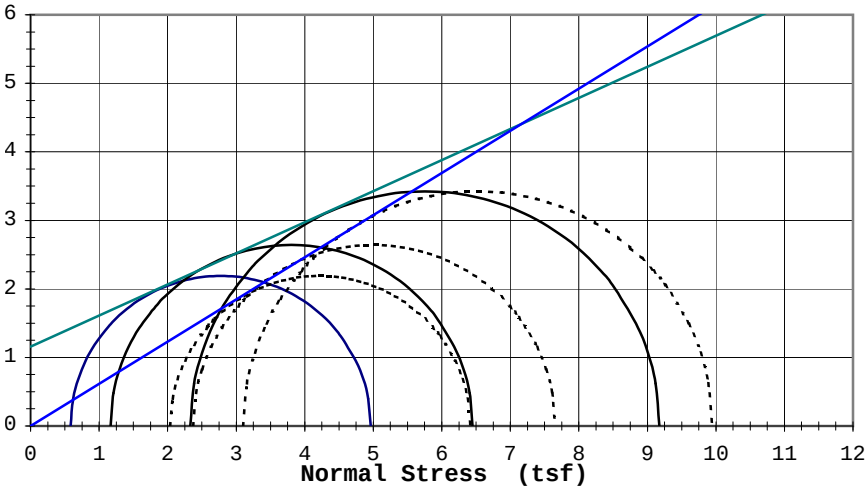
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	4.38	5.28	6.85		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	18.8		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





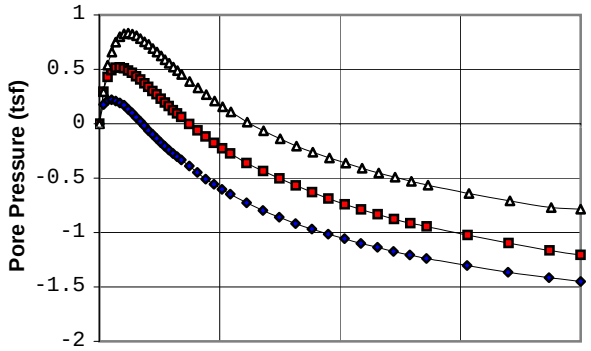
Rupture Envelope at Failure	
α = 27.7 °	a = 0.0 (tsf)

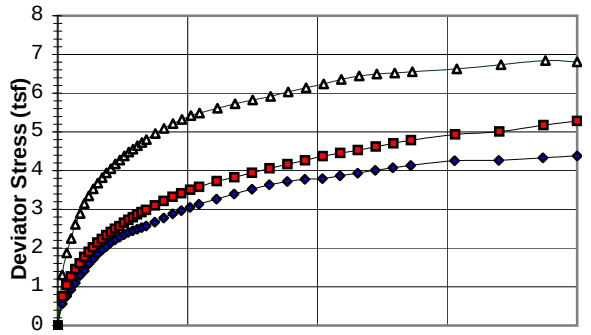
----------	Effective ϕ': 31.6 °	c'=	0.00 (tsf)
_____	Total ϕ: 24.4 °	c=	1.16 (tsf)

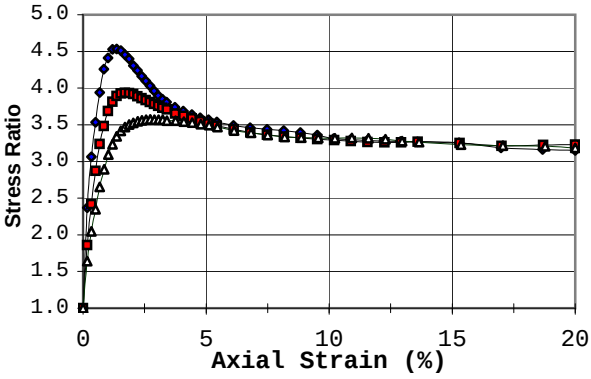
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**







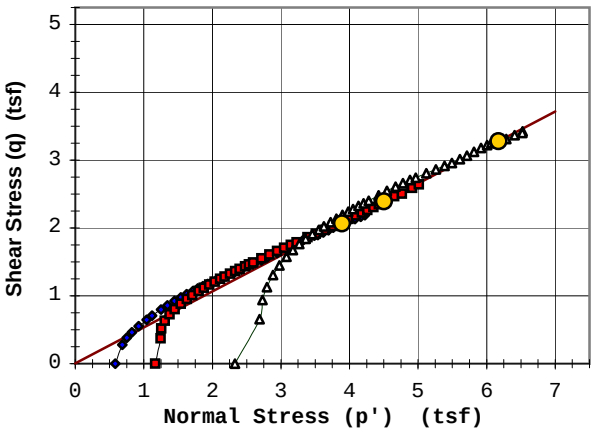
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	32.0 °
Apparent Cohesion, c' =	0.01 (tsf)

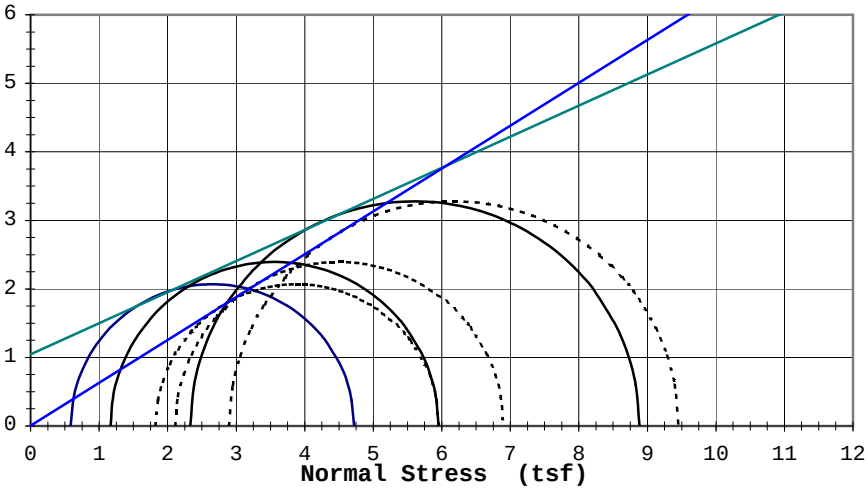
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	4.13	4.79	6.56		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.9 °	a = 0.0 (tsf)

----------	Effective ϕ': 32.0 °	c'=	0.01 (tsf)
_____	Total ϕ: 24.4 °	c=	1.04 (tsf)

Triaxial Data

Job: **13945**

Boring: PD-009 Sample: Depth: 30-33 Date: 8/17/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.56	0.18	0.17	0.75	0.29	0.17	1.31	0.29						
0.34	0.76	0.21	0.34	1.04	0.43	0.34	1.88	0.54						
0.51	0.92	0.22	0.51	1.26	0.49	0.51	2.25	0.66						
0.68	1.10	0.21	0.68	1.46	0.51	0.68	2.61	0.75						
0.85	1.29	0.19	0.85	1.61	0.52	0.86	2.90	0.80						
1.02	1.41	0.17	1.02	1.77	0.51	1.02	3.15	0.83						
1.19	1.60	0.13	1.19	1.90	0.49	1.19	3.35	0.83						
1.36	1.72	0.10	1.36	2.02	0.47	1.37	3.53	0.82						
1.53	1.85	0.06	1.53	2.14	0.43	1.54	3.68	0.81						
1.70	1.95	0.02	1.70	2.23	0.40	1.71	3.82	0.78						
1.87	2.05	-0.02	1.87	2.33	0.37	1.88	3.95	0.75						
2.04	2.14	-0.06	2.04	2.41	0.34	2.05	4.05	0.73						
2.21	2.21	-0.10	2.21	2.50	0.30	2.22	4.17	0.69						
2.38	2.28	-0.14	2.38	2.56	0.27	2.39	4.28	0.66						
2.55	2.35	-0.17	2.55	2.65	0.23	2.56	4.38	0.62						
2.72	2.40	-0.21	2.72	2.73	0.19	2.73	4.48	0.59						
2.89	2.44	-0.24	2.89	2.79	0.16	2.90	4.56	0.56						
3.06	2.49	-0.27	3.06	2.87	0.12	3.07	4.65	0.52						
3.23	2.53	-0.30	3.23	2.93	0.09	3.24	4.73	0.49						
3.40	2.57	-0.33	3.40	2.99	0.06	3.41	4.80	0.45						
3.74	2.67	-0.39	3.74	3.10	0.00	3.75	4.96	0.39						
4.08	2.77	-0.45	4.08	3.21	-0.06	4.10	5.09	0.33						
4.42	2.88	-0.51	4.42	3.32	-0.12	4.44	5.22	0.27						
4.75	2.96	-0.56	4.76	3.41	-0.18	4.78	5.32	0.21						
5.09	3.05	-0.60	5.10	3.50	-0.23	5.12	5.42	0.16						
5.44	3.13	-0.65	5.44	3.58	-0.27	5.46	5.48	0.11						
6.11	3.27	-0.73	6.12	3.72	-0.36	6.14	5.61	0.01						
6.79	3.40	-0.80	6.80	3.83	-0.43	6.83	5.73	-0.07						
7.47	3.52	-0.86	7.48	3.94	-0.50	7.51	5.83	-0.14						
8.15	3.64	-0.92	8.16	4.06	-0.57	8.19	5.92	-0.21						
8.83	3.72	-0.97	8.84	4.16	-0.63	8.87	6.03	-0.26						
9.51	3.78	-1.01	9.52	4.26	-0.69	9.56	6.14	-0.31						
10.19	3.80	-1.06	10.20	4.37	-0.74	10.24	6.24	-0.36						
10.87	3.87	-1.10	10.88	4.45	-0.79	10.92	6.35	-0.41						
11.55	3.94	-1.14	11.56	4.53	-0.83	11.61	6.45	-0.45						
12.23	4.00	-1.17	12.24	4.62	-0.88	12.29	6.50	-0.49						
12.91	4.07	-1.21	12.92	4.70	-0.91	12.97	6.52	-0.53						
13.59	4.13	-1.24	13.60	4.79	-0.95	13.65	6.56	-0.57						
15.28	4.26	-1.30	15.30	4.93	-1.02	15.36	6.63	-0.64						
16.98	4.26	-1.36	17.01	5.01	-1.10	17.07	6.74	-0.71						
18.68	4.33	-1.41	18.71	5.18	-1.16	18.77	6.85	-0.77						
20.00	4.38	-1.45	20.00	5.28	-1.21	20.00	6.81	-0.79						

Appendix I
Geotechnical Exploration and Evaluation Report

Geotechnical Exploration and Evaluation Report

Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall

St. Louis, Michigan

Prepared for:

United States Environmental Protection Agency – Region 5

Prepared by:

CH2M HILL, Inc.
A wholly owned subsidiary of Jacobs Engineering Group Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

U.S. Environmental Protection Agency
Contract Number 68HE0519D0007
Task Order Number 68HE0521F0106
DCN: GLAES-R5-21F0106-02023

September 2023

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Acronyms and Abbreviations

bgs	below ground surface
CH2M	CH2M HILL, Inc.
DGVBW	downgradient vertical barrier wall
OU	Operable Unit
site	Velsicol Chemical Corporation Superfund Site
SPT	standard penetration test
TIP	thermal integrity profiling

1. Site Description and Regional Geology

The following subsections describe the site and regional geology.

1.1 Site Description and Report Purpose

The Velsicol Chemical Corporation Superfund Site (site) is located in St. Louis, Gratiot County, Michigan; it is adjacent to a residential neighborhood (to the southeast) and is bordered by the Pine River (to the northwest). The chemical plant was shut down in 1977 after several instances of environmental contamination. The first site remedy took place from 1978 to 1986, where process discharges from the chemical plant were stopped, the plant was demolished, and a low-permeability slurry wall and clay cap were designed and installed by Conestoga Rovers and Associates to contain contaminants onsite. Groundwater levels were controlled by a groundwater collection system (that is no longer operable) and a low-permeability slurry wall to prevent migration of contaminants offsite. In the 1990s, the State of Michigan and the U.S. Environmental Protection Agency discovered there was still highly contaminated sediment in the Pine River, which initiated the Operable Unit (OU) 2 sediment remedial action from 1999 to 2006, where over 750,000 tons of contaminated sediment was dredged from the Pine River north of the site. At this time, 4,300 gallons of chemicals were also pumped out of the river. From 2012 to 2016, soil was excavated from the residential neighborhood to reduce risk to human health and the environment. From 2018 to present, in situ thermal treatment has been used to further reduce chemical contamination onsite and around the site. A groundwater collection trench is also in place and still in operation.

CH2M HILL, Inc. (CH2M) prepared this Geotechnical Exploration and Evaluation Report for the planned installation of a downgradient vertical barrier wall (DGVBW) surrounding the riverbank of the Former Plant Site. The goal of installing the DGVBW is to reduce the potential for contaminants to discharge into the Pine River. The DGVBW will consist of a combination wall consisting of driven sheet piles and cylindrical king piles, with sealed interlocks, driven to the clayey glacial till layer, with the bottom of the king piles drilled 10 feet deeper and the entire pile filled with concrete to provide adequate wall stiffness and passive resistance for proper wall performance. The DGVBW's alignment ranges from approximately 10 to 55 feet from the shore into the Pine River, running roughly parallel to the shoreline, with connections at each end into the existing riverbank and connecting with the existing slurry wall.

The existing groundwater collection trench runs along sections of the DGVBW alignment. Manholes for this system are visible at existing ground level. The collection lines that run between the manholes are assumed to have a maximum elevation of 687 feet, but as-built drawings are very approximate. The Remedial Action Contractor should locate and avoid these lines before and during construction. There are also areas with riprap, and several abandoned utilities along the DGVBW that may obstruct sheet pile and king pile installation and require removal and/or preboring before pile driving.

The area behind the DGVBW will be backfilled with aggregate to an approximate elevation of 720.5 feet. In a future contract, a clay cap and final surface cover will be installed, with a final ground surface elevation of 723 feet, which coincides with the proposed top of the DGVBW.

This remedial action is part of OU1, including only the Former Plant Site and not the Adjacent and Nearby Properties, as illustrated in Exhibit 1, which also shows the distinct OU areas and conceptual plan for the current planned remedial design for OU1. Appendix A contains final plans showing the proposed DGVBW alignment.

1.2 Regional Geology

The Michigan Basin covers the entire Lower Peninsula, including the site. The basin's sedimentary rocks, which are largely of Paleozoic age, have a maximum thickness of 16,000 feet. The whole basin is underlain by Precambrian rocks that are a mix of igneous rocks, metamorphic rocks, and metasediments. Thick glacial drift deposits cover most rocks in the basin (Gillespie et al., 2008).

Gratiot County, Michigan, is centered in the Michigan Basin and is made up of three geologic units: the Red Beds (Jurassic period) Formation, Saginaw Formation, and Grand River (Pennsylvanian period) Formation. The Saginaw and Red Beds Formations cover most of the county, with the Grand River Formation covering only 6%. The Saginaw and Red Beds Formations are evenly distributed throughout the county and are a mixture of sandstone, shale, siltstone, and shaly limestone (Gillespie et al., 2008).

The top of bedrock is on the order of 300 feet below ground surface (bgs). There are three soil deposits above the bedrock: shallow unit, till unit, and lower unit. The shallow unit consists of fill, alluvium, and post-glacial lacustrine deposits, and varies in thickness from 20 to 30 feet. The till unit consists of glacially deposited sandy silt or clay with gravel and cobbles, and thickness ranges from 30 to 80 feet. The sand and gravel seams within the till unit range from a few inches to several feet thick. The lower unit, immediately above the bedrock, consists of a series of saturated sands subdivided by two aquitards (CH2M, 2023). These findings are consistent with the previously cited literature.

2. Subsurface Conditions

The following subsections discuss the subsurface conditions at the site.

2.1 Subsurface Exploration and Laboratory Testing

A project-specific geotechnical subsurface exploration program was completed, consisting of seven soil borings and associated laboratory testing. Appendices B and C contain the soil boring logs and laboratory test results, respectively. Exhibit 2, Figure 2.1, presents the soil boring location diagram for these borings. Please note that borings were not completed at locations PD004, PD005, PD007, and PD011.

Due to budgetary and site access constraints, borings were drilled along the shoreline instead of along the DGVBW alignment in the Pine River. Exploration included conducting standard penetration tests (SPTs), pocket penetrometer tests, and vane shear tests. However, all but two of the vane shear tests were invalid because most of the tests were performed on soil in which unconfined compressive strength exceeded 2.0 tons per square foot or the soil was too hard to perform the test. Split-spoon and Shelby tube samples were obtained for classification and laboratory testing. Pitcher tube samples were used to recover soil that was too hard or soft to permit satisfactory recovery. Samples were taken at approximately 2.5-foot intervals for the first 20 feet and then at 5-foot intervals.

Laboratory testing consisted of grain size analysis, water content, Atterberg limits, and unit weight to aid in classification and soil property determination. Triaxial tests (consolidated undrained) with pore water pressure measurements were performed to estimate drained properties of the fine-grained till.

Table 1 summarizes the approximate boring locations, elevations, and depths from current (2022) borings (Figure 2.1). A land survey was performed by a Michigan-licensed surveyor to determine latitude and longitude. The water elevation was not reported in any of the current soil borings.

Table 1. Geotechnical Boring Summary

Boring Id.	Latitude	Longitude	Surface Elevation (feet)	Boring Depth (feet bgs)
PD001	13057448.21	697489.12	727.2	40
PD002	13057017.97	697376.51	723.9	40
PD003	13056733.44	697260.36	726.3	40
PD006	13056307.52	696556.52	725.9	40
PD008	13056105.25	696010.85	726.1	40
PD009	13056245.23	695771.53	726.9	40
PD010	13056398.77	695604.11	726.1	40

Historical soil borings were performed in the Pine River before the sediment dredging remedial action and were used to approximate river sediment properties and interpret the top-of-glacial till. The historical borings contained primarily environmental data, blow counts from SPTs, and qualitative soil descriptions. Exhibit 2, Figure 2.2, presents the soil boring diagram showing historical soil boring locations within the river as part of the nonaqueous phase liquid investigation (CH2M, 2003). River boring logs from this

investigation are included in Exhibit 2. The following subsections provide a general description of the subsurface conditions encountered at the site.

2.2 Soil and Bedrock

Based on the current and historical soil borings, the soil profile along the DGVBW generally consists of very soft riverine/alluvial sediments overlying very dense glacial till.

The depth of the sediment shown in the historical river borings ranged from approximately 8 to 15 feet. However, in OU2, where the sediment was dredged in the early 2000s, most of the sediment is now nonexistent, except for the area close to shore (inner bend of the river) where sediment has reaccumulated due to ongoing water movement. Material in this layer was weak and consisted of granular alluvium with organic matter. Most SPT N-values in the alluvial sediment ranged from 0 to 10 blows per foot.

Very dense glacial till lies below the sediment, where SPT typically encountered refusal (SPT of 50 blows per 6 inches) in the historical borings. The elevations where SPT values were greater than 40 blows per foot were used to estimate the top-of-glacial till profile along the DGVBW alignment. In the dredged area, at the northern section of the DGVBW, the top of till was interpreted to be at an approximate elevation of 704 feet. The middle section top of till was estimated at 707 feet. Over the southern portion of the DGVBW alignment, the top of till was conservatively estimated at 690 feet because very dense or refusal material was not encountered. The design drawings (Appendix A) show where the interpreted top-of-till elevations lie along the DGVBW.

The current (2022) borings encountered approximately 5 to 7 feet of topsoil and fill material. Underlying this layer was soft to medium stiff clay with trace sand and silt until approximately 15 to 20 feet bgs. At this depth, the clay had a higher consistency, from very stiff to hard, until reaching 20 to 30 feet bgs. Underlying this layer was very hard cohesive till.

To estimate the glacial till properties in the Pine River, samples for triaxial tests were chosen from current borings that most closely coincided with the elevation of till in the Pine River (based on historical information) and reflected the till's properties. From the triaxial tests, effective friction angles ranged from 27.8 to 36.7 degrees, effective cohesion ranged from 0 to 740 pounds per square foot, and dry unit weights ranged from 125.4 to 137.0 pounds per cubic foot.

Bedrock was not encountered in any of the borings. Borings extended to termination elevations ranging from 683.9 to 687.2 feet. All borings were terminated at 40 feet bgs. Soil boring logs are included as Appendix B to this geotechnical report.

2.3 Water Elevation

At the time of exploration, the water elevation was not noted. The historical borings indicate the Pine River's elevation was approximately 719.5 feet during exploration. The level of the Pine River is controlled by the downstream dam so it remains at an elevation of approximately 719 feet. This river level was used in the design and to estimate long-term groundwater elevation. The groundwater table may fluctuate over time and during seasonal changes because of variations in precipitation, evaporation, surface water runoff, local dewatering, and the level of the Pine River.

2.4 Design Parameters

The results of the geotechnical field investigation were evaluated and geotechnical properties along the alignment of the DGVBW assigned. Geotechnical parameters were selected based on correlations with the soil types, consistency and relative density, correlations with index parameters, laboratory testing, and engineering experience.

Given the relative consistency of the till and sediment properties, CH2M used a simplified soil profile for the DGVBW alignment. The same till and sediment properties were used throughout, with the elevations and thicknesses of each layer varied along the DGVBW. Appendix D documents geotechnical parameters of existing soil as well as parameters associated with proposed infill materials.

Appendix D also contains assumed soil design parameters for the backfill material and clay cap.
To achieve acceptable compaction of materials immediately behind the wall in standing water, an open-graded large-diameter aggregate is proposed with a maximum particle size of 2.5 inches, with a procedure developed to vibrate the materials in a manner to achieve adequate compaction to not cause problematic settlement after the final engineered cap is installed. The recommended material for this purpose is an open-graded stone (#3) with maximum particle size of 2.5 inches topped with 12 inches of an open-graded (#57) stone with a maximum particle size of 1 inch. The open-graded nature of these materials, combined with a surficial compaction (when the aggregate heights are above the elevation of the Pine River) should result in a stable subgrade on which additional materials, including the cap and lightly loaded park facilities, can be placed. If materials are desired beyond the #57 stone, there should be a nonwoven geotextile before other materials are added. Seaworks Group, LLC, performed a bathymetric survey in April 2022. It is assumed that the U.S. Army Corps of Engineers does not plan to dredge this area of the Pine River in the future and that the section of the Pine River that borders the Former Plant Site is not a traditional navigable waterway. Therefore, this analysis assumes that the current bathymetry will not decrease. The plans in Appendix A present the current bathymetry.

3. Geotechnical Design Recommendations

Because of challenges driving sheet pile during the OU2 sediment remedy (refer to Appendix I of the basis of design report for OU2 sheet pile installation documentation), the design team recommends against a wall design that will require significant penetration into the very stiff to hard glacial till soils. Instead, a combination (i.e., king pile) wall is recommended, consisting of king piles separated by a pair of sheet piles. The king piles are recommended to consist of an open-ended cylindrical steel section in which a drilled concrete shaft can be constructed. This configuration will require seating sheeting and the cylindrical (king pile) units into the till using an appropriate-sized hammer (to be determined by the remedial action contractor). The depth the sheeting and king piles extend into till is of reduced importance since the structural resistance of the cantilevered wall will be developed in the drilled shaft extension of the cylindrical piles. A shortened length of a steel rebar cage will be placed in the drilled extension (extending nominally 3 feet into the steel cylindrical pile) and the entire unit filled with concrete to the top of the cylindrical pile (i.e., the planned top of wall). The recommended sheet pile section is an NZ14 produced by Skyline Steel (Nucor), which was selected because it is the widest commonly available steel sheeting sections (which results in minimizing the number of cylindrical piles). The function of the sheeting is to transfer lateral load from the new fill to the cylindrical (king) piles as well as to provide a hydraulic barrier. The cylindrical piles are recommended to have an outside dimension of 36 inches and a wall thickness of 0.5 inch. Both the sheet piles and the cylindrical piles are recommended to consist of ASTM A252 Gr 3 (with chemical composition adhering to ASTM A572 Gr 50) steel for the cylindrical piles and ASTM A572 Gr 50 for the sheet piles.

CH2M developed the evaluations and recommendations herein for a DGVBW combi-wall with NZ-14 sheet piles and 36-inch-outer-diameter, 0.5-inch-thick steel cylindrical king piles. CH2M selected these based on costs and constructability, requirements for rotational and global geotechnical stability, as well as the required structural capacities resulting from the loading conditions.

3.1 Combination (Sheet Pile / King Pile) Downgradient Vertical Barrier Wall

The geotechnical evaluations for the DGVBW design included analysis of the following limit states: rotational stability, global stability, and structural resistance. The *International Building Code* (ICC, 2021), *American Concrete Institute Building Code Requirements for Structural Concrete* (ACI, 2019), and American Institute of Steel Construction *Steel Construction Manual*, 15th edition (AISC, 2017) were used in these analyses. Where guidance from either source was lacking, other reputable sources were referenced. Load and resistance factor design methodology was used along with a uniform static surcharge load of 100 pounds per square foot in the analysis to account for construction loading and future (lightly loaded) site use (ICC, 2021).

3.1.1 Rotational Stability

The rotational stability and deflection of the wall were evaluated for critical cross sections using the software PYWall (Version 2019.6.9) by Ensoft, Inc. PYWall uses the soil-structure interaction method of analysis, modeling a one-dimensional finite element model of the DGVBW and soil system, consisting of linearly elastic beam-column elements for the DGVBW and nonlinear (Winkler) springs to represent the soil (USACE, 1994). The critical cross sections were analyzed for both short-term and long-term (undrained and drained) conditions. Long-term conditions resulted in a lower factor of safety; therefore, further analysis focused on the long-term soil conditions. Lateral deflection was estimated under final (post-cap construction) geometry and service-state (factor of safety=1.0) loading conditions, with a

maximum permissible lateral deformation of 0.01 times the wall height. Structural adequacy of the various wall elements was calculated using a load factor of 1.6 on the retained earth pressure and a load factor of 1.75 on the applied surface load. A resistance factor of 0.9 was used for moment capacity, and a resistance factor of 0.75 was used for shear capacity.

3.1.2 Structural Resistance

The required structural capacity of the combination (king) piles and the design of the internal reinforcement was based on the maximum shear and moment obtained from PYWall. The maximum design strength was based on International Code Council, American Concrete Institute, and American Institute of Steel Construction Load and Resistance Factor Design guidelines (ICC, 2021; ACI, 2019; AISC, 2017), using load and resistance factors mentioned in Section 3.1.1.

3.1.3 Global Stability

Critical cross sections (that is, tallest or steepest sections with least favorable subsurface conditions) were modeled for global stability using the Rocscience software package Slide2 (Version 9.009) and the proposed wall geometry. Circular and noncircular failure surfaces were evaluated for each drained and undrained scenario. The Spencer method, which equilibrates both forces and moments, was used within the Slide2 program. The assumption was made that, given the massive cylindrical piles and the relatively close placement of these piles, any failure surface will extend below the wall system. An acceptable factor of safety, in excess of 1.5, was achieved in all scenarios (ICC, 2021). The results of the global stability analyses are presented in Appendix E.

3.1.4 Corrosion

The corrosivity of the site was considered in the selection of the steel used for both the sheet piles and for the cylindrical (king) piles. Understanding that any contaminated soil that may have been present along the wall alignment have been removed, understanding that neither the Pine River nor the necessary imported backfill material (by specification) will be environmentally impacted, and considering the presence of an intact and functional slurry isolation wall encasing the impacted soil in OW-1, it is assumed the potential for corrosion to be low, likely similar to corrosion on a nonenvironmental project. A sacrificial allowance of 0.125 inch on steel surfaces exposed to either the imported fill or the Pine River has been allotted to address corrosion. This sacrificial allowance results in an estimated wall life in excess of the 50-year requirement. This corrosion estimation considers typical structural grade (ASTM A572) steel for both the sheet piling and the cylindrical (king) piles.

4. Construction Considerations

In previous construction on this site, the OU2 sheet pile installation contractor experienced challenges with pile driving. Based on previous CH2M experience, a combi-wall with NZ-14 sheet piles and 36-inch-outer-diameter, 0.5-inch-thick steel cylindrical king piles are recommended. The remedial action contractor should be prepared to use an appropriately sized vibratory hammer to install the cylindrical piles and sheet piles into the glacial till unit. However, the depth of the sheet piles and cylindrical piles are driven into the till is of reduced importance since the structural resistance of the cantilevered wall will be developed in the drilled shaft extension of the cylindrical piles.

The installation of the DGVBW will incur vibrations proximate to the site. The magnitude and frequency of the vibrations experienced at any specific location will be dependent on the location of the installation and the depth of the sheeting. Although the magnitude and frequency of the incurred vibrations is not anticipated to result in structural damage to either the site equipment or private property adjacent to the site, vibration and noise monitoring will be necessary proximate to private residences that may become alarmed by the vibrations. A vibration monitoring specification was developed to detail monitoring requirements during construction.

The remedial action contractor should submit information regarding proposed sheet pile-driving equipment and methods in advance of mobilization for approval. Efforts should be made to minimize the impact on the environment. The remedial action contractor must abide by the restrictions outlined in the permit-equivalent issued through the U.S. Army Corps of Engineers (to be issued).

The remedial action contractor should perform necessary calculations (and perhaps test pile installation) to ensure that their proposed installation methodology can install sheet and cylindrical piles without incurring driving stresses exceeding 90% of the yield strength of the steel.

Concreted drilled shafts should be tested for integrity using the thermal integrity profiling (TIP) technology. TIP is preferred over the more-common cross-hole sonic logging given the simplicity of the TIP system and its ability to assess cover outside of the cage (which is paramount to assessing the ability of the shaft to transfer lateral loads to the adjacent soil). Given the number of shafts, only a portion of them, preliminarily set to one out of every three shafts, need be equipped with thermal wires and tested with the TIP system. The number of shafts should be increased if TIP testing results indicate chronic anomalies. Anomalies detected by TIP technologies should be further categorized and remediation measures should be performed on any deemed to contain defects.

Pile-driving activities should be performed under the direction and observation of an engineer or technician experienced in sheet pile installation. The engineer or technician should be present at all times during pile installation to verify that piles have been driven to the required depth. Detailed pile installation and testing records should be maintained.

A sealant will be added to the interlocks (both between sheet piles and between the sheet piles and the cylindrical piles) before installation. The sealant that is recommended is Steelant (also marketed as Wadit) or approved equivalent. This material has been tested to withstand large water pressures and is an industry standard for interlock sealant.

When field conditions differ from those described in this report, CH2M should be consulted for possible changes to recommendations or design.

5. Limitations

CH2M prepared this Geotechnical Exploration and Evaluation Report in accordance with generally acceptable engineering practice. This report is intended for the exclusive use for the Velsicol DGVBW project. The specific project details are unique relative to their location, size, configuration, and elevation.

The information in this report is limited, based on data obtained from the subsurface investigation programs referenced. Boring logs show subsurface conditions only at the specific locations and times indicated and only to the depths penetrated. Subsurface conditions and water levels at other locations or depths may differ from conditions indicated on the boring logs. The subsurface conditions may change over time because of human activities or natural effects. If subsurface conditions during construction are found to vary from those described in this report, the geotechnical recommendations are not warranted to be valid.

The geotechnical engineering recommendations presented herein are an evaluation of subsoil performance based on the geotechnical engineer's experience and professional opinion. These services were performed with the degree of skill and care normally used by other members of the geotechnical engineering profession practicing in this location and at this time. No warranty, expressed or implied, is made.

This report includes both factual and interpretive information. *Factual information* is objective data based on direct observations, such as boring logs and laboratory test results. *Interpretive information* or geotechnical engineering interpretation is based on engineering judgment or extrapolation from factual information.

Use or reuse of this report for any purpose other than as specifically intended hereunder without written verification by the geotechnical engineer will be at the user's own risk.

6. References

American Concrete Institute (ACI). 2019. *American Concrete Institute Building Code Requirements for Structural Concrete.*

American Institute of Steel Construction (AISC). 2017. *Steel Construction Manual.* 15th ed.

CH2M HILL, Inc. (CH2M). 2023. *Final Basis of Design Report, Remediation of the Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall, St. Louis, Michigan*. September.

CH2M HILL, Inc. (CH2M). 2003. *NAPL Investigation Summary Report, Velsicol/Pine River Superfund Site, St. Louis, Michigan*. August.

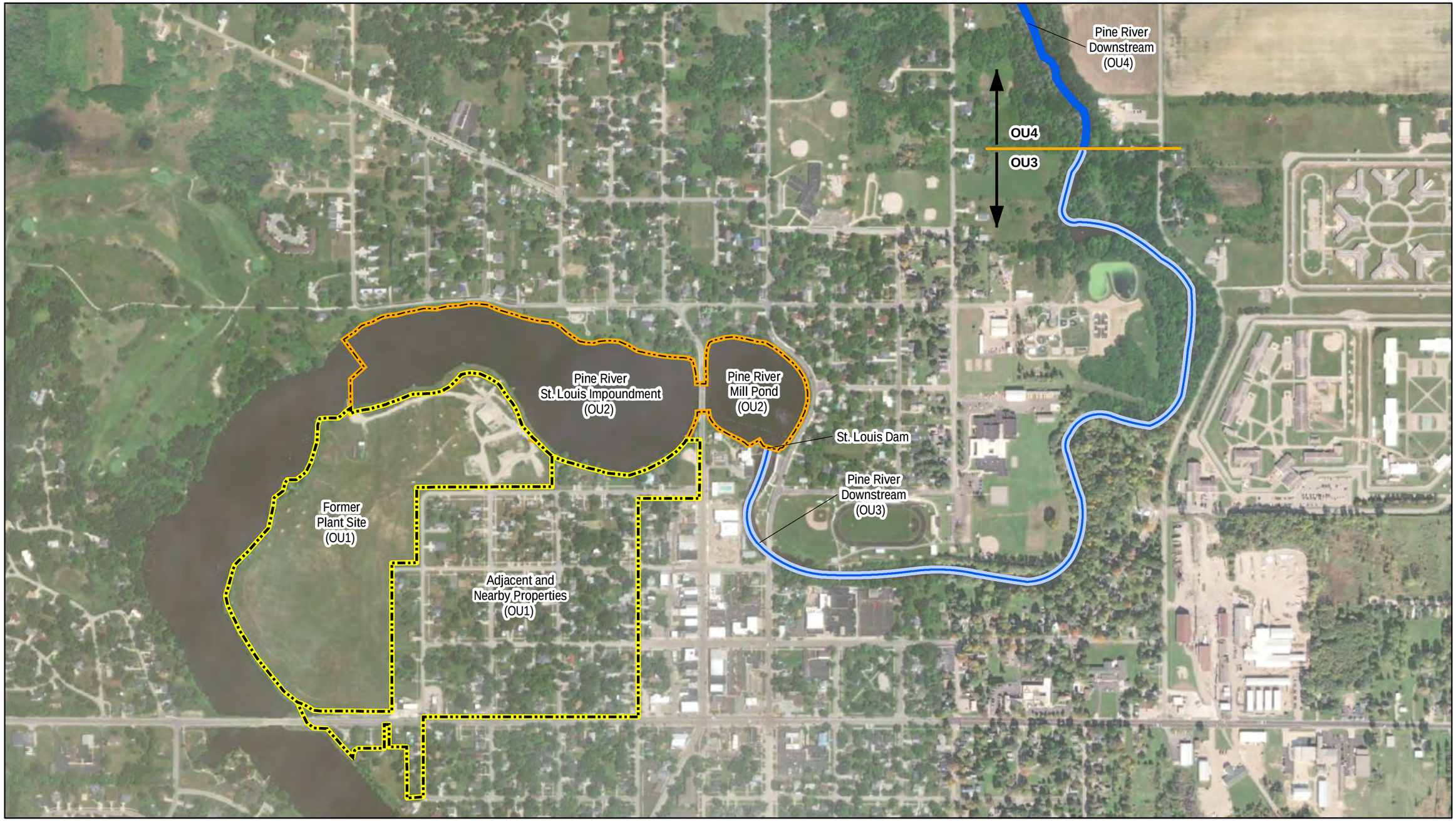
Gillespie, Robb, William B. Harrison III, and G. Michael Grammer. 2008. *Geology of Michigan and the Great Lakes.* Prepared for the Michigan Geological Repository for Research and Education.

International Code Council (ICC). 2021. *International Building Code.*

U.S. Army Corps of Engineers (USACE). 1994. *Engineering and Design: Design of Sheet Pile Walls.* CECW-ED Engineer Manual 1110-2-2504. 31 March. https://www.publications.usace.army.mil/portals/76/publications/engineermanuals/em_1110-2-2504.pdf.

Exhibits

Exhibit 1
Conceptual Site Plans



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1-1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Document Path - MKE - \\Hercules: \\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\Reports\2021\QAPP\MapFiles\Figure01_Study Areas and Operable Units.mxd User Name: mpetersh Date: 8/27/2021 Time: 3:47:13 PM

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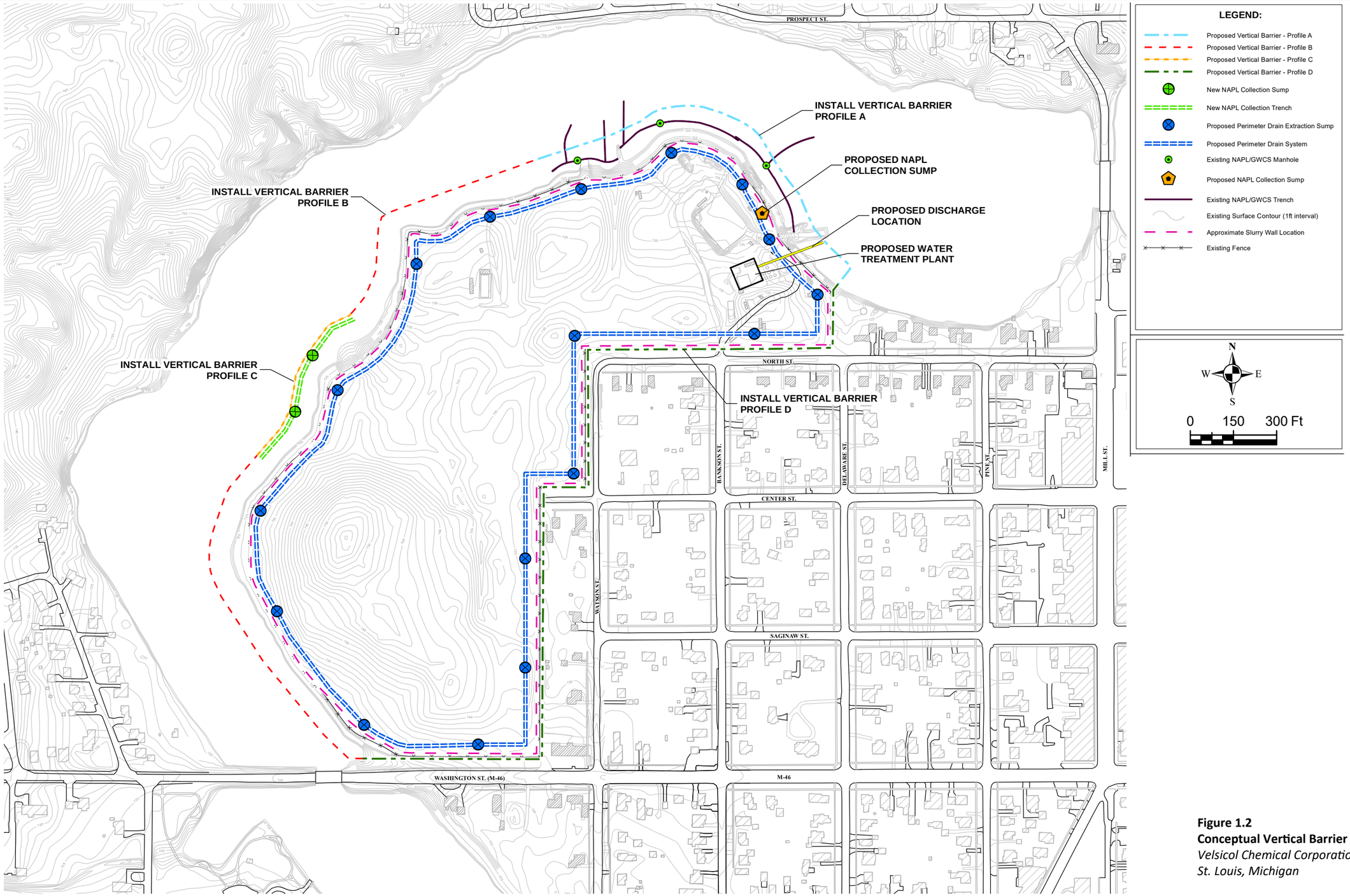

Figure 1.2
Conceptual Vertical Barrier and Drainage System
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: Weston Solutions, Fig 4-02 Alts 2,3,5, Conceptual Vert Barrier and Drainage System.mxd, 9/29/2011

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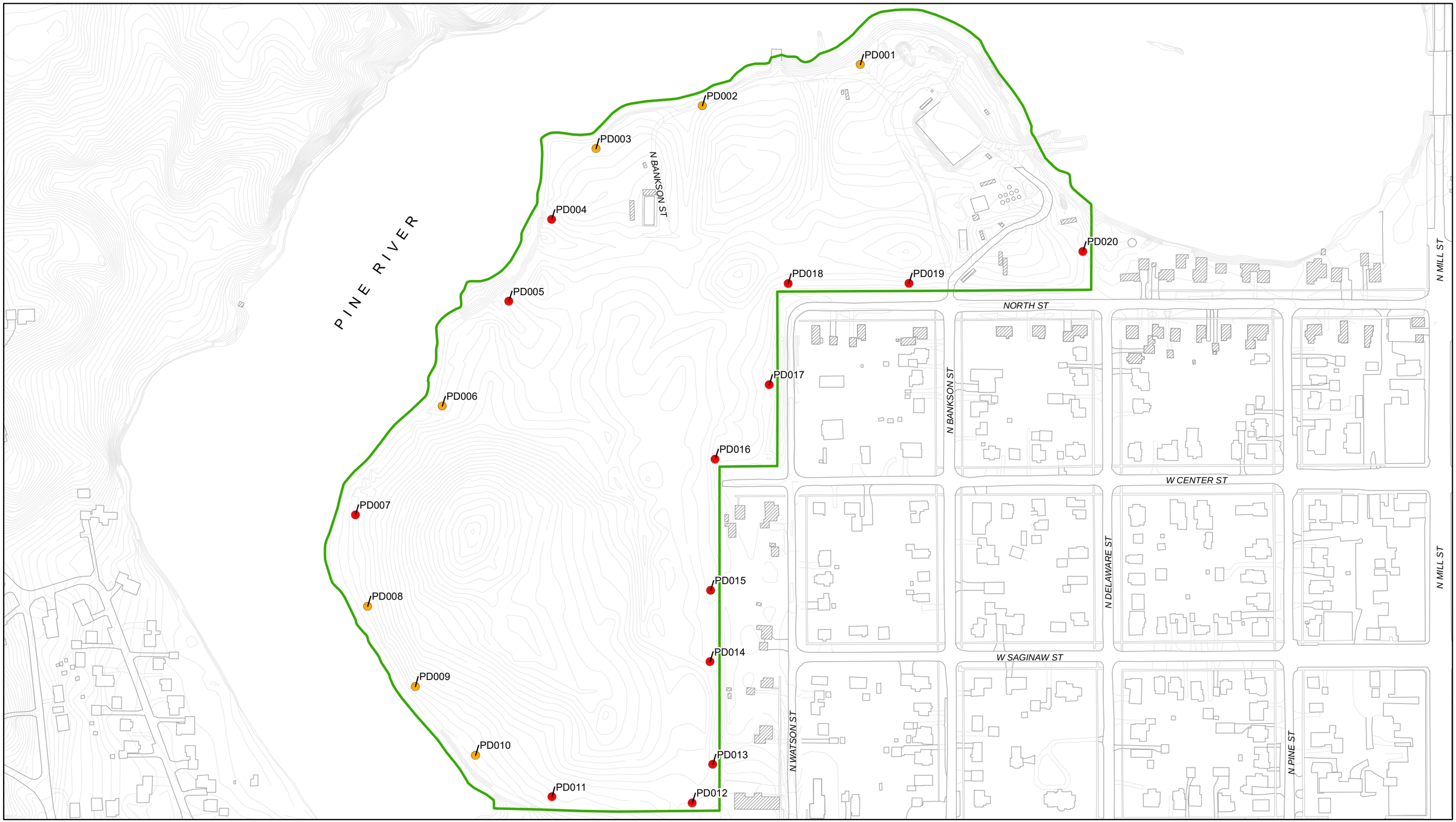
Exhibit 2
Soil Boring Maps



LEGEND

- Perimeter Drain Predesign Investigation Boring
- Perimeter Drain and Geotechnical Investigation Boring
- Former Plant Site

N

0 250 500

Approximate scale in feet

NOTES:

1. BASE MAP PROVIDED BY WESTON SOLUTIONS OF MICHIGAN, INC.
2. LAND SURVEY ELEVATIONS WERE REFERENCED TO NAVD OF 1988 FEET MSL. THE HORIZONTAL LOCATIONS WERE REFERENCED TO THE MICHIGAN STATE PLANE COORDINATE SYSTEM NAD83, INTERNATIONAL FEET - SOUTH (2113) ZONE.

FIGURE 2.1
Perimeter Drain and Geotechnical Predesign Investigation Soil Boring Locations
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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\\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\MapFiles\2022\PD_WP\Figure_2_Soil_Boring_Locations.mxd

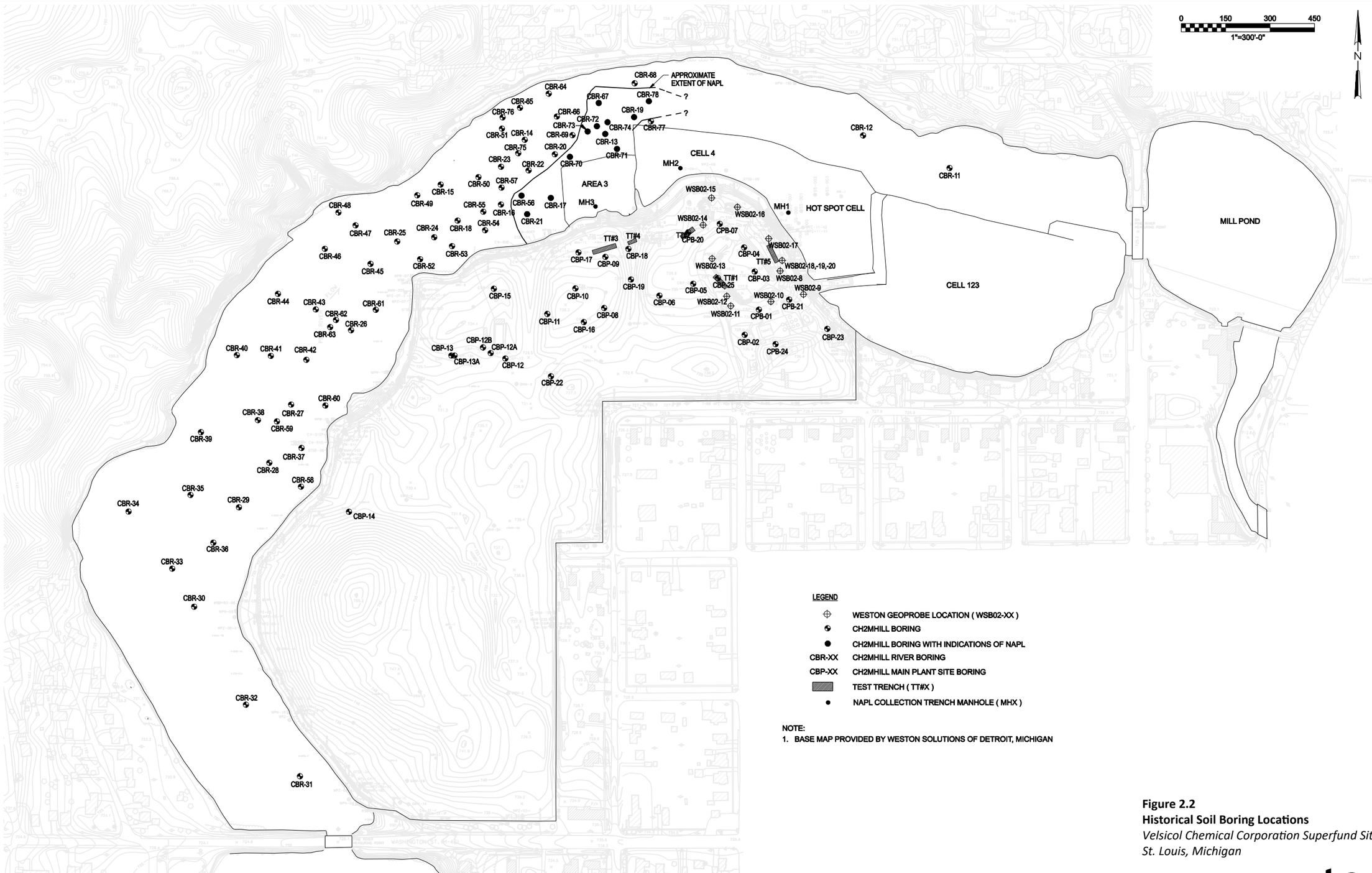

Figure 2.2
Historical Soil Boring Locations
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Source: CH2M HILL, Inc. (CH2M). 2003. NAPL Investigation Summary Report, Velsicol/Pine River Superfund Site, St. Louis, Michigan. Prepared for U.S. Environmental Protection Agency – Region 5. August.

ch2m

Soil Boring Logs

CBR-11
CBR-12
CBR-13
CBR-14
CBR-15
CBR-16
CBR-17
CBR-18
CBR-19
CBR-20
CBR-21
CBR-22
CBR-23
CBR-24
CBR-25
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CBR-75
CBR-76
CBR-77
CBR-78

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-11	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8454'N, 84 degrees 36.6705'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 7'	Depth PID 16' 0 22' 0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5						water
711.5						sediment
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						
704.5						
703.5	15 to 17	S-1	2	Push	Black Ooze - occasional fine gravel, decaying woody material (slough)	
702.5					Gray Silt - very soft	
701.5	17 to 19	S-2	2	Push		
700.5					Poorly Graded Sand with Silt (SP-SM) - Gray	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-11	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8454'N, 84 degrees 36.6705'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
699.5	19 to 21	--	--	--	fine, loose	~20' - rig action indicates cobbles and gravel
698.5						
697.5	21 to 23	S-3	2	10-6-7-20	Well Graded Gravel (GW) - Light brown, subangular, with fine to coarse sand and fragments of coarser gravel	
696.5						
	--	S-4	--	75/3"		
695.5						24' - driller reports smoother action; still tight
694.5	--	S-5	--	Bounce		
693.5						Refusal

Boring Terminated at 26' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-12	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8454'N, 84 degrees 36.6705'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon & CME, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 7'	Depth PID 18' 2-10 19.5-20' 2 23' 2 25' 2 28' 2 (seam) 29' 0 (seam)
717.5						
716.5						
715.5						
714.5						
713.5						
712.5						water
711.5						sediment
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						
704.5						
703.5						
702.5	16 to 18	CME-1	2	Push	Silty Sand (SM) - Black, fine to medium, with thin white shells, strong organic decay odor.	
701.5						
700.5	18 to 20	S-1	1.8	29-57-47-50	Clayey Sand (SC) - Grayish brown, fine to very fine, with fine gravel (well rounded), very dense, moist (TILL)	fine sand seam at ~19.5 to 20'
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-12	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8454'N, 84 degrees 36.6705'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon & CME, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5	20 to 21.5	S-2	1	50-70-90	grades to Sandy Clay (CL) at 21'	
697.5	21.5 to 22.5	S-3	1	59-92		
696.5 / 695.5	22.5 to 24.5	S-4	1.9	46-72-76-109		
					Fine Sand (SP) - Gray-brown, trace silt, wet	no sheen
694.5	24.5 to 25.5	S-5	1	37-90	Clayey Sand (SC) - Gray, fine with coarse with gravel up to 3/4" and fragments of larger (TILL)	
693.5 / 692.5	25.5 to 27.5	S-6	2	42-92-100-119	Well Graded Sand seam at ~28'	
691.5 / 690.5	27.5 to 29.5	S-7	2	22-72-78-83	Fine (to medium) Sand seam at ~28.5-29'	
689.5 / 688.5	29.5 to 31.5	S-8	2	42-46-92-80	grades to Sandy Clay (CL) at ~30-31'	
687.5 / 686.5	31.5 to 33.5	S-9	2	24-26-32-43	Clayey Sand (SC) - Gray, fine/coarse with fine gravel up to 1/2", moist (TILL)	
685.5 / 684.5	33.5 to 35.5	S-10	2	23-24-33-53		

Boring terminated at 35.5' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-13	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.863'N, 84 degrees 36.933'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 16' 19
717.5						
716.5						
715.5						
714.5						water
713.5						sediment
712.5						
711.5						
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						
704.5						
703.5	15 to 17	S-1	2	2-32-83-76	Silt and Fine Sand (ML/SM) - Soft to Stiff 15.4-15.7': Green; 15.7-16.2: Tan (SEDIMENT)	15' -black leafy organics strong decay odor
702.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, rounded, very dense (TILL)	wet to 15.8' moist at 15.8'
701.5	17 to 19	S-2	2	13-32-85-96		
700.5						

Boring terminated at 19' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-14	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.860'N, 84 degrees 36.994'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 14' 2 20.5-22' 0 29-30' 0 31.5' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5						sediment
711.5						
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						
704.5	14 to 16	S-1	2	7-13-22-26	Silty Sand (SM) - Green, fine to very fine, gray and tan streaks, loose (SEDIMENT)	decay odor, slight blue sheen
703.5					Clayey Sand (SC) - Purplish-brown, fine/coarse fragments of coarse gravel, very dense, moist (TILL)	
702.5	16 to 18	S-2	2	17-30-36-40	less gravel, more fine sand 17' - 1mm parting with fine sand	
701.5						
700.5	19 to 20	S-3	2	21-32-34-47	19.1-19.3' - fine sand seam	
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-14	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.860'N, 84 degrees 36.994'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5 – 697.5	20 to 22	S-4	2	12-17-22-26	20.5-22' -Very Fine Sand (SP)/Silt (ML) - Gray, interlayered (~1/4"-1" sand layers)	
696.5 – 695.5	22 to 24	S-5	1.4	16-23-24-49	22.7' - charcoal occasional coarse gravel	
694.5 – 693.5	24 to 26	S-6	1.7	22-30-25-32	occasional coarse gravel	
692.5 – 691.5	26 to 28	S-7	2	7-14-19-46	27' - fine sand in 1mm parting	
690.5 – 689.5	28 t0 30	S-8	2	22-46-62-63	sandier; angular gravel fragments up to 1" 29-30' - fine to medium sand seams (1-1.5")	
688.5 – 687.5	30 to 32	S-9	1.5	13-21-38-39	30-31' - increasing clay, less and finer sand 31.5' - sand seam (fine to coarse)	

Boring terminated at 32' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-15	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.835'N, 84 degrees 37.058'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5						sediment
711.5						
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						Top 0.2' of S-1 = slough (Black ooze with coarse woody debris and mag. ox., petroleum, 0 ppm
704.5						
703.5	15 to 17	S-1	2	6-12-17-16	Clay with sand (CL) - Tan, sand is fine to coarse, hard, moist (TILL) becomese gray at 15.3'	
702.5						
701.5	17 to 19	S-2	2	7-12-14-18	fine sand increases	
700.5						
699.5	19 to 21	S-3	2	7-11-10-14	less fine sand laminated clay with sand	
698.5						

Boring terminated at 21' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-16	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.824'N, 84 degrees 37.012'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5.5'	Depth PID 12' 23 14' 15 15-15.5' 6 16' 0 24-24.7' 6 26.5' 6 29.5' 0 31.7' 0
717.5						
716.5						
715.5						
714.5						water
713.5						sediment
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	S-1	2	Push	Organic Ooze/Silt (OL/ML) - Black, with woody debris and mag. ox.	organic decay odor no sheen
707.5						
706.5	12 to 14	S-2	2	Push		no sheen
705.5						
704.5	14 to 16	S-3	2	4-7-10-8		
703.5					Well Graded Sand and Gravel (SW/GW) - Tan	no sheen
702.5	16 to 18	S-4	1.5	11-10-12-14	Clayey Sand (SC) - Gray-brown, fine/coarse, moist, dense (TILL) 16.5-18' - fine sand seam (wet)	no sheen
701.5						
700.5	18 to 20	S-5	2	13-17-24-32	19' - clay increases	
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-16	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.824'N, 84 degrees 37.012'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5 – 697.5	20 to 22	S-6	1.8	18-28-37-52	clay laminations (~2-4 mm) 21' - with fine gravel up to 1"	
696.5 – 695.5	22 to 24	S-7	2	28-32-48-27		
694.5 – 693.5	24 to 26	S-8	2	15-18-19-29	24-24.7' - fine sand seam (wet)	no sheen
692.5 – 691.5	26 to 28	S-9	2	22-39-62-68	26-26.3' - medium sand 26.3-26.8' - interlayered silt and fine to very fine sand	no sheen
690.5 – 689.5	28 to 30	S-10	1.3	52-72-87-75	29.3' - with coarse gravel fragments 29.5' - 1" fine sand seam (wet)	no sheen
688.5 – 687.5	30 to 32	S-11	2	19-30-42-56	31.7' - fine to medium sand seam (wet)	no sheen
686.5 – 685.5	32 to 34	S-12	2	4-15-28-33		
684.5 – 683.5	34 to 36	S-13	2	18-20-18-34		

Boring terminated at 36' below river surface

CH2MHILL

Project No. 160558.CV.02 Boring No.: CBR-17 Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.828'N, 84 degrees 36.976'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering; Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer	
Water Levels:	Start: ; Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 11' 5 13.2-13.8' 105
717.5						
716.5						
715.5						
714.5						water
713.5						sediment
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	S-1	2	Push	Organic Ooze/Silt (OL/ML) - Black mag. ox. to 11.3' 11' - fine to medium sand layer (1") 12' - silt w/fine sand and leafy organic debris	organic decay odor
707.5						
706.5	12 to 14	S-2	2	1-5-9-15		woody debris
705.5					Well Graded Sand with Gravel (SW) - Dark brown and black, gravel up to 1.5", wet Clayey Sand (SC) - Purplish-brown, fine/coarse, dense to very dense, moist (TILL)	heavy sheen, NAPL, noxious chemical odor

Boring terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-18	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.815'N, 84 degrees 37.045'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 12' 5 14' 0 14.8' 0 21.8-22' 0 23.5' 0 25.5' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5						sediment
711.5						
710.5						
709.5						
708.5	10 to 12	S-1	2	Push	Mag. Ox. w/Silt (ML) - Black and white	
707.5					12' - Organic Silt (OL) - Black	medium sheen
706.5	12 to 14	S-2	2	P-P-17-29	Silty Sand (SM) - Black, fine, wet	
705.5						slight sheen
704.5	14 to 16	S-3	2	3-3-5-7	14.6' - Well Graded Sand (SW) - Tan, with fine gravel up to 3/4"	slight sheen
703.5					Clay (CL) - Light gray, occasional coarse gravel (dilatency: low-medium; dry strength: hi) (TILL)	
702.5	16 to 18	S-4	2	3-7-9-15	17' - occasional coarse sand becomes sandier	
701.5						
700.5	18 to 20	S-5	2	2-8-8-10	Sandy Clay (SC) - Gray-brown, fine/coarse, with fine to coarse gravel, moist (TILL)	
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-18	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.815'N, 84 degrees 37.045'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5	20 to 22	S-6	2	5-9-17-22		
697.5					21.8-22' - Fine sand seam with silt/clay rip-up clasts, wet	
696.5	22 to 24	S-7	2	9-8-17-19		
695.5					23.5' - Well graded sand seam, wet (3")	
694.5	24 to 26	S-8	2	17-22-21-42	moist	24' -Driller reports cobbly
693.5					25.5' - Fine to medium sand seam, wet (2")	26' - Refusal; boulder?

Boring terminated at 26' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-19	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.873'N, 84 degrees 36.912'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 11' 0 15' 80 16-17' 55
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5						sediment
711.5						
710.5						
709.5						
708.5	10 to 12	DM-1	2	Push	Organic Silt (OL) - Black, very soft, woody debris, occasional snail shell 11' - becomes greeenish-gray	organic decay and crude oil odors, MS slight sheen
707.5						
706.5	12 to 14	DM-2	2	Push	grades to light green and tan	
705.5						
704.5	14 to 16	DM-3	2	Push	Fine sand (SP) - Light gray with tan and brown mottling	slight sheen noxious chemical odor
703.5						
702.5	16 to 18	DM-4	2	15-29-39-47	Well Graded Sand (SW) - Tan/Brown, with gravel up to 2" Clayey Sand (SC) - Purplish-gray, fine/coarse, occasional gravel up to 2"	slight sheen noxious chemical odor
701.5						

Boring terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-20	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.852'N, 84 degrees 36.971'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" or 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 7' 0 11' 0 12' 0 13' 0 14' 5
717.5						
716.5						
715.5						
714.5						water
713.5					Mag. Ox.	sediment
712.5	6 to 8	DM-1	2	P-1-1-2	Organic Silt (OL) - Black (top 2"), green with roots, very soft	slight sheen (in black) organic decay odor
711.5						
710.5	8 to 10	DM-2	2	Push		
709.5						
708.5	10 to 12	DM-3	2	Push	Very Fine Sand/Silty Sand (SP/SM) - Tan, with brown mottling 11' - grades to fine sand, occasional coarse sand, with roots	slight odor no sheen
707.5						
706.5	12 to 14	DM-4	2	Push		
705.5					13.5' becomes purplish-gray	
704.5	14 to 16	S-1	2	18-28-25-30	14-14.5' - Angular fragments of coarse gravel Clayey Sand (SC) - Purplish-gray, fine/coarse, occasional fine gravel, very dense, moist (TILL)	14' - obstruction blocks sampler, drill past (6")
703.5						

Boring terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-21	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.819'N, 84 degrees 36.992'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 12' 12 16' 27 17' 66
717.5						
716.5						
715.5						water
714.5						sediment
713.5						
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	DM-1	2	Push	Mag. Ox. with Organic Silt (black) layers	heavy sheen (in black) crude oil odor
707.5						
706.5	12 to 14	DM-2	2	Push		
705.5					Organic Silt (OL) - Black, with leafy debris, very soft	medium sheen
704.5	14 to 16	DM-3	2	Push		
703.5					16' - becomes sandy with wood chips (up to 1/4")	
702.5	16 to 18	S-1	2	8-15-22-27	17-17.2' - Well Graded Sand (SW) - with fine gravel	medium sheen
701.5					Clayey Sand (SC) - Gray, fine/coarse, with fine gravel (round), moist, dense (TILL)	Till appears to fragment in sampler; medium sheen

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-22	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.843'N, 84 degrees 36.991'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 12' 2 16-17' 0 18' 10
717.5						
716.5						
715.5						
714.5						water
713.5						sediment
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	DM-1	2	Push	Mag. Ox.	
707.5					Organic Silt (OL) - Green (top 1" black), with roots	slight sheen slight organic decay odor
706.5	12 to 14	DM-2	2	Push		
705.5						
704.5	14 to 16	DM-3	2	Push	Silt (ML) - Tan, with occasional roots	
703.5						
702.5	16 to 18	S-1	2	10-20-22-20	Fine Sand (SP) - Tan, with brown mottling	16' - Driller reports gravelly
701.5					Clayey Sand (SC) - Purplish-gray, fine/coarse with fine to coarse gravel, very dense (TILL)	top 8" fragments; no sheen slight chemical odor

Boring terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-23	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.845'N, 84 degrees 37.012'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 12' 0 15' 0 17' 0 20' 0 22' 0 24-24.5' 0 31.5' 0 32.5' 0 33' 0 34.5' 0
717.5						
716.5						
715.5						
714.5					water	
713.5					sediment	
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	DM-1	1	Push	Black Organic Ooze, woody debris and silt Fine Sand (SP) - Tan and gray with brown, occasional wood fragments, loose	slight sheen
707.5						
706.5	12 to 14	DM-2	1	Push		
705.5						
704.5	14 to 16	DM-3	2	Push	Well Graded Sand (SW) - Grayish-brown, with occasional gravel up to 1", loose	No Sheen; No NAPL No odor
703.5						
702.5	16 to 18	S-1	2	6-17-22-34	Clayey Sand (SC) - Purplish-gray, fine/coarse with gravel up to 3/4" (round), moist (TILL)	top 1" brown
701.5						
700.5	18 to 20	S-2	1.5	12-15-23-32		
699.5					20' - fine to medium sand (1")	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-23	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.845'N, 84 degrees 37.012'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5 – 697.5	20 to 22	S-3	2	11-19-25-27	22' - coarse sand (<1")	
696.5 – 695.5	22 to 24	S-4	2	16-27-34-51		
694.5 – 693.5	24 to 26	S-5	2	28-37-62-84	24-24.5' - fine to medium sand, gray-brown, w	no sheen
692.5 – 691.5	26 to 28	S-6	2	10-18-22-28		
690.5 – 689.5	28 to 30	S-7	2	27-62-34/1"		
688.5 – 687.5	30 to 32	S-8	2	15-21-23-31	31.5' - well graded sand seam (3")	
686.5 – 685.5	32 to 34	S-9	2	15-22-23-29	32.5-34.5' - sand seams up to 4" in silt and clay	
684.5 – 683.5	34 to 36	S-10	1.5	22-30-46-38		
682.5 – 681.5	36 to 38	S-11	2	13-19-31-22		

Boring terminated at 38' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-24	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8057'N, 84 degrees 37.0628'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer	
Water Levels:	Start: / Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth / PID 11' 0 12' 0 13' 0 14' 0 15' 0 16' 0 17' 0
717.5						
716.5						
715.5						
714.5						water
713.5						sediment
712.5						
711.5						
710.5						
709.5					Mag. Ox. & Organic Silt (OL) - Black w/ wood	slight sheen
708.5	10 to 12	DM-1	2	Push	Peat (PT) - Dark brown (<2") Fine Sand (SP) - Dary gray with brown loose, wet, occasional woody debris	
707.5						
706.5	12 to 14	DM-2	2	Push	13-14' - sand becomes fine to medium	
705.5						
704.5	14 to 16	DM-3	2	P-P-P-21	15' - sand becomes well graded (SW) 2" Peat between sand (SW) and gravel (GW)	slight sheen slight sheen
703.5					Well Graded Gravel with Sand (GW) - gravel up to 2"	slight sheen
702.5	16 to 18	DM-4	1	8-17-21-22	Clayey Sand (SC) - Purplish-gray, fine/coarse with fine gravel (pea-size), dense, moist (TILL)	16-18' - Driller reports drilling like cobbles
701.5						
700.5	18 to 20	S-1	1.5	2-9-15-23	19' - fine to medium sand seam (3", wet)	no sheen
699.5						

Boring terminated at 20' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-25	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8033'N, 84 degrees 37.0910'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
					Depth to Top of Sediment = 3'	Depth PID
718.5						10' 0
						11' 0
717.5						14' 0
						16' 0
716.5					water	17' 0
					sediment	18' 0
715.5						
714.5						
713.5						
712.5						
711.5						
710.5						
709.5						
					Mag. Ox. - brown streaks	heavy sheen
708.5	10 to 12	DM-1	2	Push	Organic Silt (OL) - Black	heavy sheen
					Fine Sand (SP) - Greenish-gray with black	slight sheen
707.5						
706.5	12 to 14	DM-2	2	Push		
705.5					14' - mottling becomes brown, with occasional coarse woody debris	slight sheen
						wood chips (1/4")
704.5	14 to 16	DM-3	2	Push		
703.5						
702.5	16 to 18	S-1	1	10-23-21-27		
					Well Graded Sand and Gravel (SW) - Gray (whitish), wet	slight sheen
701.5					Clayey Sand (SC) - Brownish-gray, fine/coarse (TILL)	slight sheen

Boring terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-26	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7539'N, 84 degrees 37.1260'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 14' 97 14.5' 26 15' 55
717.5						
716.5						
715.5						water
714.5						sediment
713.5						
712.5						
711.5						
710.5						
709.5						petroleum odor
708.5	10 to 12	DM-1	1.5	Push	Organic Silt (OL)/Peat (PT) - Black, woody Fine Sand (SP) - Greenish-gray/tan, with occasional roots, loose, wet	heavy sheen slight sheen
707.5						
706.5	12 to 14	DM-2	2	13-15-16-18	Well Graded Gravel with Silt (GW-GM) - Grayish-tan (occasional green mottling) with sand (fine to coarse), gravel up to 2.5" wet, medium dense; grades to SW at base	
705.5						slight sheen
704.5	14 to 16	DM-3	1	5-11-22-24	Sandy Clay (CL) - Purplish-gray, sand is coarse, with gravel up to 2.5" and cobbles, dense, moist (TILL)	top 2" is tan
703.5						

Boring terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-27	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7125'N, 84 degrees 37.1715'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 11' 0 13' 19 14' 22 15' 19
717.5						
716.5						
715.5						water
714.5						sediment
713.5						
712.5						
711.5						
710.5						
709.5						
708.5	10 to 12	DM-1	2	Push	Organic Silt (OL) - Dark gray, with woody debris (peaty), very soft, wet	slight sheen
707.5					11.5' - becomes black with leafy debris	heavy sheen petroleum odor
706.5	12 to 14	DM-2	2	Push		
705.5						
704.5	14 to 16	DM-3	1.5	14-24-30-26	Well Graded Gravel (GW) - with cobbles and sand Clayey Sand (SC) - Light gray, fine/coarse, with fine gravel (pea-size), moist, very dense (TILL)	slight sheen
703.5						

Boring terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-28	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6801'N, 84 degrees 37.1880'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					Depth to Top of Sediment = 4'	Depth PID 5',7',8',10',12' 0 13-13.5' 0 14' 6 16.5' 10 water
714.5 713.5	4 to 6	DM-1	1.5	Push	Organic Silt (OL) - Dark gray, very soft, with coarse woody debris Poorly Graded Sand with Silt (SP-SM) - Greenish-gray, very fine to fine, with roots	sediment heavy sheen
712.5 711.5	6 to 8	DM-2	2	Push	7' - silt decreases to trace, becomes SP occasional coarse bark pieces	slight sheen
710.5 709.5	8 to 10	DM-3	2	Push	9' - fine sand increases (less very fine); fewer roots; brown mottling starts	slight shhen
708.5 707.5	10 to 12	DM-4	2	Push	10' - increase in brown mottling	
706.5 705.5	12 to 14	DM-5	2	Push	12' - sand becomes gray, fine to medium Well Graded Sand (SW) - Grayish-brown with black (becomes black at 13.5'), occasional fine to coarse gravel	no sheen slight sheen
704.5 703.5	14 to 16	DM-6	0.5	8-10-5-8		cobble at 14' ?
702.5 701.5	16 to 18	DM-7	1.5	2-4-8-16	Clayey Sand (SC) - Purplish-gray, fine/coarse, medium dense, moist (TILL)	slight sheen slight sheen

Boring terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-29	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6553'N, 84 degrees 37.211'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 7' 0 11' 0 13' 0 15' 0 15.5' 0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5	6 to 8	DM-1	2	Push	Organic Silt (OL) - Dark gray, very soft, with woody debris 7' - becomes black, more peaty debris	heavy sheen
711.5						
710.5	8 to 10	DM-2	2	Push	Silty Sand (SM) - Dark brown, fine, with woody/peaty debris	
709.5						
708.5	10 to 12	DM-3	2	Push	11' - decrease woody debris and silt; becomes SP	slight sheen
707.5						
706.5	12 to 14	DM-4	2	Push	12' - becomes greenish-gray 13' - becomes light brown fine sand alternating with dark brown silt (1/4" to 1" layering); occasional wood	
705.5						
704.5	14 to 16	DM-5	2	13-15-33-50	Clayey Sand (SC) - Light gray, fine/coarse, occasional fine gravel, moist, very dense (TILL)	no sheen ~1" gravel on top till 15' - 3" SW seam; SS 15.5' - 4" SP seam; SS
703.5						

Boring terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-30	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6000'N, 84 degrees 37.2450'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer	
Water Levels:	Start: / Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 6' 0 9' 0 12-12.5' 0 13.3-14' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	2	Push	Silt (ML) - Olive-brown, with roots, very soft, 7' - very fine sand (start coarsening downward) 8' - fine sand, brown mottling	sediment no sheen, no odor
711.5						
710.5	8 to 10	DM-2	2	Push	Poorly Graded Sand (SP) - Greenish-gray, fine (brown mottling) 10' - becomes light brown	no sheen
709.5						
708.5	10 to 12	DM-3	2	Push		
707.5						
706.5	12 to 14	DM-4	2	P-P-19-20	Well Graded Sand (SW) - Brown, with gravel Clay (CL) - Purplish-gray, with sand and fine gravel (rounded), dense, moist (TILL) 13.3-14' - Fine sand seam (gray)	no sheen no sheen no sheen
705.5						
704.5	14 to 16	S-1	2	7-15-21-22	15' - grades to Clayey Sand (SC)	
703.5						
702.5	16 to 18	S-2	2	9-18-28-31		
701.5						
700.5	18 to 20	S-3	2	18-26-48-84	19-20' - increase coarse gravel; till is lighter (almost pinkish) gray	slight sheen refusal on coarse gravel
699.5						

Boring terminated at 20' below river surface and cobbles in till

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-31	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.50543N, 84 degrees 37.16475'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer	
Water Levels:	Start: / Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 9'	Depth PID Bkgd 0-2.4 10-12' 0 12-14' 0 14-16' 0 16-18' 0 18-20' 0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5						
711.5						
710.5						water
709.5						sediment
708.5	10 to 12	1	1.1	2-1-1-2	Sandy Silt (ML) - Olive green with brown mottling, with gravel and organics, soft 11' - becomes greenish-gray	
707.5						
706.5	12 to 14	2	2	2-2-2-4	Poorly Graded Sand (SP) - Gray with reddish-brown mottling, fine to medium, loose	
705.5						
704.5	14 to 16	3	2	2-4-8-12	Silty Sand (SM) - Reddish-brown, with gravel, loose 15.5' - becomes grayish-brown, dense	
703.5						
702.5	16 to 18	4	2	5-10-13-15	Sandy Silt (ML) - Grayish-brown, trace gravel	
701.5						
700.5	18 to 20	5	2	5-9-10-16		
699.5						

Boring terminated at 20' below river surface

CH2MHILL

Proj	Boring No.: CBR-32	Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.5457N, 84 degrees 37.2074'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer		
Water Levels:	Start:	Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 12'	Depth PID 15' 0 17' 0 20' 0 24.5' 0 27' 0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5						
711.5						
710.5						
709.5						
708.5						
707.5						
706.5						
705.5						
704.5						
703.5	15 to 17	DM-1	2	Push	Organic Silt (OL) - Dark green/black, very soft Clayey Sand (SC) - Light purplish-gray, fine/coarse, with occasional gravel up to 1.5" loose, moist	medium sheen assoc. with black areas
702.5						no sheen
701.5	17 to 19	DM-2	2	5-12-15-19	17.5' - becomes brown-gray, medium dense	
700.5						

CH2MHILL

Proj Boring No.: CBR-32 | Sheet:

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.5457N, 84 degrees 37.2074'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering | Logger:
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" and 1" split spoon, 300# hammer	
Water Levels:	Start: | Finish:

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
699.5 – 698.5	19 to 21	DM-3	2	5-7-10-13	21' - becomes sandier	no sheen
697.5 – 696.5	21 to 23	DM-4	2	5-7-10-17	Clay (CL) - Brownish-gray with sand (fine/ coarse, no gravel, stiff, moist	
695.5 – 694.5	23 to 25	DM-5	2	9-11-16-16	24.5-26.5'- laminated with silt and very fine sand; silt is dark gray, sand is light gray	no sheen
693.5 – 692.5	25 to 27	DM-6	2	3-3-5-12	26.5' - sand decreases Lean Clay (CL) - Dark gray, laminated, med. stiff, med. toughness, high dry strength	no sheen

Boring terminated at 27' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-33	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6211_'N, 84 degrees 37.2618_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 300# hammer, D&M		
Water Levels:	Start: 10/29/02 0900	Finish: 9/29/02 1000

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 8' 4 13' 0 14.5' 0 15' 0 16' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	1.5	Push	Silt (ML) - Green, very soft, wet Silty Sand (SM) - Green, fine, wet, loose, roots, occasional gravel up to 1"	sediment
711.5						Slight Sheen
710.5	8 to 10	DM-2	1	Push	becomes brown at ~ 8-9'	
709.5						
708.5	10 to 12	DM-3	2	Push	10' - Grades to brown Silt with very fine sand and fine woody debris (laminated, soft, moist)	
707.5					Sand with Silt (SP-SM) - Brown, fine to medium, loose, wet	
706.5	12 to 14	DM-4	2	Push		No Sheen
705.5						
704.5	14 to 16	DM-5	2	3-6-7-11	Well Graded Sand (SW) - with gravel up to 2"	No Sheen Slight Sheen
703.5					Silty Sand (SM) - Purplish-gray, fine/coarse, moist/wet, medium dense (TILL)	15.2-15.6' - well graded No Sheen

Boring Terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-34	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.0_'N, 84 degrees 37.0_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 10/29/02 1015	Finish: 10/29/02 1100

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 6' 4 7' 0
717.5						8' 0 10.5' 0
716.5						11' 0 12' 0
715.5						14' 0 water
714.5	4 to 6	DM-1	1.8	Push	Organic Silt (ML) -Black with woody debris, very soft, wet	sediment Top 2" Heavy Sheen
713.5					Sand with Silt (SP-SM) - Greenish-gray, fine to medium, roots near top, loose, wet	
712.5	6 to 8	DM-2	1.2	Push		
711.5						Slight Sheen
710.5	8 to 10	DM-3	1.3	Push		
709.5						No Sheen
708.5	10 to 12	DM-4	1.5	Push	10-1/2' - tan mottling 11' - becomes brown with dark brown woody laminations (~ 1/4")	No Sheen No Sheen
707.5						
706.5	12 to 14	DM-5	1.5	Push		
705.5					Well Graded Sand (SW) - Gray, loose, wet, trace silt	No Sheen
704.5	14 to 15.5	DM-6	1.4	16-64-73/2"	Clayey Sand (SC) - Brownish-gray, fine/coarse, with fine gravel, very dense, moist (Till)	No Sheen

Boring terminated at 15.5' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-35	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6621_'N, 84 degrees 37.2480_'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 300# hammer, D&M/SPT	
Water Levels:	Start: 10/29/02 1130 / Finish: 10/29/02 1240

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 10' 0 12' 0 17' 0 17.8' 0
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	0.2	Push	Organic Silt and Wood (OL/PT)	Sediment Petroleum odor, Heavy Sheen
712.5						
711.5	7 to 9	DM-2	0.5	Push	chunk of wood in shoe of DM-2	
710.5						
709.5	9 to 11	DM-3	1.5	Push	Fine Sand (SP) -Gray, trace of silt, loose, wet Tan, mottling at 9-1/2', dark gray at 10'	Slight Sheen
708.5						
707.5	11 to 13	DM-4	1.7	Push	becomes fine to medium and lighter gray	No Sheen
706.5						
705.5	13 to 15	S-1	0.4	1-3-4-5	Gravel up to 3/4" and sand (SW) in shoe of S-1	Slight Sheen
704.5					Suspect Gravel at 14' blocked S-1	
		DM-5	0.0	69/6"		
703.5	15.5 to 17	S-2	1.3	16-18-22	Clayey Sand (SC) - Dark Gray, fine/coarse, with fine gravel, dense, moist (Till)	Slight Sheen
702.5						
701.5	17 to 18.5	S-3	1.2	22-34-62	2" of fine sand in bottom of S-2 Fine Sand seam ~ 17' - 17.8'	Slight Sheen

Boring Terminated at 18.5' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-36	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.63556' W 84° 37.23052'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels: 3.5' water depth	Start: 10-29-02	Finish: 10-29-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					3.5' river depth	Depth PID BG 0.0 5'-7' no sample 7'-9' 0.0 9'-11' 0.0 11'-13' 0.0
717.5						
716.5					Augers sank to 5.0 feet without drilling.	
715.5	3.5 to 5				3.5'-10.0' Silty soft sediments w/organics & petroleum contamination, black w/sheen, strong petroleum odor	
714.5						
713.5	5 to 7	1 3" SS	0.0	push		
712.5						
711.5	7 to 9	2 3" SS	0.8	push		
710.5					10.0'-10.8' Wood fibers, brown 10.8'-11.0' Sandy silt w/wood fibers, brown	
709.5	9 to 11	3 3" SS	1.8	push	11.0'-11.6' Sandy silt w/gravel & organics (ML), green w/black staining, firm 11.6'-12.5' Silty sand w/gravel (SM), gray & brown mottle, moist, hard	
708.5						
707.5	11 to 13	4 3" SS	2.0	22-37-49-37 (N/A)	12.5'-12.6' Sand seam, med, (SP), grayish brown, moist, dense 12.6'-13.0' Silty sand w/gravel (SM), gray & brown mottle, moist, hard	
706.5						
705.5					End of boring at 13.0' below river surface	
704.5						
703.5						
702.5						
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-37	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.68841' W 84° 37.16359'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels: 4.0' water depth	Start: 10-29-02	Finish: 10-29-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					4.0' river depth	Depth PID BG 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 6.6 16'-17.5 0.0
717.5						
716.5						
715.5						
714.5	4 to 10				4.0'-11.0' Soft silty sediment, grayish brown	
713.5						
712.5						
711.5						
710.5						
709.5					Augers sank to 10.0 feet without drilling.	
708.5	10 to 12	1 3" SS	2.0	push		
707.5					11.0'-13.4' Soft silty sediment w/petroleum contamination, black, strong petroleum odor	
706.5	12 to 14	2 3" SS	2.0	push		
705.5					13.4'-13.8' Wood fibers, grayish black	
704.5	14 to 16	3 3" SS	1.0	push	13.8'-15.0' Sand, med (SP), gray	
703.5					15.0'-17.0' Sandy gravel (GW), gray	
702.5	16 to 17.5	4 3" SS	1.3	32-46-41-200/0" (N/A)	17.0'-17.5' Silty sand w/gravel (SM), gray, dense	
701.5					End of boring at 17.5' below river surface	
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-38	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.70379' W 84° 37.19680'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels: 4.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					4.0' river depth	Depth PID BG 0.0 5'-7' 0.0 7'-9' no sample 9'-11' 0.0 11'-13' no sample 13'-15' 0.0 15'-17' 0.0
717.5						
716.5						
715.5					Augers sank to 10.0 feet without drilling.	
714.5	4 to 5				4.0'-6.0' Silty soft sediments w/organics & petroleum contamination, black, petroleum odor	
713.5	5 to 7	1 3" SS	0.7	push		
712.5					6.0'-6.5' Solid wood chunk w/petroleum contamination, black	
711.5	7 to 9	2 3" SS	0.0	push	6.5'-9.7' Wood fibers (1" long), w/petroleum contamination, black, petroleum odor	
710.5					9.7'-13.0' Sand, med (SP), gray, wet, loose	
709.5	9 to 11	3 3" SS	1.3	push		
708.5						
707.5	11 to 13	4 3" SS	0.0	push	Pushed a large wood chunk - no recovery in 11'-13' split spoon	
706.5						
705.5	13 to 15	5 3" SS	1.0	push	13.0'-14.5' Sand, med (SP), grayish brown, wet, loose	
704.5					14.5'-15.5' Sandy gravel (GP), gray, dense	
703.5	15 to 17	6 3" SS	1.5	10-22-33-46 (N/A)	15.5'-17.0' Sandy silt w/gravel (ML), grayish brown, hard	
702.5						
701.5					End of boring at 17.0' below river surface	
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-39	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.69696' W 84° 37.24017'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels: 6.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					6.0' river depth	Depth PID BG 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5	6 to 8	1 3" SS	2.0	push	6.0'-7.0' Silty sand, med (SM), grayish brown, very loose	
711.5					7.0'-8.5' Silty sand, fine (SM), grayish brown, very loose	
710.5	8 to 10	2 3" SS	2.0	push	8.5'-9.8' Sandy silt (ML), gray w/some rust colored stains, very soft	
709.5						
708.5	10 to 12	3 3" SS	0.6	push	9.8'-13.0' Sand, med (SP), gray w/trace rust colored stains, loose	
707.5						
706.5	12 to 14	4 3" SS	2.0	5-7-7-11 (N/A)	13.0'-13.5' Sand, coarse, w/gravel (SP), grayish brown, dense	
705.5					13.5'-14.0' Sandy silt w/gravel (ML), grayish brown, hard	
704.5					End of boring at 14.0' below river surface	
703.5						
702.5						
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-40	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.73987' W 84° 37.21304'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 300# hammer		
Water Levels: 6.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					6.0' river depth	Depth PID BG 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0
717.5						
716.5						
715.5						
714.5						
713.5						
712.5	6 to 8	1 3" SS	0.4	push	6.0'-7.0' Silty soft sediments w/organics, brown	
711.5					7.0'-9.0' Silty soft sediments w/organics & petroleum contamination, black, odor	
710.5	8 to 10	2 3" SS	1.6	push		
709.5					9.0'-11.2' Silty sediments w/organics & some wood chips, brown w/some black staining	
708.5	10 to 12	3 3" SS	1.7	push		
707.5					11.2'-13.0' Silty soft sediments w/organics & wood fibers, brown & gray	
706.5	12 to 14	4 3" SS	1.8	push		
705.5					13.0'-14.0' Sand, med (SP), gray, interbedded w/sandy silt (ML), brown, in alternating layers, medium dense	
704.5	14 to 16	5 3" SS	1.5	28-34-37-46 (N/A)	14.0'-14.5' Sand w/gravel (SP), gray, dense 14.5'-16.0' Sandy silt w/gravel (ML), gray, hard	
703.5						
702.5					End of boring at 16.0' below river surface	
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-41	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.73948' W 84° 37.18713'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 300# hammer		
Water Levels: 5.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					5.0' river depth	Depth PID BG 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0
717.5						
716.5						
715.5						
714.5					Augers sank to 8.0 feet without drilling.	
713.5	5 to 8				5.0'-11.0' Silty soft sediment, brown, slight petroleum odor	
712.5						
711.5						
710.5	8 to 10	1 3" SS	0.6	push		
709.5						
708.5	10 to 12	2 3" SS	2.0	push		
707.5					11.0'-13.5' Silty sediment w/organics & petroleum contamination, brown w/black staining, strong petroleum odor	
706.5	12 to 14	3 3" SS	2.0	push for 1.5' 10/6"		
705.5					13.5'-13.7' Solid wood chunk	
704.5	14 to 16	4 2" SS	1.7	8-10-13-16 (N/A)	13.7'-14.6' Sandy gravel (GP), gray 14.6'-16.0' Sandy silt w/gravel (ML), gray, firm to hard	
703.5						
702.5					End of boring at 16.0' below river surface	
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-42	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.73738' W 84° 37.16000'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 300# hammer		
Water Levels: 4.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					4.0' river depth	Depth PID BG 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0 16'-18' 0.0
714.5 713.5 712.5 711.5	4 to 8				4.0'-9.0' Silty soft sediments w/organics, brown	
710.5 709.5	8 to 10	1 3" SS	1.8	push	9.0'-10.0' Silty soft sediments w/organics & petroleum contamination, black, strong odor	
708.5 707.5	10 to 12	2 3" SS	1.8	push	10.0'-11.0' Wood fibers & organics, brown to black 11.0'-13.8' Sandy silt w/organics (ML), gray	
706.5 705.5	12 to 14	3 3" SS	2.0	push		
704.5 703.5	14 to 16	4 2" SS	2.0	10-10-16-23 (N/A)	13.8'-14.6' Silty sand, fine, w/trace wood chips (SM), gray, loose 14.6'-17.5' Silty sand w/gravel (SM), grayish brown, moist, hard	
702.5 701.5	16 to 18	5 2" SS	1.5	7-11-16-18 (N/A)	17.5'-17.7' Sandy gravel (GP), gray, wet 17.7'-18.0' Silty sand w/gravel (SM), grayish brown, moist, hard	
700.5 699.5					End of boring at 18.0' below river surface	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-43	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.76542' W 84° 37.15291'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 4.0' water depth	Start: 10-30-02	Finish: 10-30-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					4.0' river depth	Depth PID BG 0.0 4'-6' 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0
714.5 713.5	4 to 6	1 3" SS	0.7	push	4.0'-4.2' Solid wood chunks, stained black 4.2'-8.0' Silty soft sediments w/organics, brown	
712.5 711.5	6 to 8	2 3" SS	1.4	push		
710.5 709.5	8 to 10	3 3" SS	2.0	push	8.0'-10.0' Silty sand w/organics (SM), gray w/trace rust staining, very loose	
708.5 707.5	10 to 12	4 2" SS	2.0	5-5-7-10 (N/A)	10.0'-11.4' Sandy silt w/trace organics (ML), brown, very soft 11.4'-14.0' Sand, med to coarse, w/gravel (SP), brown, medium dense	
706.5 705.5	12 to 14	5 2" SS	0.4	3-4-8-11 (N/A)		
704.5 703.5	14 to 16	6 2" SS	2.0	3-3-9-14 (N/A)	14.0'-15.5' Silty sand, fine to med, w/trace gravel (SM), brown to gray, medium dense 15.5'-16.0' Silty sand w/gravel (SM), grayish brown, very dense	
702.5 701.5 700.5 699.5					End of boring at 16.0 feet below river surface	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-44	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.77403' W 84° 37.18183'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 6.0' water depth	Start: 10-31-02	Finish: 10-31-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5 713.5					6.0' river depth	Depth PID BG 0.0 6'-8' 0.0 8'-10' 1.0 10'-12' 0.7 12'-14' 0.0 14'-16' 0.0 16'-18' 0.0
712.5 711.5	6 to 8	1 3" SS	0.9	push	6.0'-6.4' Silty soft sediments, brown 6.4'-8.2' Silty soft sediments w/organics & petroleum contamination, black, strong odor	
710.5 709.5	8 to 10	2 3" SS	0.4	push	8.2'-12.0' Wood fibers (~3/4" long), stained black w/petroleum contamination	
708.5 707.5	10 to 12	3 3" SS	0.4	push		
706.5 705.5	12 to 14	4 3" SS	0.4	push	12.0'-15.0' Sandy gravel (GP), gray, medium dense	
704.5 703.5	14 to 16	5 2" SS	0.6	push	15.0'-16.0' Silty sand w/gravel (SM), grayish brown, medium dense	
702.5 701.5	16 to 18	6 2" SS	1.0	23-42-44-53 (86)	16.0'-18.0' Silty sand w/gravel (SM), grayish brown, very dense	
700.5 699.5					End of boring at 18.0 feet below river surface	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-45	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.79077' W 84° 37.11134'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 4.0' water depth	Start: 10-31-02	Finish: 10-31-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					4.0' river depth	Depth PID BG 0.0 4'-6' 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0 16'-18' 0.0
717.5						
716.5						
715.5						
714.5	4 to 6	1 3" SS	2	push	4.0'-4.6' Magnesium oxide 4.6'-5.5' Silty soft sediments w/petroleum contamination, black, strong odor	
713.5					5.5'-9.0' Silty soft sediments w/organics, brown, slight petroleum odor	
712.5	6 to 8	2 3" SS	0.8	push		
711.5						
710.5	8 to 10	3 3" SS	1.5	push		
709.5					9.0'-10.0' Silty soft sediments w/trace organics, greenish gray, somewhat more firm	
708.5	10 to 12	4 3" SS	0.9	push	10.0'-13.0' Silty sediments w/trace organics, greenish gray, firm	
707.5						
706.5	12 to 14	5 2" SS	1.3	push		
705.5					13.0'-15.0' Silty sand (SM), brown, medium dense	
704.5	14 to 16	6 2" SS	1.3	13-14-18-17 (32)	15.0'-15.6' Silty sand w/gravel (SM), grayish brown, medium dense	
703.5					15.6'-16.0' Sand, fine to med (SP), gray, medium dense	
702.5	16 to 18	7 2" SS	0.7	15-17-21-28 (38)	16.0'-16.2' Sandy gravel (GP), gray 16.2'-18.0' Silty sand w/gravel (SM), grayish brown, dense	
701.5						
700.5					End of boring at 18.0 feet below river surface	
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-46	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.79905' W 84° 37.14623'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 5.0' water depth	Start: 10-31-02	Finish: 10-31-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5					5.0' river depth	Depth PID BG 0.0 5'-7' 0.0 7'-9' 0.0 9'-11' 0.0 11'-13' 0.0 13'-15' 0.0 15'-17' 0.0
713.5 712.5	5 to 7	1 3" SS	0.8	push	5.0'-7.0' Soft silty sediments w/petroleum contamination, brown w/some black staining, petroleum odor	
711.5 710.5	7 to 9	2 3" SS	1.4	push	7.0'-8.0' Silty soft sediments w/organics & petroleum contamination, black, odor 8.0'-9.0' Silty sand (SP), greenish gray, loose	
709.5 708.5	9 to 11	3 3" SS	1.2	push	9.0'-11.0' Sand, fine to med (SP), greenish gray, loose	
707.5 706.5	11 to 13	4 3" SS	2.0	push	11.0'-14.0' Sand, fine to med (SP), greenish gray, medium dense	
705.5 704.5	13 to 15	5 2" SS	1.2	push	14.0'-16.0' Sandy gravel (GP), brown	
703.5 702.5	15 to 17	6 2" SS	1.0	15-14-28-86 (42)	16.0'-17.0' Silty sand w/gravel (SM), grayish brown, dense	
701.5 700.5 699.5					End of boring at 17.0 feet below river surface	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-47	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.81226' W 84° 37.12284'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 6.0' water depth	Start: 10-31-02	Finish: 10-31-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5 713.5					6.0' river depth	Depth PID BG 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0 16'-18' 0.0
712.5 711.5	6 to 8	1 3" SS	1.8	push	6.0'-6.4' Silty soft sediments w/organics & magnesium oxide, brown 6.4'-7.7' Silty soft sediments w/organics & petroleum contamination, black, strong odor	
710.5 709.5	8 to 10	2 3" SS	1	push	7.7'-8.2' Wood fibers (1/4"-1/2") 8.2'-8.4' Peat layer (PT), well preserved leaves 8.4'-10.0' Sandy silt w/wood chips (ML), brown, soft	
708.5 707.5	10 to 12	3 3" SS	0.7	push	10.0'-12.0' Silt w/organics (ML), grayish brown, soft	
706.5 705.5	12 to 14	4 3" SS	0.5	push	12.0'-14.0' Sand, med (SP), gray w/trace green, medium dense	
704.5 703.5	14 to 16	5 2" SS	0.1	42-64-90-81 (154)	14.0'-17.0' Sand w/gravel, dense (SP) Poor recovery in 14'-16' split spoon - probably pushed a chunk of gravel	
702.5 701.5	16 to 18	6 2" SS	0.5	37-45-105/6" (150)	17.0'-18.0' Silty sand w/gravel (SM), grayish brown, dense	
700.5 699.5					End of boring at 18.0 feet below river surface	

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-48	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8193_'N, 84 degrees 37.1359_'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M/SPT	
Water Levels:	Start: 11/1/02 1130 / Finish: 11/1/02 1230

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 16' 0.5 17' 0.8 to 1.8 19' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	2	Push	Organic Silt (OL) -Green, very soft, wet becomes black with petroleum and trace of Magnesium Oxide at 7', leaves	sediment Heavy Sheen
711.5						
710.5	8 to 10	DM-2	1	Push		
709.5						
708.5	10 to 12	DM-3	2	Push		Heavy Sheen
707.5						
706.5	12 to 14	DM-4	2	Push	Silty Sand (SM) - Dark Gray, fine, loose, wet	
705.5						Driller reports firmer push at 14'
704.5	14 to 16	DM-5	2	Push		Slight Sheen
703.5					Sand with Silt (SW-SM) - Light Gray, fine to coarse, with fine to coarse gravel up to 2-1/2"	
702.5	16 to 18	DM-6	2	11-10-14-27	17' - Grades to Sand (SP) - Light gray, fine to medium, medium dense, wet	Slight Sheen
701.5						
700.5	18 to 20	S-1	2	23-48-59-57	Clayey Sand (SC) - Light gray, fine/coarse, with fine gravel, very dense, moist (Till)	Slight Sheen

Boring Terminated at 20' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-49	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8290_'N, 84 degrees 37.0758_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/1/02 1250	Finish: 11/1/02 1350

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 13' 5 14' 2
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	2	Push	0-6" Magnesium Oxide	sediment
711.5					Organic Silt (OL) - Black, very soft, with magnesium oxide inter-layered	Heavy Sheen Petroleum Odor
710.5	8 to 10	DM-2	1	Push		
709.5					10' - No Magnesium Oxide, Petroleum decreases; becomes dark gray	Medium Sheen
708.5	10 to 12	DM-3	1	Push	11' - becomes sandy	
707.5					12' - driller reports firmer	
706.5	12 to 14	DM-4	2	11-10-14-21	Well Graded Gravel (GW) - Dark gray with brown/tan mottling, with well graded sand, gravel up to 2"	Slight Sheen
705.5					Silty Sand (SM) - Light (purplish) gray, very fine to fine, dense, moist, laminated	Slight Sheen

Boring Terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-50	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8392_'N, 84 degrees 37.0292_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/1/02 1415	Finish: 11/1/02 1515

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 10' 0 14' 1 15.5' 0 16' 0
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	0	Push	Intermixed Organic Silt and Magnesium Oxide Green and white	sediment Medium Sheen
711.5						
710.5	8 to 10	DM-2	1.7	Push	Sand (SP) - Green, very fine, wet, loose with fine roots, wood	No Sheen
709.5						
708.5	10 to 12	DM-3	2	Push	11' - becomes tan with gray mottling, finer	
707.5						
706.5	12 to 14	DM-4	2	Push	13' - coarse wood, sand becomes very fine In DM-4 shoe: Fine Sand (Light Gray)	
705.5						
704.5	14 to 16	DM-5	2	Push	Well Graded Sand with Gravel (SW) - Tan	Slight Sheen
703.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, occasional fine gravel, loose at top, becomes dense, moist (TILL)	Slight Sheen 15' - driller reports gravelly drilling
702.5	16 to 18	S-1	2	9-14-18-26		
701.5						

Boring Terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-51	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8662_'N, 84 degrees 37.0114_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M/SPT		
Water Levels:	Start: 11/1/02 1530	Finish: 11/1/02 1620

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 13' 0 14' 12 15' 15 17' 25
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	0.8	Push	Organic Silt (OL) - Dark Gray-black, very soft wet, with trace of Magnesium Oxide	Sediment Heavy Sheen Petroleum Odor
712.5						
711.5	7 to 9	DM-2	2	Push	8' - Becomes medium-gray 9' - Peat	Petroleum and Sheen decrease
710.5						
709.5	9 to 11	DM-3	2	Push	10-1/2' - Grades into Silt (ML)-Dark Gray, moist, with roots	
708.5						
707.5	11 to 13	DM-4	2	Push	12' - Becomes greenish brown	
706.5					Fine Sand (SP) - Greenish gray, loose, moist	
705.5	13 to 15	S-1	1.5	9-11-14-20	Well Graded Sand (SW) -Tan, with gravel up to 1"	Slight Sheen
704.5					Clayey Sand (SC) - Light brown, fine/coarse, dense, moist, occasional gravel up to 1" (Till)	Slight Sheen
703.5	15 to 17	S-2	1.5	12-22-24-34	14.5' - 3" gray very fine sand seam 15' - becomes purplish-gray	Slight Sheen
702.5						Slight Sheen

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-52	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7935_'N, 84 degrees 37.0735_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA, 140# hammer, D&M		
Water Levels:	Start: 11/2/02 0920	Finish: 11/2/02 955

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 9' 5 11' 2 12' 1
717.5						
716.5						
715.5						water
714.5	4 to 6				Too loose to sample	sediment
713.5						
712.5	6 to 8	DM-1	0.3	Push	Magnesium Oxide	Medium Sheen
711.5						
710.5	8 to 10	DM-2	2	Push	Mixed with organic silt at 9'	Medium Sheen
709.5					Organic Silt (OL) - Black, very soft, wet, with wood, 10-10.5' brown	Slight Sheen
708.5	10 to 12	DM-3	2	Push	10.5' - Grades to Silty Sand (SM) -Greenish gray, very fine, loose, moist	
707.5					11' - becomes tan mottled gray; sand is fine with occasional 1" roots	Slight Sheen
706.5	12 to 14	DM-4	2	4-12-22-30	12-13' - finer sand	
705.5					Clayey Sand (SC) - Purplish gray, fine/coarse, occasional fine gravel, moist (Till)	Top 3" are light brown brown mottling, No Sheen

Boring Terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-53	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8008_'N, 84 degrees 37.0492_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA, 140# hammer, D&M		
Water Levels:	Start: 11/2/02 1030	Finish: 11/2/02 1100

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 7' 0 11' 0 12' 0
717.5						
716.5						
715.5						water
714.5	4 to 6	DM-1	0.5	Push	Organic Silt (OL) -Black, very soft, mixed with Magnesium Oxide	sediment Slight Sheen
713.5						
712.5	6 to 8	DM-2	2	Push		
711.5					Sand with Silt (SP-SM) - Medium Brown, fine, loose, wet	Slight Sheen
710.5	8 to 10	DM-3	0.5	P-13-10-22	8' - Grades to Silty Sand, very fine/silt (SM/ML) with black mottling	Slight Sheen
709.5					Fine Sand (SP) - Light brown, trace silt, in DM-3 shoe. Suspect loose fine sand at 9' that fell out	Slight Sheen
708.5	10 to 12	S-1		10-17-33-40	Fine Sand (SP) -Light to dark brown, trace silt	Slight Sheen
707.5					Clayey Sand (SC) -Purplish-gray, fine/coarse, dense to very dense, moist	

Boring Terminated at 12' below river surface

CH2MHILL

Proj. No.: 160558.CV.02 Boring No.: CBR-54 Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8097_'N, 84 degrees 37.0240_'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger: TVW
Drilling Method & Equipment: Diedrich D-50 Track-mounted rig on barge; 4-1/4" ID HSA w/3" split spoon, 140# hammer, D&M	
Water Levels:	Start: 11/2/02 1150 / Finish: 11/2/02 None

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 3'	Depth PID 5' 6 6' 0 8' 0 11' 0 12'- 13' 0 water
717.5						
716.5						
715.5	3 to 5	DM-1	0.5	P-22-2-1	Fine Sand with Silt (SP-SM) - Dark Brown with black, staining, loose, wet, trace of Magnesium Oxide	sediment Heavy Sheen
714.5					Silty Sand (SM) - Medium Brown, very fine, occasional coarse sand, native roots	
713.5	5 to 7	DM-2	1	13-4-4-3		Slight Sheen
712.5						Suspect Obstacle 7-8'
711.5	7 to 9	DM-3	1	15-22-5-4		Slight Sheen
710.5					Fine Sand (SP) - Medium Brown, loose, wet, trace of silt	
709.5	9 to 11	DM-4	1.5	Push		Slight Sheen
708.5						Slight Sheen
707.5	11 to 13	DM-5	2	10-22-42-82		Slight Sheen
706.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, n moist, very dense (Till)	

Boring Terminated at 13' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-55	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8200_'N, 84 degrees 36.0254_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/2/02 1310	Finish: 11/2/02 1350

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 11' 16 15' 16
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	0.5	Push	Silt (ML) - Dark gray, very soft, wet, with Magnesium Oxide	sediment
711.5						
710.5	8 to 10	DM-2	1.3	Push	8'-9' - Magnesium Oxide	Heavy Sheen
709.5					Organic Silt (OL) - Black, leaves, roots, very soft, wet, stems, fibers	
708.5	10 to 12	DM-3	2	Push		
707.5					12' - becomes dark-gray, less petroleum	Medium Sheen
706.5	12 to 14	DM-4	2	Push		
705.5						
704.5	14 to 16	DM-5	2	1-22-24-27	Well Graded Sand and Gravel (SW/GW) - Dark gray/brown, gravel up to 2-1/2"	Medium Sheen
703.5					Clayey Sand (SC) - Purplish-gray, fine/coarse dense to very dense, moist (Till)	Slight Sheen

Boring Terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-56	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8293_'N, 84 degrees 36.9945_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/5/02 1415	Finish: 11/5/02 1500

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 14' 39 15' 69 16' 100
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	0.4	Push	Silt (ML) - Dark Gray (minor black), very soft, wet	sediment Medium Sheen
712.5						
711.5	7 to 9	DM-2	2	Push	Magnesium Oxide	
710.5						
709.5	9 to 11	DM-3	2	Push		
708.5						
707.5	11 to 13	DM-4	2	Push	bottom 2" of Magnesium Oxide is green	
706.5					Organic Silt (OL) - Black, very soft, wet, leafs, twigs, fibers	Petroleum odor Heavy Sheen
705.5	13 to 15	DM-5	2	Push		
704.5					Well Graded Sand (SW) - Dark Brown/Black, with fine sand and wood in top 0.9" occasional snail shells, with gravel up to 2"	
703.5	15 to 17	DM-6	2	P-10-32-61		Medium Sheen
702.5					Clayey Sand (SC) - Purplish-gray, with fine gravel, sand is fine/coarse	

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-57	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24._8334_'N, 84 degrees 36.0116_'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering / Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA w/3" split spoon, 140# hammer, D&M	
Water Levels:	Start: 11/2/02 1520 / Finish: 11/2/02 None

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 13' 9 15' 6 16' 7 16.5' 9 17' 10 18' 6
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	0.2	Push	Silt (ML) - Greenish-gray, very soft, loose	sediment Slight Sheen
711.5						
710.5	8 to 10	DM-2	1.2	Push	Becomes black at 9'	Slight Sheen
709.5					Magnesium Oxide	
708.5	10 to 12	DM-3	2	Push		
707.5						
706.5	12 to 14	DM-4	2	Push	Organic Silt (OL) - Dark Gray, very soft, decaying-leaves, laminations of very fine sand	Medium Sheen
705.5						
704.5	14 to 16	DM-5	1.5	Push		Slight Sheen
703.5					Peat (PT) - Dark Brown, fibrous, silty becomes sandy with larger wood at 16'	Slight Sheen
702.5	16 to 18	DM-6	1.8	15-46-45-47	Well Graded Sand and Gravel (GW/SW) - dark brown, gravel up to 2", snail shells	Slight Sheen
701.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, with fine gravel	Slight Sheen

Boring Terminated at 18' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-58	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.6669_'N, 84 degrees 36.1638_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/3/02 955	Finish: 11/3/02 1030

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					Depth to Top of Sediment = 4'	Depth PID 7' 8 12' 23 14' 1 water
714.5 713.5	4 to 6	DM-1	0.3	Push	Silt (ML) - Greenish gray, very soft, wet	sediment Slight Sheen
712.5 711.5	6 to 8	DM-2	1.3	Push	Organic Silt (OL) - Black, very soft, wet, fibers stems, leaves, bark	Heavy Sheen, Petroleum Odor
710.5 709.5	8 to 10	DM-3	2	Push		Heavy Sheen, Petroleum
708.5 707.5	10 to 12	DM-4	2	Push	becomes sandy (fine to medium) at 12'	Heavy Sheen, Petroleum
706.5 705.5	12 to 14	DM-5	2	P-P-26-53	Fine Sand (SP) - Black, dense, wet Clayey Sand (SC) - Brownish-gray, fine/ coarse, with fine gravel, moist, dense	Medium Sheen Slight Sheen

Boring Terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-59	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7031_'N, 84 degrees 36.1823_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA, 140# hammer, D&M		
Water Levels:	Start: 11/3/02 1140	Finish: 11/3/02 1200

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					Depth to Top of Sediment = 4'	Depth PID 5' 0 8' 5 10' 3 12' 6 14' 106 15' 81 16' 11 water sediment
714.5 713.5	4 to 6	DM-1	0.3	Push	Organic Silt (OL) - Greenish-Gray, very soft, wet, fibrous/peaty	Slight Sheen
712.5 711.5	6 to 8	DM-2	1.3	Push	At 7' becomes Black	Heavy Sheen Petroleum
710.5 709.5	8 to 10	DM-3	2	Push	Fine Sand (SP) - Dark Gray, loose, wet, woody, debris, occasional snail shells Becomes brown at 10' Larger roots at 11'	Slight Sheen
708.5 707.5	10 to 12	DM-4	2	Push		No Sheen
706.5 705.5	12 to 14	DM-5	2	Push	At 13-1/2' - Becomes light brown, fine to medium, with dark brown woody layers up to 1/2" 14-1/2' -Grades to Well Graded Sand and Gravel (SW/GW) - Gray brown, medium dense, gravel up to 1/2" wet, dense	Slight Sheen
704.5 703.5	14 to 16	DM-6	2	10-29-64-86	Clayey Sand (SC) - Light purplish gray, fine/coarse with fine gravel, dense, moist (Till)	Slight Sheen Tan mottles in top 2"

Boring Terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-60	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7120_'N, 84 degrees 37.1454_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 Track-mounted rig on barge; 4-1/4" ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/3/02 1215	Finish: 11/3/02 1240

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 3'	Depth PID 3' 13 4' 37 7' 81 8' 87 9' 31 water
717.5						
716.5						
715.5	3 to 5	DM-1	1	Push	Silty Sand (SM) - Greenish Gray, fine/coarse occasional fine gravel, wood chips, moist, medium dense At 4' becomes tan, fine, less silt	Sediment Slight Sheen
714.5						Slight Sheen
713.5	5 to 7	DM-2	2	Push		
712.5					Well Graded Sand with Silt (SW-SM) - yellow-brown, with fine to coarse gravel (up to 1.5") becomes silty (sand is finer) at till contact	Slight Sheen
711.5	7 to 9	DM-3	2	8-14-24-43		Slight Sheen
710.5					Clayey Sand (SC) -Purplish-gray, fine/coarse, with occasional fine gravel, moist, dense (Till)	Slight Sheen

Boring Terminated at 9' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-61	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7653_'N, 84 degrees 37.1072_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 Track-mounted rig on barge; 4-1/4" ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/3/02 1335	Finish: 11/3/02 None

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 3'	Depth PID 8' 1 9' 10 10' 18 12' 2
717.5						
716.5						Water
715.5	3 to 5	DM-1	0.5	Push	Magnesium Oxide and black Organic Silt	Sediment Heavy Sheen Petroleum
714.5						
713.5	5 to 7	DM-2	1.2	Push		
712.5					At 7' - Brown Peat (PT)	
711.5	7 to 9	DM-3	2	11-10-11-12	Silt with Sand (ML) - Greenish Gray/Peat (PT) -Brown, very soft, wet, sand is fine, occasional fine gravel. Peat decreases at 8'	
710.5					Well Graded Gravel and Sand (GW) - Tan, medium dense/loose, wet, cobbles	Slight Sheen
709.5	9 to 11	DM-4	2	33-17-16-24		Slight Sheen
708.5					10' - increase cobbles; less silt	Slight Sheen
707.5	11 to 12.5	DM-5	1.5	44-58-78	Clayey Sand (SC) - light purplish-gray, fine/coarse occasional fine gravel, very dense, moist (Till)	Slight Sheen

Boring terminated at 12.5' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-62	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.7596_'N, 84 degrees 37.1375_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 Track-mounted rig on barge; 4-1/4" ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/3/02 1510	Finish: 11/3/02 1550

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 4'	Depth PID 7' 2 10' 2 12' 6
717.5						
716.5						
715.5						water
714.5	4 to 6	DM-1	0.8	Push	Organic Silt (OL) -Green, very soft, wet Black at 5' trace magnesium oxide Peaty at 6'	sediment Heavy Sheen Petroleum
713.5					At 7' - Petroleum decreases	
712.5	6 to 8	DM-2	1.5	Push	Peat (PT) - Brown, fine gravel, leafy, silty	Slight Sheen
711.5						
710.5	8 to 10	DM-3	2	Push	At 9' - Larger wood Sand (SP) - Dark Gray, very fine, loose, wet	
709.5						
708.5	10 to 12	DM-4	2	Push	10' - Grades to Silty Sand (SM)- Light gray, fine, moist 12' - Greenish Gray with tan mottling	No Sheen No Sheen
707.5						
706.5	12 to 14	DM-5	2	10-20-20-22	1/2" of Fine to Medium Sand at contact Clayey Sand (SC) - Gray, fine/coarse, occasional fine gravel, dense, moist (Till)	No Sheen No Sheen
705.5						

Boring terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-63	Sheet: 1 of 2

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.75559' W 84° 37.14190'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 3"SS w/140# hammer, & triple tube core barrel		
Water Levels: 4.0' water depth	Start: 11-4-02	Finish: 11-4-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					4.0' river depth	Depth PID BG 0.0 4'-6' 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 14 12'-14' 1.2 14'-16' 0.0 16'-21' 0.0
717.5						
716.5						
715.5						
714.5	4 to 6	1 3" SS	0.1	push	4.0'-6.0' Silty soft sediment, brown	
713.5						
712.5	6 to 8	2 3" SS	1.8	push	6.0'-7.0' Silty soft sediment w/organics & petroleum contamination, stained black, mild petroleum odor	
711.5					7.0'-8.0' Silt w/organics (ML), brown, soft	
710.5	8 to 10	3 3" SS	1.3	15-14-12-8 (N/A)	8.0'-11.2' Sand fine to med (SP), gray w/some brown bands, medium dense	
709.5						
708.5	10 to 12	4 3" SS	0.9	3-3-7-7 (N/A)	11.2'-13.0' Sand w/gravel, med (SP), grayish brown, medium dense, mild odor	
707.5						
706.5	12 to 14	5 3" SS	1.6	12-11-17-42 (N/A)	13.0'-14.0' Sandy silt w/gravel (ML), grayish brown, firm, slight odor	
705.5						
704.5	14 to 16	6 3T core barrel	0.4	N/A	14.0'-16.5' Silty clay w/sand, gravel, & cobbles (CL-ML), grayish brown, moist, hard	Note: the triple tube barrel sampler would not retain sand during advancement. This contributed to the poor recovery. This drilling method was not used after this boring.
703.5						
702.5					16.5'-18.0' Sandy silt w/gravel (ML), gray, hard	
701.5	16 to 21	7 3T core barrel	2.6	N/A		
700.5					18.0'-20.5' Gravel w/silt (GP), gray	
699.5						

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Proj. No.: 160558.CV.02	Boring No.: CBR-63	Sheet: 2 of 2

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.75559' W 84° 37.14190'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 3"SS w/140# hammer, & triple tube core barrel		
Water Levels: 4.0' water depth	Start: 11-4-02	Finish: 11-4-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
698.5					20.5'-21.0' Clayey silt w/sand & gravel (CL-ML), gray, firm	Depth PID 21'-26' 0.0 26'-29' 0.0
697.5 696.5 695.5 694.5 693.5	21 to 26	8 3T core barrel	1.3	N/A	21.0'-29.0' Sandy silt w/gravel (ML), gray, hard, with some gravel layers. Significant amounts of sand are washed up through the augers in the circulation water, so there are likely sand seams in this interval that are not noted in the samples.	
692.5 691.5 690.5	26 to 29	9 3T core barrel	0.8	N/A		
689.5 688.5 687.5 686.5 685.5 684.5 683.5 682.5 681.5 680.5 679.5					End of boring at 29.0' below river surface	

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Proj. No.: 160558.CV.02	Boring No.: CBR-64	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.88571' W 84° 36.97577'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/2" & 3" split spoon, 140# hammer		
Water Levels: 4.0' water depth	Start: 11-4-02	Finish: 11-4-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5						Depth PID BG 0.0 4'-6' 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0
717.5						
716.5						
715.5						
714.5	4' to 6'	1 3" SS	0.6	push	4.0'-7.0' Silty soft sediments w/organics & wood pieces, grayish brown, slight petroleum odor	
713.5						
712.5	6' to 8'	2 3" SS	2.0	push	7.0'-7.4' Peat layer 7.4'-8.8' Silty soft sediments, grayish brown	
711.5						
710.5	8' to 10'	3 3" SS	2.0	push	8.8'-10.0' Silty sand, fine (SM), greenish gray, loose	
709.5						
708.5	10' to 12'	4 3" SS	2.0	push	10.0'-11.0' Silt (ML), greenish gray, very soft 11.0'-13.2' Silt w/gravel (ML), greenish gray soft	
707.5						
706.5	12' to 14'	5 3" SS	2.0	push for 1.5' 46/6"	13.2'-14.5' Sandy silt w/gravel (ML), gray & brown mottle, hard	
705.5						
704.5	14' to 16'	6 2" SS	1.6	15-27-36-51 (63)	14.5'-16.0' Silty sand, fine, w/gravel (SM), gray, brittle, very dense	
703.5						
702.5					End of boring at 16.0' below river surface	
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-65	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.87781' W 84° 36.99770'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 140# hammer		
Water Levels: 4.0' water depth	Start: 11-5-02	Finish: 11-5-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5						Depth PID BG 0.0 4'-6' 0.0 6'-8' 0.0 8'-10' 0.0 10'-12' 0.0 12'-14' 0.0 14'-16' 0.0
717.5						
716.5						
715.5						
714.5	4' to 6'	1 3" SS	0.8	push	4.0'-5.2' Silty soft sediment, brown 5.2'-5.6' Silty soft sediment w/organics & petroleum contamination, black, petro odor	
713.5					5.6'-6.8' Silty soft sediment w/wood fibers, grayish brown	
712.5	6' to 8'	2 3" SS	1.8	push	6.8'-7.0' Peat 7.0'-9.2' Silt w/organics (ML), gray, very soft	
711.5					9.2'-10.0' Silt w/organics (ML), gray & brown mottle, soft	
710.5	8' to 10'	3 3" SS	2.0	push	10.0'-10.9' Sand w/gravel, med (SP), brown, medium dense	
709.5					10.9'-11.2' Silt w/gravel (ML) grayish brown, soft	
708.5	10' to 12'	4 3" SS	2.0	push for 1.0' 10-23 (N/A)	11.2'-11.4' Sand, med, w/gravel (SP), brown, medium dense 11.4'-11.6' Sand, fine (SP), gray, med dense	
707.5					11.6'-12.4' Sandy gravel (GP), brown, med dns	
706.5	12' to 14'	5 3" SS	1.8	7-13-27-58 (N/A)	12.4'-13.0' Clay silt w/sand & gravel (CL-ML), gray & brown mottle, hard	
705.5					13.0'-14.0' Clayey silt w/sand & gravel (CL-ML), gray, hard	
704.5					End of boring at 14.0' below river surface	
703.5						
702.5						
701.5						
700.5						
699.5						

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Proj. No.: 160558.CV.02	Boring No.: CBR-66	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.87298' W 84° 36.96961'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig; 8"OD HSA w/2" & 3" split spoon, 140# & 300# hammers		
Water Levels: 5.0' water depth	Start: 11-5-02	Finish: 11-5-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5						Depth PID BG 0.0 5'-7' 0.0 7'-9' 0.0 9'-11' 0.0 11'-13' 5.7 13'-15' 4.9 15'-17' 19 17'-18.5' 1.3
717.5						
716.5						
715.5						
714.5						
713.5	5 to 7	1 3" SS	0.5	push	5.0'-7.2' Silty soft sediments, dark brown	
712.5						
711.5	7 to 9	2 3" SS	2.0	push	7.2'-7.7' Silty soft sediments w/organics & petroleum contamination 7.7'-8.4' Silt (ML), stained gray, soft 8.4'-11.3' Silt (ML), greenish gray, soft	
710.5						
709.5	9 to 11	3 3" SS	0.8	push		
708.5					11.3'-13.0' Sand, fine (SP), greenish gray & brown mottle, medium dense	
707.5	11 to 13	4 3" SS	1.0	3-4-4-4 (N/A) (140# hammer)	13.0'-13.7' Silt w/gravel (ML), grayish green & brown mottle, firm 13.7'-13.8' Sandy gravel (GP), possible brown DNAPL staining, odor	
706.5						
705.5	13 to 15	5 3" SS	1.5	push for 0.5' 38-57 (N/A) (140# hammer)	13.8'-14.1' Silty sand w/gravel (SM), gray & brown mottle, dense 14.1'-14.3' Degraded granite-type cobble & silty sand w/gravel (SM)	
704.5						
703.5	15 to 17	6 2" SS	1.3	37-75-90-50/1" (165) (140# hammer)	14.3'-15.3' Silty sand w/gravel (SM), brown, dense, odor 15.3'-17.0' Sand, fine, w/gravel (SP), brown, dense, odor	
702.5						
701.5	17 to 18.5'	7 2" SS	1.3	30-41-52 (N/A) (300# hammer)	17.0'-18.5' Silty sand w/gravel (SM), grayish brown, moist, dense	
700.5					End of boring at 18.5' below river surface	
699.5						

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Proj. No.: 160558.CV.02	Boring No.: CBR-67	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.88080' W 84° 36.93825'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 140# hammer		
Water Levels: 5.0' water depth	Start: 11-5-02	Finish: 11-5-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5						Depth PID BG 0.0 5'-7' 0.0 7'-9' 0.9 9'-11' 0.5 11'-13' 63 13'-15' 35
717.5						
716.5						
715.5						
714.5						
713.5	5 to 7	1 3" SS	0.1	push	5.0'-7.5' Silty soft sediments, dark brown	
712.5						
711.5	7 to 9	2 3" SS	0.6	push	7.5'-10.0' Silty soft sediments w/organics & petroleum contamination, black, petro odor	
710.5						
709.5	9 to 11	3 3" SS	1.8	push	10.0'-10.5' Silt w/organics (ML), stained gray, soft 10.5'-11.7' Silt w/organics (ML), grayish green, soft	
708.5						
707.5	11 to 13	4 3" SS	1.9	push	11.7'-12.2' Sandy silt (ML), greenish gray w/brown bands, soft 12.2'-13.6' Silty sand, fine (SM), greenish gray, loose, odor	
706.5						
705.5	13 to 14.5	5 3" SS	1.5	push for 0.5' 34-82 (N/A)	13.6'-13.9' Sand w/gravel (SP), brown, dense 13.9'-14.5' Silty sand w/gravel (SM), brown, dense (impacted till), "Area 3" odor	
704.5					End of boring at 14.5' below river surface	
703.5						
702.5						
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-68	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River N 43° 24.89160' W 84° 36.91028'	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: R. Stryker
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 8"OD HSA w/3" split spoon, 140# hammer		
Water Levels: 5.0' water depth	Start: 11-5-02	Finish: 11-5-02

Elevation	Sample: Interval (ft bgs)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5						Depth PID BG 0.0 5'-7' no sample 7'-9' 0.5 9'-11' 2.9 11'-13' 0.9 13'-15' 4.9 15'-16.5' 10.1
717.5						
716.5						
715.5						
714.5						
713.5	5 to 7	1 3" SS	0.0	push	5.0'-7.3' Silty soft sediments, brown	
712.5						
711.5	7 to 9	2 3" SS	1.5	push	7.3'-10.2' Silty soft sediments w/organics & petroleum contamination, black, petro odor	
710.5						
709.5	9 to 11	3 3" SS	1.3	push	10.2'-10.4' Peat w/wood chunks 10.4'-11.0' Silt w/organics (ML), greenish gray, soft	
708.5						
707.5	11 to 13	4 3" SS	1.3	push	11.0'-13.0' Silt (ML), greenish gray, soft to firm	
706.5						
705.5	13 to 15	5 3" SS	1.4	push	13.0'-15.6' Silt (ML), greenish gray, soft to firm, slight odor	
704.5						
703.5	15 to 16.5	6 3" SS	1.5	30-120-145 (N/A)	15.6'-16.5' Silty sand w/gravel (SM), brown, dense (degraded till)	
702.5					End of boring at 16.5' below river surface	
701.5						
700.5						
699.5						

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-69	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8627_'N, 84 degrees 36.9576_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/5/02 1540	Finish: 11/5/02 1630

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 9' 3 11' 0 13' 2 14' 5 15' 9 17' 6
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	0.2	Push	Organic Silt (OL) - Green/black, very soft, wet peaty, trace Magnesium Oxide	sediment Slight Sheen
712.5						
711.5	7 to 9	DM-2	2	Push	Magnesium Oxide Organic Silt (OL) - Brown/Black, shells, peaty 2" peat (PT) at contact	Slight Sheen
710.5					Silty Sand (SM) - Greenish gray, very fine, roots, loose, wet	Slight Sheen
709.5	9 to 11	DM-3	2	Push		Slight Sheen
708.5						
707.5	11 to 13	DM-4	2	Push	At 13' grades into Fine Sand (SP-SM) - Gray with tan mottling, loose, wet, with silt	Slight Sheen
706.5						No Sheen
705.5	13 to 15	DM-5	1.7	P-P-P-27		Slight Sheen gravel from shoe Slight Sheen
704.5					Well Graded Sand (SW) - Tan, with fine gravel medium dense to dense, wet	
703.5	15 to 17	S-1	2	9-21-38-39		Slight Sheen
702.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, moist, very dense (Till)	Slight Sheen Slight Sheen

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02 Boring No.: CBR-70 Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site
Location: Pine River 43 degrees 24.8506_'N, 84 degrees 36.9547_'W
Elevation: ~719.5
Drilling Contractor: Coleman Engineering
Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"OD HSA, 140# hammer, D&M
Water Levels:
Start: 11/6/02 820
Finish: 11/6/02 920

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 6' 4 9' 1 11' 0 13' 1 15' 0 16' 14 16.5' 13 17' 99
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	1.2	Push	Magnesium Oxide Organic Silt (OL) - Dark brown/black staining very soft, wet, peaty	Petroleum sediment High sheen, petroleum appears most concentrated at contact-with Magnesium Oxide
712.5						
711.5	7 to 9	DM-2	2	Push	Silty Sand (SM) - Green, very fine, wood, wet loose	Slight Sheen
710.5						Slight Sheen
709.5	9 to 11	DM-3	2	Push		
708.5						
707.5	11 to 13	DM-4	2	Push	Grades to gray at 12' and brown at 13'	Slight Sheen
706.5						
705.5	13 to 15	DM-5	2	Push		
704.5					Mottled Gray/Tan at 15', denser	Slight Sheen
703.5	15 to 17	DM-6	2	P-P-P-55	Becomes Fine to Medium at 15.5'-15.8' Silty Fine Sand at 15.8'-16' - Gray	Slight Sheen Slight Sheen
702.5					Well Graded Sand and Gravel (SW/GW)-Gray loose to medium dense, wet, gravel up to 2" Clayey Sand (SC) -Gray, fine/coarse, with fine gravel, wet, very dense (Till) - in shoe of DM-6	16'-16.5' Slight Sheen 161/2-17' Heavy Sheen, NAPL Heavy Sheen, NAPL

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02 Boring No.: CBR-71 Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8553_'N, 84 degrees 36.9176_'W
Elevation: ~719.5	Drilling Contractor: Coleman Engineering; Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M	
Water Levels:	Start: 11/6/02 940; Finish: 11/6/02 1020

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 5' 9 7' 6 8' 8 11' 6 13' 9 14' 199 14.5' 66 15' 16
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	1	Push	Magnesium Oxide and Organic Silt	Sediment Slight Sheen Petroleum?
712.5					2" Peat (PT)-Brown, silty at 7'	No sheen
711.5	7 to 9	DM-2	2	Push	Silty Sand (SM) - Green, very fine, loose, wet, occasional black, occasional roots	No Sheen
710.5						
709.5	9 to 11	DM-3	2	Push		No Sheen
708.5						
707.5	11 to 13	DM-4	2	Push	Becomes olive-brown at 12' At 13' - Grades to Fine sand with silt (SP-SM) Tan/green, mottled. Occasional gravel up to 1-1/2"	Slight Sheen
706.5						
705.5	13 to 15	DM-5	2	P-P-22-52	13'-14', Decrease Silt, becomes fine to medium	Slight Sheen
					Well Graded Sand and Gravel (SW/GW)- wet, loose	Slight Sheen, slight odor
704.5					Clayey Sand (SC) - Purplish-gray, fine/coarse, very dense, moist (Till)	Slight Sheen

Boring Terminated at 15' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-72	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8679_'N, 84 degrees 36.9328_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/6/02 1045	Finish: 11/6/02 None

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5					Depth to Top of Sediment = 5'	Depth PID 8' 13 11' 13 12' 25 15' 53 15.5' 150 16' 42 16.5' 27 17' 7 water
713.5 712.5	5 to 7	DM-1	0.8	Push	Magnesium Oxide	sediment
711.5 710.5	7 to 9	DM-2	1.7	Push	Organic Silt (OL) - Dark brown/black very soft, wet, becomes sandy (fine) and peaty at 8'	Medium Sheen, Mild Petroleum odor Slight Sheen
709.5 708.5	9 to 11	DM-3	2	Push	Silty Sand (SM) - Green, loose, wet, roots, very fine, at 11' becomes brown	Slight Sheen
707.5 706.5	11 to 13	DM-4	2	Push	At 12' - Grades to Fine Sand (SP) brown/Tan mottling	Slight Sheen
705.5 704.5	13 to 15	DM-5	2	Push	At 15' - Becomes dark gray, finer, with wood, then grades coarser to 15-1/2'	Slight Sheen Slight Sheen No Sheen
703.5 702.5	15 to 17	DM-6	2	8-16-32-55	Well Graded Sand (SW) - Gray, with occasional gravel up to 1-1/2", wet, medium dense Clayey Sand (SC) - Purplish-gray, fine/coarse, dense (Till)	Slight Sheen Slight Sheen Slight Sheen

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-73	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: from Plant Outfall: 120 degrees 'N, 160 degrees 'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/6/02 1150	Finish: 11/6/02 1240

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 5'	Depth PID 8' 14 9' 8 11' 7 12' 53 15' 57 16' 12 17' 19
717.5						
716.5						
715.5						
714.5						water
713.5	5 to 7	DM-1	6.8	Push	Magnesium Oxide	sediment
712.5					Black organic silt with Petroleum, wet	Heavy Sheen mixed in at base of Mag Oxide
711.5	7 to 9	DM-2	2	Push	Silty Sand (SM) - Dark brown, very fine, roots loose, wet, becomes light brown at 8-1/2'	Slight Sheen
710.5						
709.5	9 to 11	DM-3	2	Push	At 10' becomes green At 11' grades to Silt (ML) - Green, very soft	No Sheen
708.5						
707.5	11 to 13	DM-4	2	Push	Fine Sand (SP) - Tan/Gray, loose, wet	Slight Sheen
706.5						
705.5	13 to 15	DM-5	2	21-15-29-106	At 15' - Less tan mottling, more gray	Slight Sheen Slight Sheen
704.5					4" Well Graded Sand(SW)-Tan, with gravel up to 1-1/2" at Till contact	
703.5	15 to 17	DM-6	2	44-49-62-70		Slight Sheen
702.5					Clayey Sand (SC) - Purplish gray, fine/coarse, occasional fine gravel, very dense, moist (Till)	Slight Sheen

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-74	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 30 degrees 24.__'N, 84 degrees 36._'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M		
Water Levels:	Start: 11/6/02 1330	Finish: 11/6/02 1410

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5					Depth to Top of Sediment = 5'	Depth PID 9' 26 11' 19 13' 128 14' 15 15' 36 water
713.5 712.5	5 to 7	DM-1	0.5	Push	Magnesium Oxide mixed with organic silt black, green	Sediment Medium Sheen Petroleum Heavy Sheen
711.5 710.5	7 to 9	DM-2	1.5	Push	Silty Sand (SM) - Green, very fine, loose, wet, with wood	Slight Sheen
709.5 708.5	9 to 11	DM-3	2	Push	At 10' becomes Gray, Fine Fine Sand (SP) - Tan/Gray mottles, loose, wet, occasional wood	Slight Sheen
707.5 706.5	11 to 13	DM-4	2	Push	At 13' - Less Tan mottles, more gray	Slight Sheen Slight Sheen
705.5 704.5	13 to 15	DM-5	2	P-20-33-75	13.8 to 14' -Well Graded Sand (SW) Brown to black and white medium sand with fine gravel Clayey Sand (SC) - Purplish-Gray, fine/coarse very dense, moist (Till) Top 3" Tan	Slight Sheen Slight Sheen

Boring Terminated at 15' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-75	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8528_'N, 84 degrees 36.9930_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA, 140# hammer, D&M/SPT		
Water Levels:	Start: 11/7/02 930	Finish: 11/7/02 1030

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5 714.5					Depth to Top of Sediment = 5'	Depth PID 7' 0 9' 0 11' 0 12' 2 13' 5 16' 0 water
713.5 712.5	5 to 7	DM-1	0.2	Push	Magnesium Oxide Magnesium Oxide mixed with organic silt (OL) black/white	Sediment Heavy Sheen Petroleum No Sheen
711.5 710.5	7 to 9	DM-2	2	Push	Fine Sand (SP) - Brown, loose, wet	
709.5 708.5	9 to 11	DM-3	2	Push	At 11' - becomes Tan/Gray mottled with black spots	Slight Sheen
707.5 706.5	11 to 13	DM-4	2	Push	At 12' becomes fine to medium (20-40), gray (Less Tan)	Slight Sheen
705.5 704.5	13 to 15	DM-5	0.5	21-15-29-106	Well Graded Sand and Gravel (SW/GW) Tan, medium dense, angular, wet	Slight Sheen DM-5 blocked by cobble
703.5 702.5	15 to 17	S-1	2	44-49-62-70	Clayey Sand (SC) - Purplish gray, fine/coarse, very dense, moist (Till)	Slight Sheen

Boring Terminated at 17' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-76	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8727_'N, 84 degrees 37.0050_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/7/02 1100	Finish: 11/7/02 1130

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5 717.5 716.5 715.5					Depth to Top of Sediment = 4'	Depth PID 7.5' 1 8.5' 0 10' 6 13' 22 14' 2 water
714.5 713.5	4 to 6	DM-1	0.1	Push	Organic Silt (OL) - Dark Gray, very soft	sediment Decay odor, Slight Sheen
712.5 711.5	6 to 8	DM-2	1.5	Push	Peaty (wood up to 2") at contact Silty Sand (SM) - Dark Gray, very fine to fine	Slight Sheen
710.5 709.5	8 to 10	DM-3	2	Push	wood (cored branch At 9-1/2') becomes light gray, fine at contact	Slight Sheen
708.5 707.5	10 to 12	DM-4	1.5	7-5-9-8	Well Graded Sand (SW) - Tan, with fine to coarse gravel (RD), loose, wet Gravel decreases, occasional Wood	Slight Sheen Slight Sheen
706.5 705.5	12 to 14	DM-5	2	7-9-17-27	Clayey Sand (SC) - Gray (Top 3" Tan) fine to coarse, medium density, moist (Till)	Slight Sheen

Boring terminated at 14' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-77	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24._8708_'N, 84 degrees 36.8919_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/7/02 1155	Finish: 11/7/02 1230

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 9' 1 11' 1 12' 2 13.5' 3 14.5' 5 15.8' 6 16' 5
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	1	Push	Organic Silt (OL) - Dark gray, very soft, wet	sediment No Sheen
711.5						
710.5	8 to 10	DM-2	1	Push	At 9' - Intermixed with black ooze	Petroleum, medium sheen
709.5						
708.5	10 to 12	DM-3	2	Push	Silty Sand (SM) - Greenish Gray, very fine, loose, wet	Slight Sheen
707.5						
706.5	12 to 14	DM-4	1.5	Push	Silt (ML) - Greenish Gray with Tan mottling, fine roots, soft, moist (former top soil?)	No Sheen
705.5					Sand (SP) - Gray with Tan mottling, very fine to fine, loose, moist to wet	Slight Sheen
704.5	14 to 16	DM-5	2	P-P-19-82	At 14.5' - becomes purplish-gray, interlayered with dark gray silt to 15.3'	Slight Sheen
703.5					15-1/2' to 15.8 -Well graded sand (SW) - gray, with fine gravel (ang.), medium dense, wet	Slight Sheen
					15.8 - 16' - Clayey sand (SC) - Purplish-gray, fine/coarse, with occasional fine gravel, dense, moist (Till)	Slight Sheen

Boring Terminated at 16' below river surface

CH2MHILL

Proj. No.: 160558.CV.02	Boring No.: CBR-78	Sheet: 1 of 1

SOIL BORING LOG

Project: Velsicol Chemical Site	Location: Pine River 43 degrees 24.8821_'N, 84 degrees 36.8938_'W	
Elevation: ~719.5	Drilling Contractor: Coleman Engineering	Logger: TVW
Drilling Method & Equipment: Diedrich D-50 bombardier-mounted rig on barge; 4-1/4"ID HSA w/3" split spoon, 140# hammer, D&M		
Water Levels:	Start: 11/7/02 1250	Finish: 11/7/02 1330

Elevation	Sample: Interval (FBRS)	Sample: Number and Type	Sample: Recovery (feet)	Standard Penetration Test Results 6"-6"-6"-6" (N)	Soil Description: Soil name, USCS group symbol, color, moisture content, relative density or consistency, soil structure, mineralogy	Comments: Depth of casing, drilling rate, drilling fluid loss, tests and instrumentation
718.5					Depth to Top of Sediment = 6'	Depth PID 7' 8 9' 4 10' 2 12' 15 14' 50 15' 63 17' 3
717.5						
716.5						
715.5						
714.5						
713.5						water
712.5	6 to 8	DM-1	0.3	Push	Organic Silt (OL) - Black, very soft, wet	sediment Petroleum odor Heavy Sheen
711.5						
710.5	8 to 10	DM-2	2	Push		
709.5					Peat (PT) - Dark brown, silty	
708.5	10 to 12	DM-3	2	Push	Silty Sand (SM) - Green, very fine to fine, Dark Green silt on top)	Slight Sheen
707.5						
706.5	12 to 14	DM-4	2	Push	Sand (SP) - Greenish-gray to gray with tan mottling, fine, loose moist	Slight Sheen
705.5					becomes gray with dark tan mottling	Slight Sheen
704.5	14 to 16	DM-5	2	12-37-72-86	14.8' -Well Graded Sand (SW) -tan/gray, with Fine gravel, Medium density, wet	Slight Sheen
703.5					Sandy Clay (SC) - Purplish-Gray, Fine/coarse, with fine gravel, very dense, moist (Till)Top 2" tan	

Boring Terminated at 16' below river surface

Appendix A
Final Plans

See Appendix A of the *Final Basis of Design Report - Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient vertical Barrier Wall, St. Louis, Michigan* (CH2M, 2023)

Appendix B
Soil Boring Logs

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5	SPT1	15,42,20,26	0-1.0 Pulverized Concrete 1-1.5 (CL) Sandy Clay, Brown, gravel, some silt, dry, hard, more sand at bottom 1.5-2.0 No Recovery	NA	NA	NA	No Sample
	2.5-4.5	1.5	SPT 2	13,9,9,8	2.5-4.5 (CL) Sandy Clay, Brown, gravel, some silt, dry, hard, more sand at bottom	NA	NA	NA	NA
5	5-7	1	SPT3	7,5,3,2	5.0-6.0 No Recovery 6.0-7.0 (CL) Sandy Clay, gray, trace gravel, wet, damp, medium stiff, low plastic	NA	NA	NA	(5-7) Sample @ 0955
	7.5-9.5	0.5	SPT 4	WOR,WOR,1,2	7.5-9.0 No Recovery 9.0-9.5 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(7.5-9.5) Sample @ 1015
10	10-12	0.5	SPT5	WOR,WOR,1 for 1'	10.0-11.5 No Recovery 11.5-12.0 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(10-12) Sample @ 1025
	12.5-14.5	0.5	SPT6	WOR x 4	12.5-14.0 No Recovery 14.0-14.5 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(12.5-14.5) Sample @ 1045
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	0.2	SPT 7	WOR x 4	15.0-16.8 No Recovery 16.8-17.0 (CL) Sandy Clay, gray, some gravel, wet, soft, medium plastic	NA	NA	NA	(15-17) Sample @ 1130
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	1.5'	ST 1	NA	20-23 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	NA	1kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1300
	23-25	1.5	SPT8	12,12,26,27	23.0-23.5 No Recovery 23.5-25 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25 kg/cm2	NA	(23-25) Sample @ 1315
25	25-28	-	ST2	NA	25-28 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25 kg/cm2	Shelby Tube 25-28	(25-28) Sample @ 1513
	28-30	1.5	SPT 9	38,45,50/0.4	28.0-28.5 No Recovery 28.5-30.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, small wet gravel layer top 0.2', till	NA	NA	NA	(28-30) Sample @ 1530
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD001	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/6/22 @ 0930

ELEVATION (ft amsl): 729.67 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	-	ST 3	NA	30-33 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25+ kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1615 (Laboratory Sample # ST (A, B, C))
	33-35	1.8	SPT10	37,40,41,50/0.4	33.0-33.2 No Recovery 33.2-35.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, sand seam bottom 0.2', till	NA	NA	NA	(33-35) Sample @ 1650
35	35-38	-	ST 4	NA	35-38 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	4.5+ TSF	2.25+ kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1720
	38-40	1	SPT 11	43,50/0.4	38.0-39.0 No Recovery 39.0-40.0 (CL) Clay, gray, some silt, trace gravel, non plastic, very stiff to hard, till	NA	NA	NA	(38-40) Sample @ 1730 (Laboratory Sample # 15)
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.9	SPT1	5,20,29,21	0-0.2 Topsoil, dry, silty, organics 0.2-1.9 (CL) Clay, brown, dry, some silt and gravel, hard, frangible	NA	NA	NA	(0-2) Sample @ 0949
	2.5-4.5	2	SPT 2	12,15,16,10	2.5-2.7 (ML) Sandy silt, some gravel, loose, dry 2.7-4.5 (CL) Clay, brown-gray, damp, very stiff, non-plastic,trace gravel and silt	NA	NA	NA	(2.5-4.5) Sample @ 0955
5	5-7	1.5	SPT3	6,4,5,4	5.0-5.5 No Recovery 5.5-7.0 (CL) Sandy clay, moist, gray-brown, some gravel and silt, non-plastic, medium stiff, gravel seam top 0.2'	2.0 TSF	NA	NA	(5-7) Sample @ 1050
	7.5-9.5	0.5	SPT 4	2,5,2,2	7.5-9.0 No Recovery 9.0-9.5 (CL) Sandy clay, moist, gray-brown, some gravel and silt, non-plastic, medium stiff, , small gravel layer at top 0.1, gray black with white magnesium oxide on shoe	NA	NA	NA	(7.5-9.5) Sample @ 1100
10	10-12	1	SPT5	1,1,2,2	10.0-11.0 No Recovery 11.0-12.0 (SP) Clayey sand, Dark gray to black, brick chunk at top, hydrocarbon odor, soft, loose, non-plastic, wet, gravel to 0.2'	NA	NA	NA	(10-12) Sample @ 1110
	12.5-14.5	1.5	SPT6	3,3,3,6	12.5-13.0 No Recovery 13.0-14.5 (CL) Clay, brown, some silt, moist, medium stiff, low-medium plastic, trace gravel, black wood 13.1-13.6, gravel at top 0.2'	2.0 TSF	NA	NA	(12.5-14.5) Sample @1115
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.8	SPT 7	4,4,8,12	15.0-15.2 No Recovery 15.2-17.0 (CL) Clay, brown, some silt, medium stiff, low-medium plastic, trace gravel, Sand seam at 16.7, wet, gravel at tip	2.0 TSF	NA	NA	(15-17) Sample at 1125 (Laboratory Sample # 7)
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	Hard drilling start @ 20'
20	20-23	1.9	ST 1	NA	20.0-23.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic	4.5+ TSF	1.13 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1215
	23-25	0.8	SPT8	43, 50/0.4	23.0-24.2 No Recovery 24.2-25.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	NA	NA	(23-25) Sample @ 1225
25	25-28	-	ST 2	NA	25-28 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	NA	NA	Shelby Tube 25-28	Encountered hard object @ 26.4, stopped and pulled tube and lost sample due to tube being damaged
	28-30	0.5	SPT 9	50/0.4	28.0-29.5 No Recovery 29.5-30.0 (CL) Sily clay, gray, damp to dry, hard, non plastic, trace gravel, till	4.5+ TSF	NA	NA	(28-30) Sample @ 1430
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD002	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/7/22 @ 0940

ELEVATION (ft amsl): 727.09 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	3	ST 3	NA	30-33 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	2.0 kg/cm2	Shelby Tube 30-33	Not pushed complete 3', 3' of recovery. Hard drilling @ 33', (30-33)Sample @ 1500
	33-35	2	SPT10	27,43,50, 50/0.4	33.0-35.0 (CL) Silty clay, gray, dry to damp, hard, trace gravel, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1525 (Laboratory Sample # 13)
35	35-38	-	ST 4	NA	35-38 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+TSF	1.0 kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1610
	38-40	2	SPT 11	26,36,48,43	38.0-40.0 (CL) Gray clay, very stiff, moist, some silt, trace gravel, non plastic, till	4.5+ TSF	NA	NA	(38-40) Sample @ 1620
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5	SPT1	9,11,16,23	0-0.3 Topsoil, dry, silt and sand, organics 0.3-1.5 (CL) Brown clay, some silt, sand, trace gravel, hard, frangible, sand seam at 0.9' 1.5-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 0845
	2.5-4.5	2	SPT 2	5,4,10,19	2.5-3.0 (CL) Brown clay, some silt, sand, trace gravel, hard, frangible 3.0-4.5 (CL) Clay, Brown, silty, trace gravel, stiff,moist, non plastic, some magnesium oxide bottom 0.2'	NA	NA	NA	(2.5-4.5) Sample @ 0850
5	5-7	2	SPT3	8,19,15,20	5.0-6.0 (CL) Clay, Brown, silty, trace gravel, stiff,moist, non plastic 6.0-7.0 (CL) Clay, brown-back, moist, some sand and silt, trace gravel, stiff, non plastic, hydrocarbon odor	4.5+ TSF	NA	NA	(5-7) Sample @ 1030, gravel after 7.3
	7.5-9.5	1.5	SPT 4	19,25,22,18	7.5-8.0 No Recovery 8.0-9.5 (SP) Sand, brown, some gravel, coarse - medium, medium dense, wet, slight chemical odor, more gravel at top	NA	NA	NA	(7.5-9.5) Sample @ 1045
10	10-12	2	SPT5	2,1,1,2	10.0-12.0 magnesium oxide, dark gray to white at top, with sand, wet	NA	NA	NA	(10-12) Sample @ 1055
	12.5-14.5	0.5	SPT6	0,1,1,2	12.5-14.0 No Recovery 14.0-14.3 magnesium oxide, white 14.3-14.5 Peat, black, slight odor	NA	NA	NA	(12.5-14.5) Sample @1105
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5	SPT 7	2,3,3,5	15.0-15.5 No Recovery 15.5-15.7 (CL) Black sandy clay, wet, soft, low plastic 15.7-17.0 (CL) Brown Clay, some sand, trace silt and gravel, medium stiff, low plastic, moist, increased silt with depth, decreased sand with depth	NA	NA	NA	(15-17) Sample at 1115 (Laboratory Sample # 7)
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	0.55	ST 1	NA	Bottom of shelby (CL) Gray clay, silty, very stiff, trace gravel, moist, non plastic, till	4.5+ TSF	1.0 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 1150
	23-25	2	SPT8	26,27,36,36	23.0-25.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, till	4.5+ TSF	NA	NA	(23-25) Sample @ 1350
25	25-28	2.5	ST 2	NA	25.0-28.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, till	4.5 TSF	0.25 kg/cm2	Shelby Tube 25-28	(25-28) Sample @ 1350 (Laboratory Sample # ST (A, B, C))
30	28-30	2	SPT 9	7,10,14,19	28.0-30.0 (CL) Silty clay, brown, moist, hard, non plastic, trace gravel, increased silt, stiff, till	4.0 TSF	NA	NA	(28-30) Sample @ 1400

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD003	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/8/22 @ 0840

ELEVATION (ft amsl): 729.47 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.0 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	0	ST 3	NA	No Shelby tube sample recovery - tube destroyed during sample collection attempt.	NA	NA	NA	Shelby Tube 30-33, No recovery, Tube damaged
	33-35	2	SPT10	55,58,62,67	33.0-35.0 (ML) Clayey silt, Gray-brown, hard, slightly moist, trace sand and gravel - till, non plastic	NA	NA	NA	(33-35) Sample @ 0928 (7/9/22) (Laboratory Sample # 12)
35	35-38	0	ST 4	NA	No pitcher barrel/shelby tube sample - sampler damaged and inoperable	NA	NA	NA	Shelby Tube 35-38, No recovery, Tube damaged
	38-40	1.5	SPT 11	30,36,50/0.4	38.0-39.6 (ML) Clayey silt, Gray-brown, hard, slightly moist, trace sand and gravel - till, non plastic 39.6-40.0 (SP) Sand, Fine, gray-brown, wet, medium dense	>4.5 TSF	NA	NA	(38-40) Sample @ 1000
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	2	SPT1	8,15,22,11	0-0.4 Topsoil, dry, silty, organics 0.4-2.0 (CL) Brown-gray clay, hard, frangible, dry, silty, trace gravel, sand seam 0.8-1.0	3.5 TSF	NA	NA	(0-2) Sample @ 1630
	2.5-4.5	2	SPT 2	6,4,7,20	2.5-3.0 (CL) Brown-gray clay, hard, frangible, dry, silty, trace gravel, 3.0-4.5 (CL) Clay, brown-gray, moist to dry, some silt, trace gravel, very stiff-hard, non-plastic	4.5+ TSF	1.0 kg/cm2	NA	(2.5-4.5) Sample @ 1640
5	5-7	1.5	SPT3	11,13,8,6	5.0-5.5 No Recovery 5.5-6.6 (CL) Brown clay, silty, trace gravel, hard, moist, non-plastic 6.6-7.0 (ML) Black silt with fine sand, medium dense - soft, trace gravel, moist, odor, magnesium oxide, mottled	4.5+ TSF	0.25 kg/cm2	NA	(5-7) Sample @ 0800
	7.5-9.5	1	SPT 4	3,4,4,4	7.5-8.5 No Recovery 8.5-8.7 (ML) Black silt with fine sand, medium dense - soft, trace gravel, moist, odor, magnesium oxide, mottled 8.7-9.5 (SP) Light brown sand, medium, medium dense to loose, wet, trace gravel an clay, odor, decreasing clay with depth	NA	NA	NA	(7.5-9.5) Sample @ 0805
10	10-12	1.5	SPT5	8,10,12,8	10.0-11.8 (SP) Coarse sand with gravel, black, wet, medium dense 11.8-12.0 (ML) Light brown silt, stiff, moist, non-plastic,little clay	NA	NA	NA	(10-12) Sample @ 0820
	12.5-14.5	2	SPT6	7,14,20,19	12.5-14.5 (ML) Light brown silt, moist, soft-firm, low plastic, (sand seam 11.3-11.5', wet, medium)	2.0 TSF	0.5 kg/cm2	NA	(12.5-14.5) Sample @0830 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5	SPT 7	11,15,23,27	15.0-15.5 No Recovery 15.5-16.5 (GW) Sandy gravel, coarse sand, wet, interbedded silt (ML) loose-medium dense, trace clay 16.5-17.0 (CL) Light brown clay, silty, trace gravel, moist, very stiff-hard, non plastic, till	4.5+ TSF	0.63 kg/cm2	NA	(15-17) Sample at 0845
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	1.5	ST 1	NA	20-23 Bottom of shelby, (CL) Gray clay, silty, very stiff to hard, moist, trace gravel, non plastic, till	4.5+ TSF	1.0 kg/cm2	Shelby Tube 20-23	(20-23) Sample @ 0940
	23-25	2	SPT8	16,23,30,34	23.0-25.0 (CL) Gray clay, silty, trace gravel, very stiff to hard, moist, till	4.5+ TSF	~1.0 kg/cm2	NA	(23-25) Sample @ 0950
25	25-28	1.8.	ST 2	NA	25-28 Bottom of shelby (CL) Sandy clay, light to dark brown, some gravel, wet, very stiff, low plastic, till	4.5+ TSF	0.5 kg/cm2	Shelby Tube 25-28	Started shelby , got plugged, had to pull, clean and continue, (25-28) Sample @ 1150 (Laboratory Sample # ST (A, B, C))
30	28-30	0.9	SPT 9	20, 50/0.4	28.0-29.1 No Recovery 29.1-30.0 (CL) Gray sandy clay with gravel, some silt, wet to dry at bottom, non-plastic, hard, crumbly, till	4.5 TSF	1.0 kg/cm2	NA	(28-30) Sample @ 1210

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD006	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/13/22 @ 1620

ELEVATION (ft amsl): 729.04 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~8.7 END : 7/14/22 1440 LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	0.8	ST 3	NA	30.0-33.0 Bottom of shelby (CL) Gray sandy clay with gravel, some silt, wet to dry at bottom, non-plastic, hard, crumbly (till), increased gravel, potentially clayey gravel with sand	4.5+ TSF	0.63 kg/cm2	Shelby Tube 30-33	Rough drilling ~35' due to presence of gravel, (30-33)Sample @ 1310
	33-35	0.7	SPT10	52, 50/0.3	33.0-34.3 No Recovery 33.4-35.0 (CL) Gray sandy clay, hard, some silt, trace gravel, non-plastic, moist, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1320 (Laboratory Sample # 13)
35	35-38	1	ST 4	NA	35.0-38.0 Bottom of shelby, (CL) Gray clay, silty, trace gravel, moist, low plastic, very stiff to hard, till	4.5+ TSF	1.0 kg/cm2	Shelby tube 35-38	Issues advancing - pushed 1.2' and stopped, (35-38) Sample @ 1410
	38-40	0.5	SPT 11	50/0.4	38.0-38.4 (ML) Gray silt, hard, trace gravel and minor clay, moist, low plasticity 38.4-38.5 (SP) Gray sand/gravel, medium-coarse, cobble at end, poorly sorted End of Boring 38.5' bgs	NA	NA	NA	(38-40) Sample @ 1440
40									
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.5/2.0	SPT1	7,11,17,15	0.0-1.5 (CL) Brown silty clay, dry, frangible, sand seam 0.9-1.0', trace sand and gravel 1.5-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 0820
	2.5-4.5	1.8/2.0	SPT 2	11,11,11,8	2.5-2.7 No Recovery 2.7-4.5 (CL) Brown silty clay, hard, dry, frangible, trace gravel, crumbly	3.5 TSF	NA	NA	(2.5-4.5) Sample @ 0825, setup for mud
5	5-7	1.5/2.0	SPT3	7,9,11,10	5.0-5.5 No Recovery 5.5-7.0 (CL) Clay, brown-gray, moist, silty, trace gravel, very stiff, non plastic, sand seam 6.7-6.8 with black peat, odor, wet, medium	4.5+ TSF	NA	NA	(5-7) Sample @ 0920
	7.5-9.5	1.0/2.0	SPT 4	10,8,15,6	7.5-8.5 No Recovery 8.5-9.5 (SP) Sand, dark brown, fine-medium, medium dense, little clay, moist, trace gravel, little silt	NA	NA	NA	(7.5-9.5) Sample @ 0930
10	10-12	1.2/2.0	SPT5	2,2,3,4	10.0-10.8 No Recovery 10.8-12.0 (CL) Light brown clay, silty, mottling, moist, medium plastic, firm, trace sand, slight odor, increasing silt with depth	1.0 TSF	NA	NA	(10-12) Sample @ 0940
	12.5-14.5	1.5/2.0	SPT6	4,5,9,10	12.5-13.0 No Recovery 13.0-14.5 (CL) Light brown clay, silty, mottling, moist, trace sand, slight odor, increasing silt with depth, very stiff, low plastic, sand seam 14.2-14.3'	3.5 TSF	NA	NA	(12.5-14.5) Sample @ 0955
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	2.0/2.0	SPT 7	11,21,28,33	15.0-15.5 (SP) Clayey sand, some silt, trace gravel, medium dense, medium to fine, wet 15.5-17.0 (CL) Silty brown clay, moist, very stiff, non-plastic, trace gravel, mottling, some sand to little, till	4.5+ TSF	0.56 kg/cm2	NA	(15-17) Sample at 1010
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	Hard rough drilling 19'
20	20-22	1.5/2.0	SPT 8	19,23,24,34	20.0-20.5 No Recovery 20.5-22.0 (CL) Gray clay, silt, trace gravel, moist, very stiff, non-plastic, till	4.5+ TSF	2.25 kg/cm2	NA	(20-22) Sample @ 1035, Gravelly rough drilling @ ~ 23-24
25	22-28	NA	NA	NA	No Shelby, adjusted sampling	NA	NA	NA	NA
30	28-30	2.0/2.0	SPT 9	10,16,19,19	28.0-30.0 (CL) Gray clay, silt, trace gravel, moist, very stiff, non-plastic, till	4.5+ TSF	1.75 kg/cm2	NA	(28-30) Sample @ 1100

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD008	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 0815

ELEVATION (ft amsl): 729.48 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : NA LOGGER : A. Kiewit

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	2.0/3.0	ST1	NA	30.0-33.0 Bottom of shelby, (CL) Clay, gray-brown, hard, moist, little sand and silt, trace gravel, till	4.5 TSF	1.25 kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1215
	33-35	2.0/2.0	SPT10	22,30,50,50/0.4	33.0-34.2 (CL) Clay, gray-brown, hard, moist, little sand and silt, trace gravel, till, Increasing silt bottom 0.2' 34.2-35.0 (SP) Sand, fine-medium with depth, tan, wet, trace gravel, dense	4.5+ TSF	1.125 kg/cm2	NA	(33-35) Sample @ 1230 (Laboratory Sample # 11)
35	35-38	2.2/3.0	ST 2	NA	35.0-38.0 Bottom of shelby, (CL) Gray clay, silty, very stiff - hard, trace gravel, moist, non-plastic, till	4.5+ TSF	1.5 kg/cm2	Shelby tube 35-38	(35-38) Sample @ 1315
	38-40	0.2/2.0	SPT 11	50/0.2	38.0-39.8 No Recovery 39.8-40.0 (CL) Gray clay, silty, very stiff - hard, trace gravel, moist, non-plastic, till	4.5+ TSF	NA	NA	(38-40) Sample @ 1325
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.0/2.0	SPT1	5,14,27,18	0.0-0.3 Topsoil, organics 0.3-1.0 (ML) Sandy silt, light brown, dry, some clay, trace gravel, loose 1.0-2.0 No Recovery	3.5 TSF	NA	NA	(0-2) Sample @ 1630
	2.5-4.5	2.0/2.0	SPT 2	7,14,13,13	2.5-4.5 (CL) Silty Clay, brown, dry, frangible, trace gravel, hard, little sand	NA	NA	NA	(2.5-4.5) Sample @ 1645
5	5-7	1.5/1.5	SPT3	5,7,9,7	5.0-6.5 (CL) Clay, gray and brown, very stiff, moist, little fine sand and silt 6.5-7.0 (SM) Sand, fine, brown to black, medium dense, moist, stained with faint hydrocarbon odor	NA	NA	NA	(5-7) Sample @ 1725
	7.5-9.5	1.0/2.0	SPT 4	5,5,4,3	7.5-9.5 (CL) Sandy to silty clay, gray and brown, medium stiff, moist, trace gravel, hydrocarbon odor	NA	NA	NA	(7.5-9.5) Sample @ 1735
10	10-12	1.5/2.0	SPT5	3,5,6,10	10.0-11.5 (CL) Clay, gray-brown, stiff, moist, medium plastic, trace sand and gravel 11.5-12.0 (ML) Silt, gray, medium stiff, moist to wet	NA	NA	NA	(10-12) Sample @ 1745
	12.5-14.5	1.5/2.0	SPT6	7,7,7,10	12.5-14.5 (ML) Sandy silt, gray, medium stiff, wet, little clay	NA	NA	NA	(12.5-14.5) Sample @ 1750 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-17	1.5/2.0	SPT 7	11,11,9,9	15.0-16.5 (SM) Sand, gray, medium dense, wet, trace coarse sand and gravel 16.5-17.0 (CL) Clay, gray brown, stiff, moist, some silt, little fine sand	NA	NA	NA	(15-17) Sample @ 1800
	17-20	NA	NA	NA	No Sampling	NA	NA	NA	NA
20	20-23	2.4/3.0	ST 1	NA	20-23 Bottom of shelby (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.5 kg/cm2	Shelby Tube 20-23	Sample 20-23 @ 0915
	23-25	1.5/2.0	SPT8	17,25,28,36	23.0-23.5 No Recovery 23.5-25.0 (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.5 kg/cm2	NA	(23-25) Sample @ 0920
25	25-28	--	ST 2	NA	25-28 Bottom of shelby, (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	2.0 kg/cm2	Shelby Tube 25-28	(35-28) Sample @ 1010
	28-30	2.0/2.0	SPT 9	12,15,19,28	28.0-30.0 (CL) Gray clay, silty, moist, very stiff to hard, trace gravel, low plastic, till	4.5+ TSF	1.75 kg/cm2	NA	(28-30) Sample @ 1015
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD009	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/12/22 @ 1625

ELEVATION (ft amsl): 730.73 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~11.5 END:7/13/22 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	2.0/3.0	ST 3	NA	30.0-33.0 Bottom of shelby, (CL) Gray clay, silty, moist, very stiff, trace gravel, low plastic, till	3.0 TSF	1.5 kg/cm2	Shelby Tube 30-33	(30-33) Sample @ 1115 (Laboratory Sample # ST (A, B, C))
	33-35	2.0/2.0	SPT10	8,10,22,21	33.0-34.2 (CL) Gray clay, silty, moist, very stiff, trace gravel, low plastic, till 34.2-35.0 (ML) Gray silt, soft, low plastic, moist to wet, trace clay	2.5 TSF	1.5 kg/cm2	NA	(33-35) Sample @ 1250 (Laboratory Sample # 13)
35	35-38	1.0/3.0	ST 4	NA	35.0-38.0 Bottom of shelby, (ML) Gray silt, trace clay, soft, wet, medium plastic	1.5 TSF	NA	Shelby tube 35-38	(35-38) Sample @ 1345
	38-40	1.4/2.0	SPT 11	20,38,35,23	38.0-38.6 No Recovery 38.6-39.0 (ML) Gray silt, trace clay, soft, wet, medium plastic 39.0-40.0 (SP) Fine sand, fray, medium dense, wet, gravel at top decreasing to 0 at bottom	NA	NA	NA	(38-40) Sample @ 1400
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	0-2	1.0/2.0	SPT1	5,8,5,11	0.0-0.2 Topsoil, organics 0.2-1.0 (CL) Clay, brown, silty, some sand, trace gravel, dry, sand seam 0.8-1.0 1.0-2.0 No Recovery	NA	NA	NA	(0-2) Sample @ 1020
	2.5-4.5	0.5/2.0	SPT 2	8,20,22,20	2.5-4.0 No Recovery 4.0-4.5 (CL) Clay, brown, silty, some sand, trace gravel, dry	NA	NA	NA	(2.5-4.5) Sample @ 1030
5	5-7	1.5/1.5	SPT3	8,6,7,8	5.0-5.5 No Recovery 5.5-6.6 (CL) Clay, brown-gray, some sand and silt, trace gravel, moist, very stiff, non plastic 6.6-7.0 (SP) Sand, dark gray-black, medium, medium dense, wet, slight odor, trace silt	4.5+ TSF	NA	NA	(5-7) Sample @ 1118
	7.5-9.5	1.0/2.0	SPT 4	3,1,1,3	7.5-8.5 No Recovery 8.5-9.0 (SP) Sand, dark gray-black, medium, medium dense, wet, slight odor, trace silt 9.0-9.5 (CL) Sandy clay, increasing clay with depth, medium stiff, medium plastic, moist, peat at bottom, odor	NA	NA	NA	(7.5-9.5) Sample @ 1130
10	10-12	2.0/2.0	SPT5	3,5,6,9	10.0-11.5 (ML) Gray silt, wet, medium stiff, non-plastic, trace clay 11.5-12.0 (CL) Clay, brown, some silt, trace gravel, moist, non plastic	3.5 TSF	NA	NA	(10-12) Sample @ 1150
	12.5-14.5	2.0/2.0	SPT6	8,12,13,14	12.5-13.0 (CL) Clay, brown, some silt, trace gravel, moist, non plastic 13.0-14.0 (ML) Sandy silt to silty sand with depth, gray wet, soft to loose, non-low plastic 14.0-14.5 (CL) Clay, brown, silty, trace gravel, stiff, non-plastic, moist	4.0 TSF	NA	NA	(12.5-14.5) Sample @ 1205 (Laboratory Sample # 6)
15									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	15-18	NA	NA	NA	No Sampling	NA	NA	NA	NA
	18-20	1.5/2.0	SPT 7	17,21,22,34	18.0-20.0 (CL) Clay, brown, silty, trace gravel, stiff, non-plastic, moist	4.5+TSF	1.63 kg/cm2	NA	(18-20) Sample @ 1220
20	20-23	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	23-25	1.8/2.0	SPT8	15,18,49,50/0.4	23.0-23.2 No Recovery 23.2-24.5 (CL) Clay, brown, moist, some silt, trace gravel, very stiff, non-plastic, till 24.5-25.0 (SP) Sand, gray, medium, medium dense, wet, well sorted	4.5+ TSF	1.63 kg/cm2	NA	(23-25) Sample @ 1240 (Laboratory Sample # 8)
25	25-28	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube, Gravel ~ 27'
	28-30	2.0/2.0	SPT 9	29,39,39,40	28.0-30.0 (SP) Sand with gravel, tan-gray, medium dense-dense, medium-coarse, wet, little clay and silt, moderate cohesive	NA	NA	NA	(28-30) Sample @ 1315
30									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

PROJECT NUMBER	BORING NUMBER	
D3542500	PD010	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Velsicol GLAES - Geotechnical Investigation LOCATION : St. Louis, MI DATE/TIME: 7/11/22 @ 1015

ELEVATION (ft amsl): 729.63 DRILLING SUBCONTRACTOR : Coleman Engineering

DRILLING METHOD AND EQUIPMENT USED : D120 Auger Rig

WATER LEVELS : ~6.6 LOGGER : A. Kiewit S. Chumney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. Pocket Pen	Shear Vane	Shelby Tube	Notes
	30-33	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	33-35	0.4/2.0	SPT10	50/0.35	33.0-34.6 No Recovery 34.6-35.0 (CL) Clay, brown-gray, silty, trace gravel, moist, very stiff-hard, non-plastic, till	4.5+ TSF	NA	NA	(33-35) Sample @ 1400
35	35-38	NA	NA	NA	NA	NA	NA	NA	No Shelby Tube
	38-40	0.8/2.0	SPT 11	50,50/0.5,38,40	38.0-39.2 No Recovery 39.2-40.0 (CL) Clay, brown-gray, silty, trace gravel, moist, very stiff-hard, non-plastic, till	4.5+TSF	1.75 kg/cm2	NA	(38-40) Sample @ 1610
40					End of Boring 40' bgs				
45									

Notes:
WOR = weight of rod
TSF = tons per square foot
kg/cm2 = kilograms per square centimeter

Appendix C
Laboratory Test Results

Velsicol GLAES RD Geotechnical Investigation Sample Summary Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/6/2022	9:55	PD-001	5-7	3	SS	VCS-OU1-GT-SO-PD001-5.0/7.0	22CV14-17
7/6/2022	10:15	PD-001	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD001-7.5/9.5	22CV14-18
7/6/2022	10:25	PD-001	10-12	5	SS	VCS-OU1-GT-SO-PD001-10.0/12.0	22CV14-19
7/6/2022	10:45	PD-001	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD001-12.5/14.5	22CV14-20
7/6/2022	11:30	PD-001	15-17	7	SS	VCS-OU1-GT-SO-PD001-15.0/17.0	22CV14-21
7/6/2022	13:00	PD-001	20-23	8	ST	VCS-OU1-GT-SO-PD001-20.0/23.0	22CV14-22
7/6/2022	13:15	PD-001	23-25	9	SS	VCS-OU1-GT-SO-PD001-23.0/25.0	22CV14-23
7/6/2022	15:13	PD-001	25-28	10	ST	VCS-OU1-GT-SO-PD001-25.0/28.0	22CV14-24
7/6/2022	15:30	PD-001	28-30	11	SS	VCS-OU1-GT-SO-PD001-28.0/30.0	22CV14-25
7/6/2022	16:15	PD-001	30-33	12	ST	VCS-OU1-GT-SO-PD001-30.0/33.0	22CV14-26
7/6/2022	16:50	PD-001	33-35	13	SS	VCS-OU1-GT-SO-PD001-33.0/35.0	22CV14-27
7/6/2022	17:20	PD-001	35-38	14	ST	VCS-OU1-GT-SO-PD001-35.0/38.0	22CV14-28
7/6/2022	17:30	PD-001	38-40	15	SS	VCS-OU1-GT-SO-PD001-38.0/40.0	22CV14-29

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/7/2022	9:49	PD-002	0-2	1	SS	VCS-OU1-GT-SO-PD002-0.0/2.0	22CV14-30
7/7/2022	9:55	PD-002	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD002-2.5/4.5	22CV14-31
7/7/2022	10:50	PD-002	5-7	3	SS	VCS-OU1-GT-SO-PD002-5.0/7.0	22CV14-32
7/7/2022	11:00	PD-002	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD002-7.5/9.5	22CV14-33
7/7/2022	11:10	PD-002	10-12	5	SS	VCS-OU1-GT-SO-PD002-10.0/12.0	22CV14-34
7/7/2022	11:15	PD-002	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD002-12.5/14.5	22CV14-35
7/7/2022	11:25	PD-002	15-17	7	SS	VCS-OU1-GT-SO-PD002-15.0/17.0	22CV14-36
7/7/2022	12:15	PD-002	20-23	8	ST	VCS-OU1-GT-SO-PD002-20.0/23.0	22CV14-37
7/7/2022	12:25	PD-002	23-25	9	SS	VCS-OU1-GT-SO-PD002-23.0/25.0	22CV14-38
7/7/2022	NA	PD-002	25-28	10	ST (No Recovery)	NA	NA
7/7/2022	14:30	PD-002	28-30	11	SS	VCS-OU1-GT-SO-PD002-28.0/30.0	22CV14-39
7/7/2022	15:00	PD-002	30-33	12	ST	VCS-OU1-GT-SO-PD002-30.0/33.0	22CV14-40
7/7/2022	15:25	PD-002	33-35	13	SS	VCS-OU1-GT-SO-PD002-33.0/35.0	22CV14-41
7/7/2022	16:10	PD-002	35-38	14	ST	VCS-OU1-GT-SO-PD002-35.0/38.0	22CV14-42
7/7/2022	16:20	PD-002	38-40	15	SS	VCS-OU1-GT-SO-PD002-38.0/40.0	22CV14-43

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/8/2022	8:45	PD-003	0-2	1	SS	VCS-OU1-GT-SO-PD003-0.0/2.0	22CV14-44
7/8/2022	8:50	PD-003	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD003-2.5/4.5	22CV14-45
7/8/2022	10:30	PD-003	5-7	3	SS	VCS-OU1-GT-SO-PD003-5.0/7.0	22CV14-46
7/8/2022	10:45	PD-003	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD003-7.5/9.5	22CV14-47
7/8/2022	10:55	PD-003	10-12	5	SS	VCS-OU1-GT-SO-PD003-10.0/12.0	22CV14-48
7/8/2022	11:05	PD-003	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD003-12.5/14.5	22CV14-49
7/8/2022	11:15	PD-003	15-17	7	SS	VCS-OU1-GT-SO-PD003-15.0/17.0	22CV14-50
7/8/2022	11:50	PD-003	20-23	8	ST	VCS-OU1-GT-SO-PD003-20.0/23.0	22CV14-51
7/8/2022	13:05	PD-003	23-25	9	SS	VCS-OU1-GT-SO-PD003-23.0/25.0	22CV14-52
7/8/2022	13:50	PD-003	25-28	10	ST	VCS-OU1-GT-SO-PD003-25.0/28.0	22CV14-53
7/8/2022	14:00	PD-003	28-30	11	SS	VCS-OU1-GT-SO-PD003-28.0/30.0	22CV14-54
7/9/2022	9:28	PD-003	33-35	12	SS	VCS-OU1-GT-SO-PD003-33.0/35.0	22CV14-55
7/9/2022	10:00	PD-003	38-40	13	SS	VCS-OU1-GT-SO-PD003-38.0/40.0	22CV14-56
Note: No Shelby Tubes from 30'-33' bgs and from 35'-38' bgs due to Pitcher Sampler failure							

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/13/2022	16:30	PD-006	0-2	1	SS	VCS-OU1-GT-SO-PD006-0.0/2.0	22CV14-96
7/13/2022	16:40	PD-006	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD006-2.5/4.5	22CV14-97
7/14/2022	8:00	PD-006	5-7	3	SS	VCS-OU1-GT-SO-PD006-5.0/7.0	22CV14-98
7/14/2022	8:05	PD-006	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD006-7.5/9.5	22CV14-99
7/14/2022	8:20	PD-006	10-12	5	SS	VCS-OU1-GT-SO-PD006-10.0/12.0	22CV15-01
7/14/2022	8:30	PD-006	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD006-12.5/14.5	22CV15-02
7/14/2022	8:45	PD-006	15-17	7	SS	VCS-OU1-GT-SO-PD006-15.0/17.0	22CV15-03
7/14/2022	9:40	PD-006	20-23	8	ST	VCS-OU1-GT-SO-PD006-20.0/23.0	22CV15-04
7/14/2022	9:50	PD-006	23-25	9	SS	VCS-OU1-GT-SO-PD006-23.0/25.0	22CV15-05
7/14/2022	11:50	PD-006	25-28	10	ST	VCS-OU1-GT-SO-PD006-25.0/28.0	22CV15-06
7/14/2022	12:10	PD-006	28-30	11	SS	VCS-OU1-GT-SO-PD006-28.0/30.0	22CV15-07
7/14/2022	13:10	PD-006	30-33	12	ST	VCS-OU1-GT-SO-PD006-30.0/33.0	22CV15-08
7/14/2022	13:20	PD-006	33-35	13	SS	VCS-OU1-GT-SO-PD006-33.0/35.0	22CV15-09
7/14/2022	14:10	PD-006	35-38	14	ST	VCS-OU1-GT-SO-PD006-35.0/38.0	22CV15-10
7/14/2022	14:40	PD-006	38-40	15	SS	VCS-OU1-GT-SO-PD006-38.0/40.0	22CV15-11

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/12/2022	8:20	PD-008	0-2	1	SS	VCS-OU1-GT-SO-PD008-0.0/2.0	22CV14-68
7/12/2022	8:25	PD-008	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD008-2.5/4.5	22CV14-69
7/12/2022	9:20	PD-008	5-7	3	SS	VCS-OU1-GT-SO-PD008-5.0/7.0	22CV14-70
7/12/2022	9:30	PD-008	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD008-7.5/9.5	22CV14-71
7/12/2022	9:40	PD-008	10-12	5	SS	VCS-OU1-GT-SO-PD008-10.0/12.0	22CV14-72
7/12/2022	9:55	PD-008	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD008-12.5/14.5	22CV14-73
7/12/2022	10:10	PD-008	15-17	7	SS	VCS-OU1-GT-SO-PD008-15.0/17.0	22CV14-74
7/12/2022	10:35	PD-008	20-22	8	SS	VCS-OU1-GT-SO-PD008-20.0/22.0	22CV14-75
7/12/2022	11:00	PD-008	28-30	9	SS	VCS-OU1-GT-SO-PD008-28.0/30.0	22CV14-76
7/12/2022	12:15	PD-008	30-33	10	ST	VCS-OU1-GT-SO-PD008-30.0/33.0	22CV14-77
7/12/2022	12:30	PD-008	33-35	11	SS	VCS-OU1-GT-SO-PD008-33.0/35.0	22CV14-78
7/12/2022	13:15	PD-008	35-38	12	ST	VCS-OU1-GT-SO-PD008-35.0/38.0	22CV14-79
7/12/2022	13:25	PD-008	38-40	13	SS	VCS-OU1-GT-SO-PD008-38.0/40.0	22CV14-80
Note: No Shelby Tubes from 20'-23' bgs and from 25'-28' due to Pitcher Sampler failure							

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/12/2022	16:30	PD-009	0-2	1	SS	VCS-OU1-GT-SO-PD009-0.0/2.0	22CV14-81
7/12/2022	16:45	PD-009	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD009-2.5/4.5	22CV14-82
7/12/2022	17:25	PD-009	5-7	3	SS	VCS-OU1-GT-SO-PD009-5.0/7.0	22CV14-83
7/12/2022	17:35	PD-009	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD009-7.5/9.5	22CV14-84
7/12/2022	17:45	PD-009	10-12	5	SS	VCS-OU1-GT-SO-PD009-10.0/12.0	22CV14-85
7/12/2022	17:50	PD-009	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD009-12.5/14.5	22CV14-86
7/12/2022	18:00	PD-009	15-17	7	SS	VCS-OU1-GT-SO-PD009-15.0/17.0	22CV14-87
7/13/2022	9:15	PD-009	20-23	8	ST	VCS-OU1-GT-SO-PD009-20.0/23.0	22CV14-88
7/13/2022	9:20	PD-009	23-25	9	SS	VCS-OU1-GT-SO-PD009-23.0/25.0	22CV14-89
7/13/2022	10:10	PD-009	25-28	10	ST	VCS-OU1-GT-SO-PD009-25.0/28.0	22CV14-90
7/13/2022	10:15	PD-009	28-30	11	SS	VCS-OU1-GT-SO-PD009-28.0/30.0	22CV14-91
7/13/2022	11:15	PD-009	30-33	12	ST	VCS-OU1-GT-SO-PD009-30.0/33.0	22CV14-92
7/13/2022	12:50	PD-009	33-35	13	SS	VCS-OU1-GT-SO-PD009-33.0/35.0	22CV14-93
7/13/2022	13:45	PD-009	35-38	14	ST	VCS-OU1-GT-SO-PD009-35.0/38.0	22CV14-94
7/13/2022	14:00	PD-009	38-40	15	SS	VCS-OU1-GT-SO-PD009-38.0/40.0	22CV14-95

Velsicol GLAES RD Geotechnical Investigation Sample Table

Date	Time	Soil Boring	Sample Interval (ft bgs)	Sample Number	Shelby Tube (ST)/ Split Spoon (SS)	Sample ID	SAS Number
7/11/2022	10:20	PD-010	0-2	1	SS	VCS-OU1-GT-SO-PD010-0.0/2.0	22CV14-57
7/11/2022	10:30	PD-010	2.5-4.5	2	SS	VCS-OU1-GT-SO-PD010-2.5/4.5	22CV14-58
7/11/2022	11:18	PD-010	5-7	3	SS	VCS-OU1-GT-SO-PD010-5.0/7.0	22CV14-59
7/11/2022	11:30	PD-010	7.5-9.5	4	SS	VCS-OU1-GT-SO-PD010-7.5/9.5	22CV14-60
7/11/2022	11:50	PD-010	10-12	5	SS	VCS-OU1-GT-SO-PD010-10.0/12.0	22CV14-61
7/11/2022	12:05	PD-010	12.5-14.5	6	SS	VCS-OU1-GT-SO-PD010-12.5/14.5	22CV14-62
7/11/2022	12:20	PD-010	18-20	7	SS	VCS-OU1-GT-SO-PD010-18.0/20.0	22CV14-63
7/11/2022	12:40	PD-010	23-25	8	SS	VCS-OU1-GT-SO-PD010-23.0/25.0	22CV14-64
7/11/2022	13:15	PD-010	28-30	9	SS	VCS-OU1-GT-SO-PD010-28.0/30.0	22CV14-65
7/11/2022	14:00	PD-010	33-35	10	SS	VCS-OU1-GT-SO-PD010-33.0/35.0	22CV14-66
7/11/2022	14:10	PD-010	38-40	11	SS	VCS-OU1-GT-SO-PD010-38.0/40.0	22CV14-67

No Shelby Tubes were collected due to broken Pitcher Sampler

Laboratory Testing Summary

Boring Number	Sample Number	Depth (Feet)	Soil Classification Based on Laboratory Test Results	Particle Size			Atterberg Limits			Moisture Content	Triaxial Shear
				Percent Gravel	Percent Sand	Percent Fines	LL	PL	PI		CU (tsf)
PD-001	ST (A)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	7.7	7.86
	ST (B)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	7.8	14.32
	ST (C)	30-33	(SC-SM) Silty clayey sand with a little gravel	11.8	45.4	42.8	16	10	6	6.8	11.51
	15	38-40	(CL) Lean clay with sand	6.5	41.2	52.3	17	10	7	9.8	
PD-002	7	15-17	(CL) Lean clay, some sand, grayish brown	0.2	11.2	88.6					
	13	33-35	(CL-ML) Silty clay, with sand, trace gravel	7.0	42.5	50.5	16	10	6	8.0	
PD-003	7	15-17	(CL) Sandy lean clay, trace gravel, grayish brown	2.7	46.6	50.7					
	ST (A)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	10.9	5.64
	ST (B)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	10.7	6.89
	ST (C)	25-28	(CL) Sandy lean clay with a trace of gravel	2.9	34.1	63.0	21	10	11	11.2	10.32
	12	33-35	(CL-ML) Silty clay with sand	5.4	43.8	50.8	16	10	6	7.9	
PD-006	6	12.5-14.5	(ML) Silt, some sand, trace gravel, light brown	5.9	10.6	83.6					
	ST (A)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	11.4	5.03
	ST (B)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	12.6	5.60
	ST (C)	25-28	(CL) Sandy lean clay with a little gravel	5.4	34.6	60.0	21	11	10	12.3	5.44
	13	33-35	(SM) Silty sand, fine to medium, some gravel	11.0	52.6	36.4	NP	NP	NP	8.4	
PD-008	11	33-35	(SM) Silty sand, fine	5.9	49.5	44.6	12	11	1	8.3	
PD-009	6	12.5-14.5	(ML) Sandy silt, light grayish brown	0.7	19.9	79.4					
	ST (A)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.4	4.38
	ST (B)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.4	5.28
	ST (C)	30-33	(CL) Sandy lean clay with a little gravel	5.0	35.4	59.6	20	11	9	10.6	6.85
	13	33-35	(CL) Lean clay, some sand	0.1	7.9	92.0	22	14	8	18.4	
PD-010	6	12.5-14.5	(SM) Silty sand, fine, light grayish brown	0.0	71.4	28.6					
	8	23-25	(CL) Sandy lean clay	0.4	38.9	60.7	19	11	8	9.8	

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay with sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-001
Sample No.: 15
Depth: 38'-40'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	11.1	4.2	95.8
4M	4.76	6.2	2.3	93.5
10M	2.00	11.0	4.1	89.4
20M	0.85	2.86	4.9	95.1 / 85.0
40M	0.42	3.20	5.5	89.6 / 80.1
60M	0.25	5.60	9.7	79.9 / 71.4
100M	0.149	6.76	11.7	68.2 / 61.0
140M	0.106	2.91	5.0	63.2 / 56.5
200M	0.074	2.71	4.7	58.5 / 52.3
LBW		33.77	58.4	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 57.88 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: R. Edlebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-001

Soil Description: (CL) Lean clay with sand

Sample No.: 15

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 38'-40'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 1

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.4 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.67 g	57.88 g

Starting Date: 8/17/22 Starting Time: 7:12:00 Sedimentation Cylinder No.: HYD 20

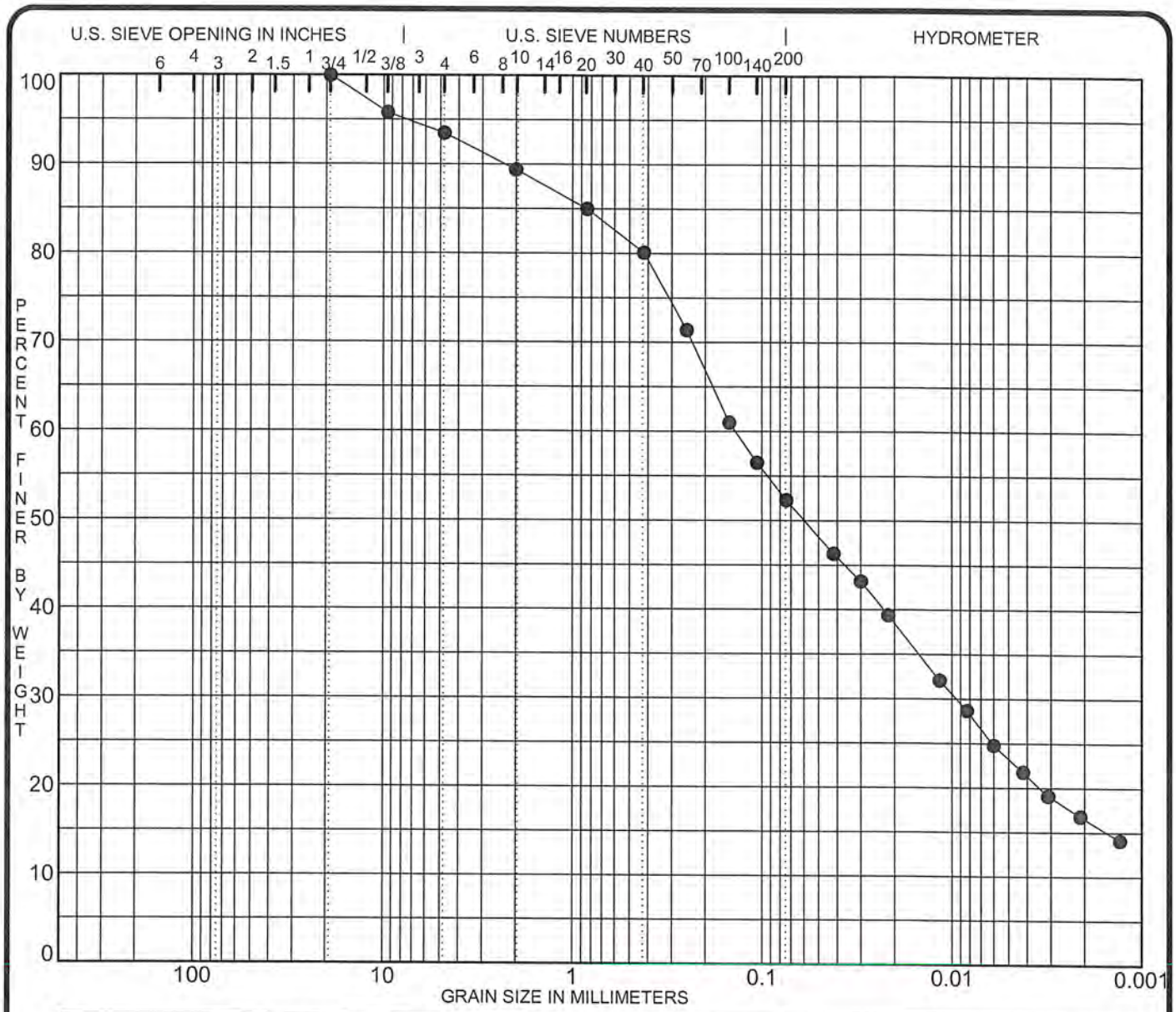
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:13:00	1.0	36.50	23.5	6.25	30.25	51.7	0.01297	10.4	0.0418	46.3
7:14:00	2.0	34.50	23.5	6.25	28.25	48.3	0.01297	10.7	0.0300	43.2
7:16:00	4.0	32.00	23.5	6.25	25.75	44.0	0.01297	11.1	0.0216	39.4
7:27:00	15.0	27.25	23.5	6.25	21.00	35.9	0.01297	11.9	0.0116	32.1
7:42:00	30.0	25.00	23.5	6.25	18.75	32.1	0.01297	12.2	0.0083	28.7
8:12:00	60.0	22.50	23.5	6.25	16.25	27.8	0.01297	12.7	0.0060	24.8
9:16:00	124.0	20.50	23.5	6.25	14.25	24.4	0.01297	13.0	0.0042	21.8
11:12:00	240.0	18.75	23.5	6.25	12.50	21.4	0.01297	13.3	0.0031	19.1
15:12:00	480.0	17.25	24.0	6.25	11.00	18.8	0.01282	13.5	0.0021	16.8
7:12:00	1440.0	15.50	24.0	6.25	9.25	15.8	0.01282	13.8	0.0013	14.1

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: N. Ellebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-001 #15 38'-40'	(CL) LEAN CLAY WITH SAND						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-001 #15 38'-40'	19.10	0.14	0.059	0.009		6.5	41.2	29.0	23.3

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay, some sand, grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-002
Sample No.: 7
Depth: 15'-17'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5	0.00	0.0	100.0
4M	4.76	0.22	0.2	99.8
10M	2.00	0.57	0.6	99.2
20M	0.85	0.36	0.6	99.4 / 98.6
40M	0.42	0.69	1.2	98.2 / 97.4
60M	0.25	1.20	2.1	96.1 / 95.3
100M	0.149	1.43	2.5	93.6 / 92.9
140M	0.106	0.78	1.4	92.2 / 91.5
200M	0.074	1.64	2.9	89.3 / 88.6
LBW		49.66	88.6	
Pan		0.41	0.7	

Wet weight = - gm
Dry Initial weight = 56.17 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/8/2022
Laboratory: Iron Mountain
Submitted By: N. Ellebeck
Date: 8/27/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-002

Soil Description: (CL) Lean clay, some sand, grayish brown

Sample No.: 7

Prior Testing: [ ] No [X] Yes Type: Moisture

Depth: 15'-17'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 8

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	99.2 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.92 g	56.17 g

Starting Date: 8/4/22 Starting Time: 7:00:00 Sedimentation Cylinder No.: HYD 11

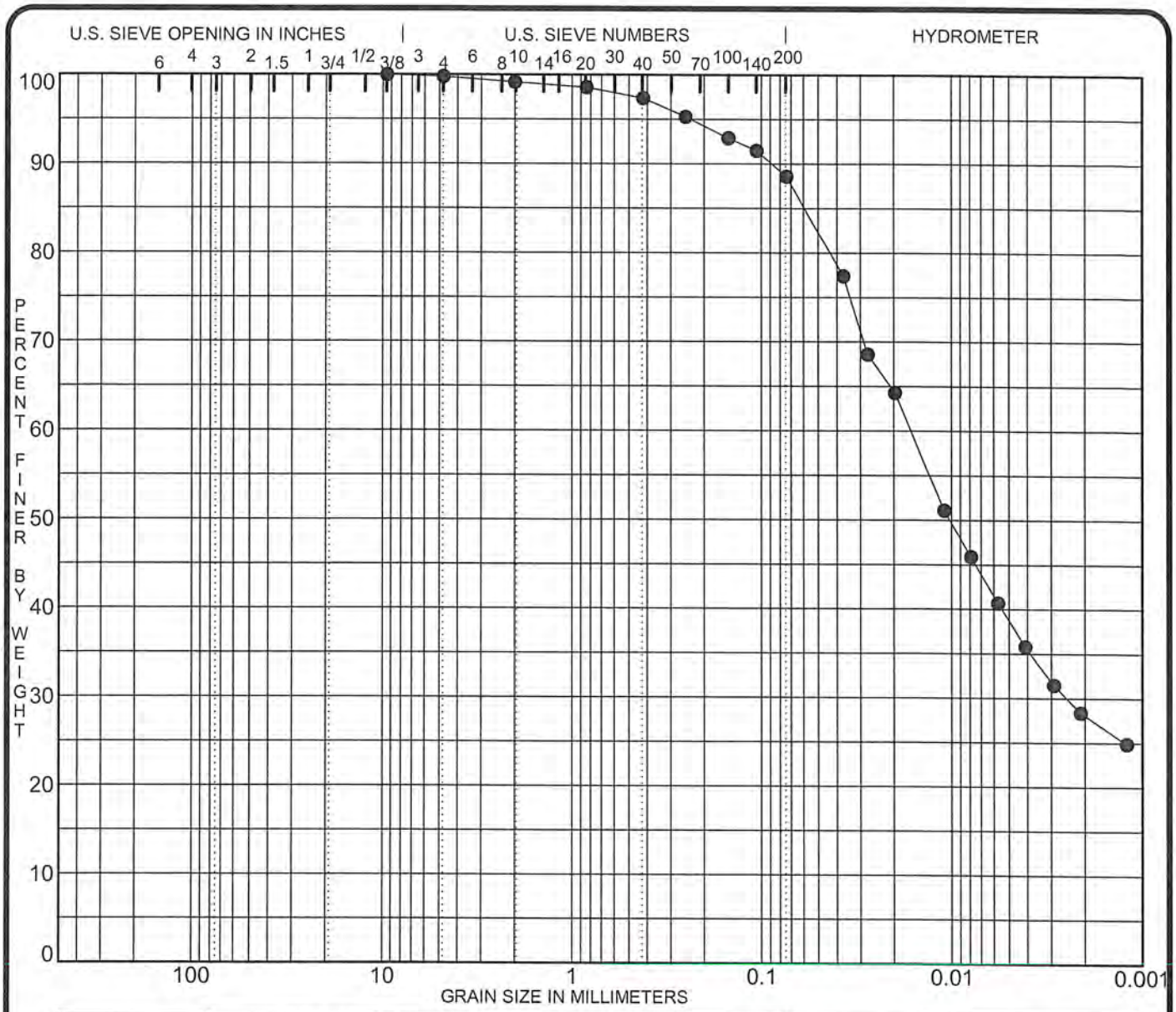
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:01:00	1.0	50.50	23.5	6.25	44.25	78.0	0.01297	8.1	0.0369	77.4
7:02:00	2.0	45.50	23.5	6.25	39.25	69.2	0.01297	8.9	0.0274	68.6
7:04:00	4.0	43.00	23.5	6.25	36.75	64.8	0.01297	9.2	0.0197	64.3
7:15:00	15.0	35.50	23.5	6.25	29.25	51.6	0.01297	10.6	0.0109	51.1
7:30:00	30.0	32.50	23.5	6.25	26.25	46.3	0.01297	11.1	0.0079	45.9
8:00:00	60.0	29.50	23.5	6.25	23.25	41.0	0.01297	11.5	0.0057	40.7
9:00:00	120.0	26.75	23.5	6.25	20.50	36.1	0.01297	12.0	0.0041	35.8
11:00:00	240.0	24.25	23.5	6.25	18.00	31.7	0.01297	12.4	0.0029	31.5
15:00:00	480.0	22.50	24.0	6.25	16.25	28.6	0.01282	12.7	0.0021	28.4
7:00:00	1440.0	20.50	24.0	6.25	14.25	25.1	0.01282	13.0	0.0012	24.9

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-002 #7 15'-17'**	**(CL) LEAN CLAY, some sand, grayish brown**						

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-002 #7 15'-17'**	**9.50**	**0.02**	**0.010**	**0.002**		**0.2**	**11.2**	**50.0**	**38.6**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL-ML) Silty clay, with sand, trace gravel
Remarks:

Job No.: GL 191059F2
Boring No.: PD-002
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	13.0	5.5	94.5
4M	4.76	3.5	1.5	93.0
10M	2.00	7.9	3.3	89.7
20M	0.85	2.23	4.1	95.9 / 86.0
40M	0.42	3.03	5.5	90.4 / 81.1
60M	0.25	5.74	10.4	80.0 / 71.8
100M	0.149	7.10	12.9	67.1 / 60.2
140M	0.106	3.06	5.6	61.5 / 55.2
200M	0.074	2.86	5.2	56.3 / 50.5
LBW		30.96	56.2	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 55.05 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: W. Ellebest
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-002

Soil Description: (CL-ML) Silty clay, with sand, trace gravel

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 7

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	55.86 g	55.05 g

Starting Date: 8/17/22 Starting Time: 7:06:00 Sedimentation Cylinder No.: HYD 21

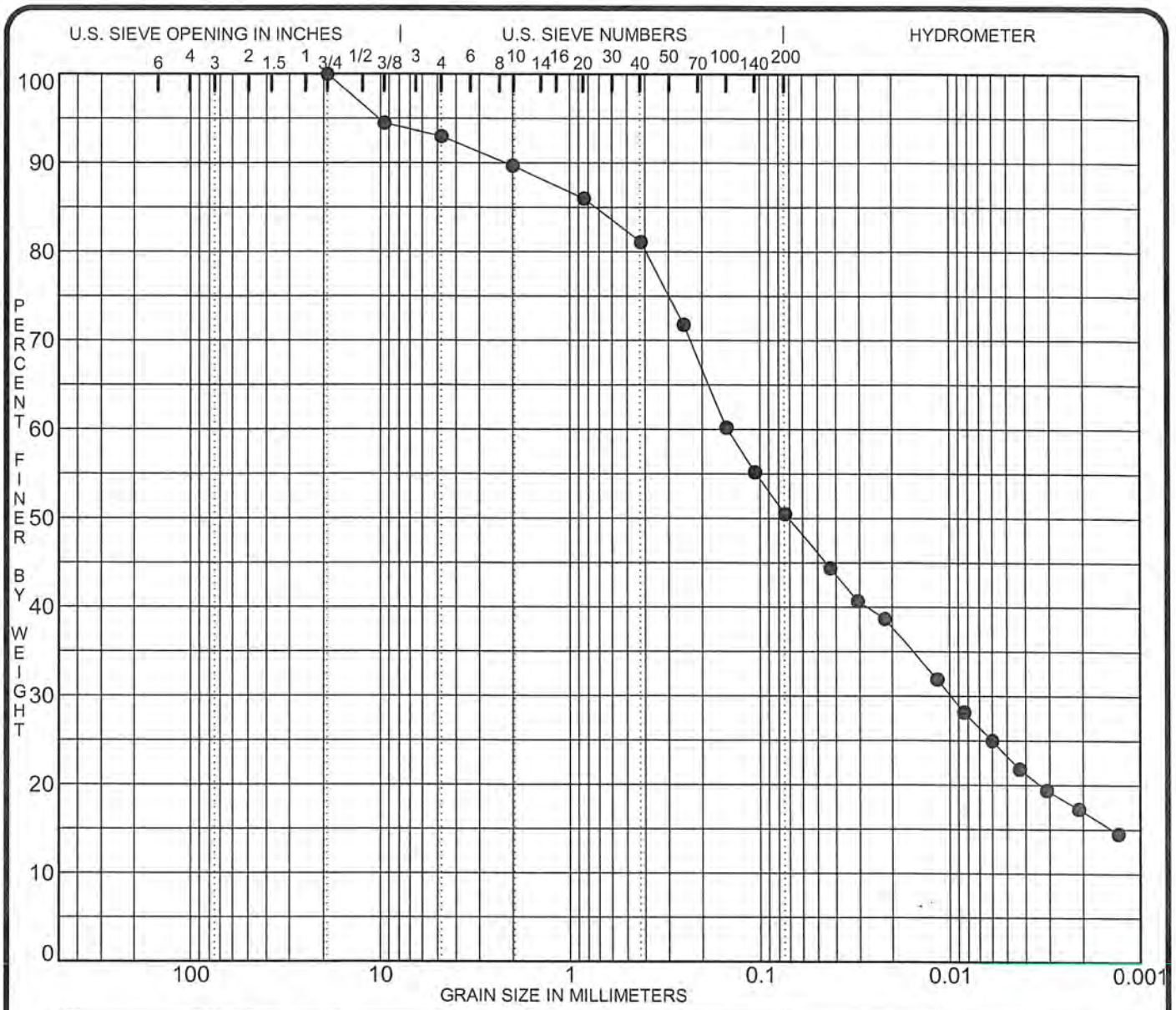
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:07:00	1.0	33.75	23.5	6.25	27.50	49.5	0.01297	10.9	0.0428	44.4
7:08:00	2.0	31.50	23.5	6.25	25.25	45.4	0.01297	11.2	0.0307	40.7
7:10:00	4.0	30.25	23.5	6.25	24.00	43.2	0.01297	11.4	0.0219	38.7
7:21:00	15.0	26.00	23.5	6.25	19.75	35.5	0.01297	12.0	0.0116	31.9
7:36:00	30.0	23.75	23.5	6.25	17.50	31.5	0.01297	12.5	0.0084	28.2
8:06:00	60.0	21.75	23.5	6.25	15.50	27.9	0.01297	12.9	0.0060	25.0
9:06:00	120.0	19.75	23.5	6.25	13.50	24.3	0.01297	13.2	0.0043	21.8
11:06:00	240.0	18.25	23.5	6.25	12.00	21.6	0.01297	13.3	0.0031	19.4
15:06:00	480.0	17.00	24.0	6.25	10.75	19.3	0.01282	13.5	0.0021	17.3
7:06:00	1440.0	15.25	24.0	6.25	9.00	16.2	0.01282	13.8	0.0013	14.5

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: Dr Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **PD-002 #13 33'-35'**	**(CL-ML) SILTY CLAY, with sand, trace gravel**						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **PD-002 #13 33'-35'**	**19.10**	**0.15**	**0.071**	**0.010**		**7.0**	**42.5**	**27.4**	**23.1**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Sandy lean clay, trace gravel, grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-003
Sample No.: 7
Depth: 15'-17'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.00	0.0	100.0
3/8"	9.5	1.42	1.5	98.5
4M	4.76	1.14	1.2	97.3
10M	2.00	2.54	2.7	94.6
20M	0.85	2.14	4.0	96.0 / 90.8
40M	0.42	2.78	5.1	90.9 / 86.0
60M	0.25	6.03	11.1	79.8 / 75.5
100M	0.149	7.58	14.0	65.8 / 62.2
140M	0.106	3.51	6.5	59.3 / 56.1
200M	0.074	3.06	5.7	53.6 / 50.1
LBW		27.94	51.6	
Pan		1.09	2.0	

Wet weight = - gm
Dry Initial weight = 54.13 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: W. Edebert

Date: 8/8/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-003

Soil Description: (CL) Sandy lean clay, trace gravel, grayish brown

Sample No.: 7

Prior Testing: [X] No [ ] Yes Type:

Depth: 15'-17'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 11

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	94.6 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	54.60 g	54.13 g

Starting Date: 8/4/22 Starting Time: 7:06:00 Sedimentation Cylinder No.: HYD 13

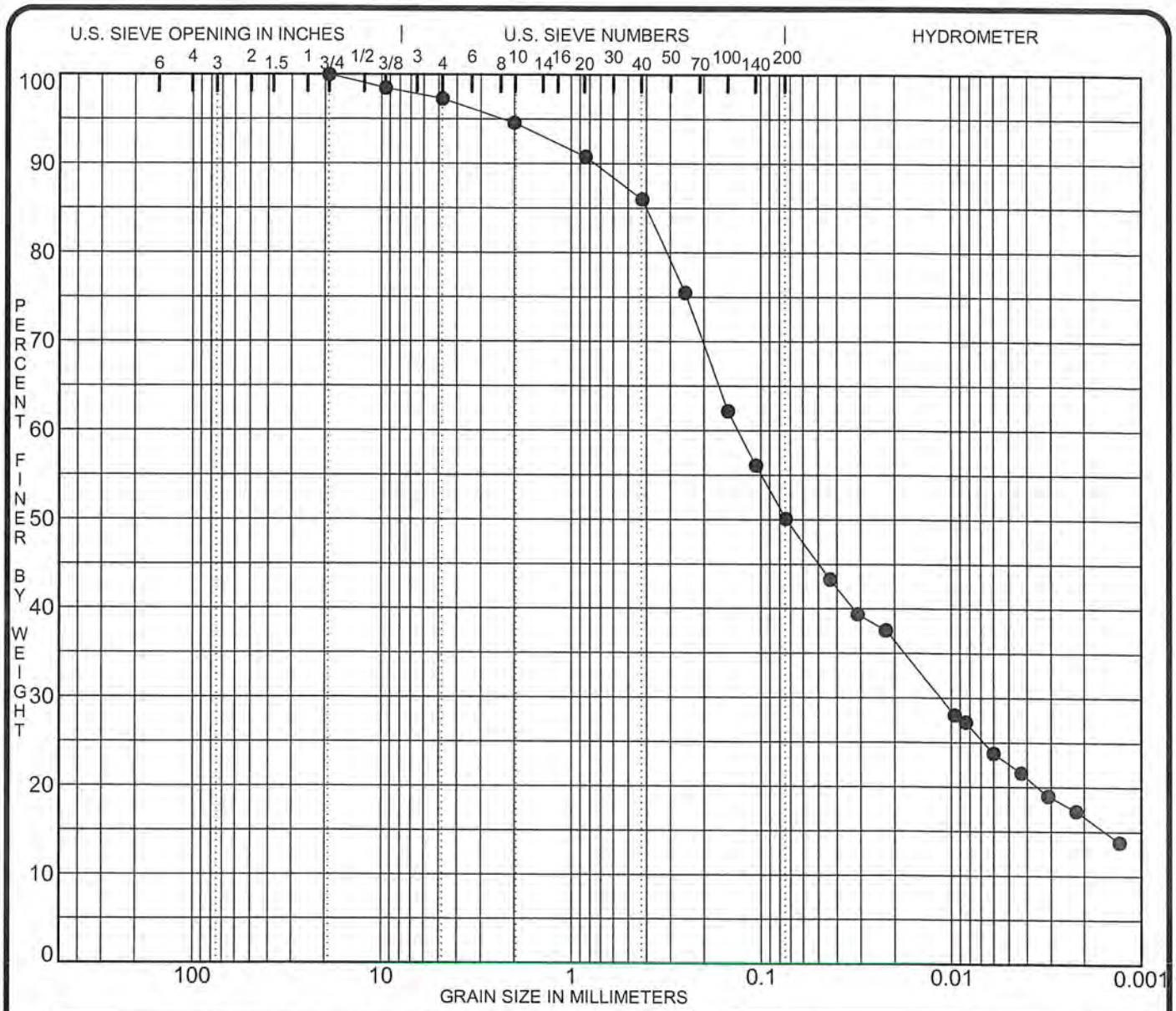
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:07:00	1.0	31.25	23.5	6.25	25.00	45.7	0.01297	11.2	0.0434	43.3
7:08:00	2.0	29.00	23.5	6.25	22.75	41.6	0.01297	11.5	0.0311	39.4
7:10:00	4.0	28.00	23.5	6.25	21.75	39.8	0.01297	11.7	0.0222	37.6
7:29:00	23.0	22.50	23.5	6.25	16.25	29.7	0.01297	12.7	0.0096	28.1
7:36:00	30.0	22.00	23.5	6.25	15.75	28.8	0.01297	12.7	0.0084	27.3
8:06:00	60.0	20.00	23.5	6.25	13.75	25.1	0.01297	13.0	0.0060	23.8
9:06:00	120.0	18.75	23.5	6.25	12.50	22.9	0.01297	13.3	0.0043	21.6
11:06:00	240.0	17.25	23.5	6.25	11.00	20.1	0.01297	13.5	0.0031	19.0
15:06:00	480.0	16.25	24.0	6.25	10.00	18.3	0.01282	13.7	0.0022	17.3
7:06:00	1440.0	14.25	24.0	6.25	8.00	14.6	0.01282	14.0	0.0013	13.8

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: W. Edlebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-003 #7 15'-17'	(CL) SANDY LEAN CLAY, trace gravel, grayish brown						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-003 #7 15'-17'	19.10	0.13	0.073	0.011		2.7	47.2	27.5	22.6

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL-ML) Silty clay with sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-003
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	6.5	2.9	97.1
4M	4.76	5.5	2.5	94.6
10M	2.00	8.5	3.8	90.8
20M	0.85	2.41	4.1	95.9 / 87.1
40M	0.42	3.36	5.7	90.2 / 81.9
60M	0.25	6.59	11.1	79.1 / 71.8
100M	0.149	7.65	12.8	66.3 / 60.2
140M	0.106	3.13	5.3	61.0 / 55.4
200M	0.074	2.97	5.0	56.0 / 50.8
LBW		33.08	55.8	
Pan		0.1	0.2	

Wet weight = - gm
Dry Initial weight = 59.29 gm
Moisture Content - %

Tested By: Jeanne Johnson / Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: N. Ellebest
Date: 8/27/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-003

Soil Description: (CL-ML) Silty clay with sand

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 11

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	90.8 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	60.16 g	59.29 g

Starting Date: 8/17/22 Starting Time: 7:18:00 Sedimentation Cylinder No.: HYD 24

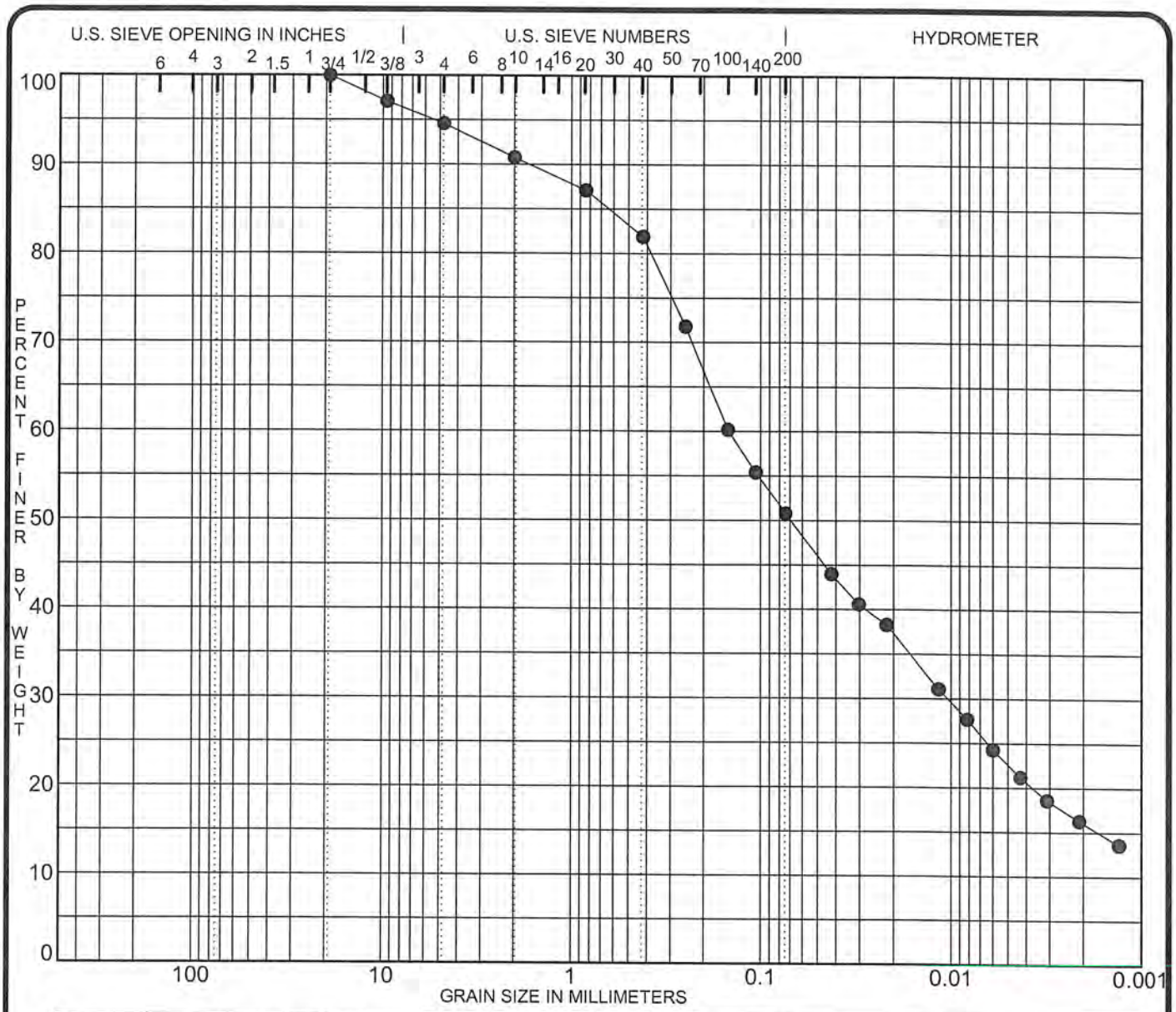
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:19:00	1.0	35.25	23.5	6.25	29.00	48.4	0.01297	10.6	0.0422	44.0
7:20:00	2.0	33.00	23.5	6.25	26.75	44.7	0.01297	10.9	0.0303	40.6
7:22:00	4.0	31.50	23.5	6.25	25.25	42.2	0.01297	11.2	0.0217	38.3
7:33:00	15.0	26.75	23.5	6.25	20.50	34.2	0.01297	12.0	0.0116	31.1
7:49:00	31.0	24.50	23.5	6.25	18.25	30.5	0.01297	12.4	0.0082	27.7
8:18:00	60.0	22.25	23.5	6.25	16.00	26.7	0.01297	12.7	0.0060	24.3
9:18:00	120.0	20.25	23.5	6.25	14.00	23.4	0.01297	13.0	0.0043	21.2
11:18:00	240.0	18.50	23.5	6.25	12.25	20.5	0.01297	13.3	0.0031	18.6
15:18:00	480.0	17.00	24.0	6.25	10.75	17.9	0.01282	13.5	0.0021	16.3
7:18:00	1440.0	15.25	24.0	6.25	9.00	15.0	0.01282	13.8	0.0013	13.6

Remarks:

Tested By: Jeanne Johnson Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-003 #13 33'-35'	(CL-ML) SILTY CLAY WITH SAND						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-003 #13 33'-35'	19.10	0.15	0.069	0.010		5.4	43.8	28.2	22.6

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (ML) Silt, some sand, trace gravel, light brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-006
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.00	0.0	100.0
3/8"	9.5	7.02	5.9	94.1
4M	4.76	0.00	0.0	94.1
10M	2.00	0.34	0.3	93.8
20M	0.85	0.14	0.3	99.7 / 93.5
40M	0.42	0.26	0.5	99.2 / 93.0
60M	0.25	0.85	1.5	97.7 / 91.6
100M	0.149	1.85	3.3	94.4 / 88.5
140M	0.106	1.48	2.7	91.7 / 86.0
200M	0.074	1.44	2.6	89.1 / 83.6
LBW		49.23	88.4	
Pan		0.38	0.7	

Wet weight = - gm
Dry Initial weight = 55.63 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/8/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-006

Soil Description: (ML) Silt, some sand, trace gravel, light brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 10

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	93.8 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.58 g	55.63 g

Starting Date: 8/4/22 Starting Time: 7:12:00 Sedimentation Cylinder No.: HYD 10

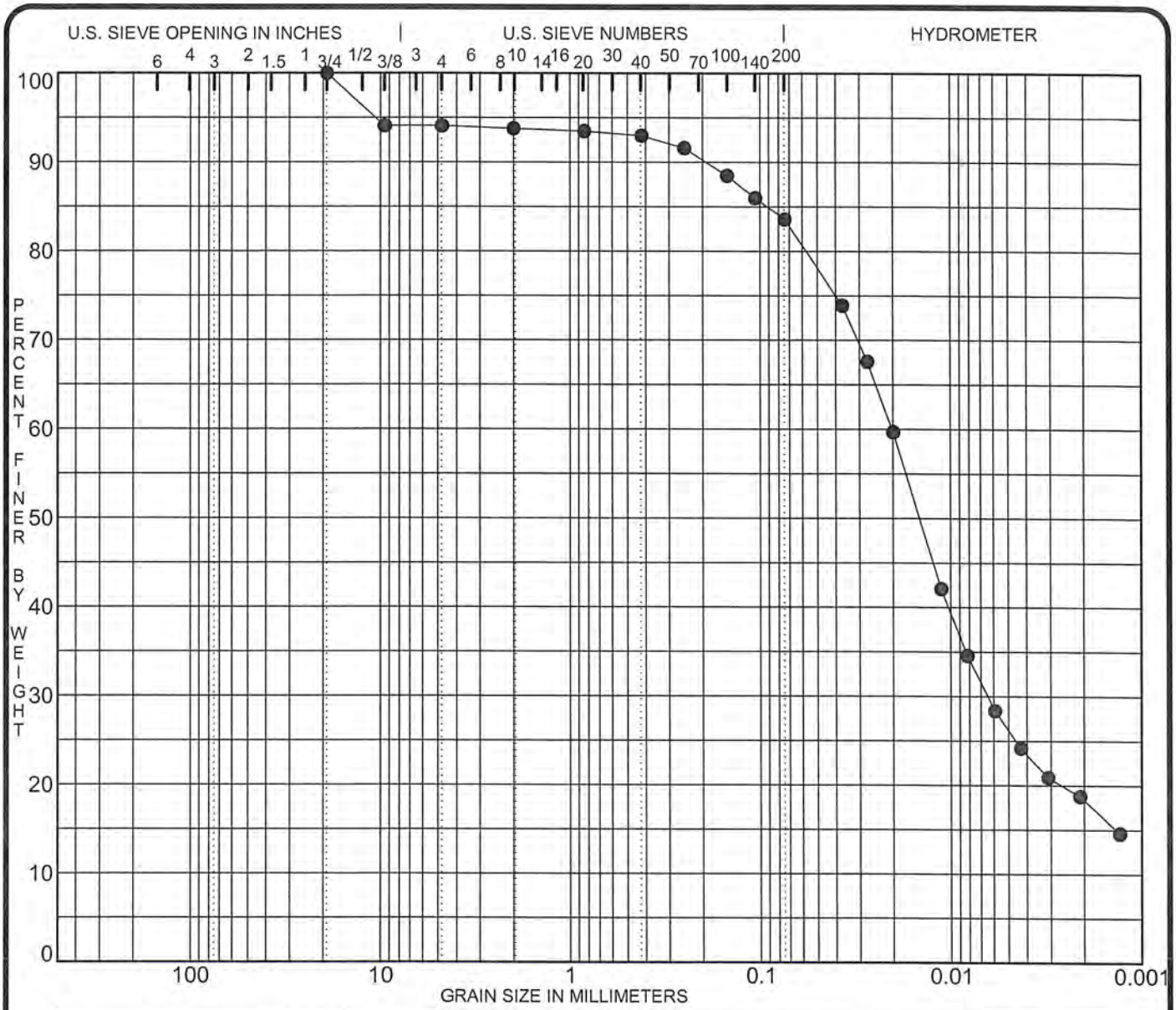
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:13:00	1.0	50.50	23.5	6.25	44.25	78.7	0.01297	8.1	0.0369	73.9
7:14:00	2.0	46.75	23.5	6.25	40.50	72.1	0.01297	8.8	0.0272	67.6
7:16:00	4.0	42.00	23.5	6.25	35.75	63.6	0.01297	9.4	0.0199	59.7
7:27:00	15.0	31.50	23.5	6.25	25.25	44.9	0.01297	11.2	0.0112	42.1
7:42:00	30.0	27.00	23.5	6.25	20.75	36.9	0.01297	11.9	0.0082	34.6
8:12:00	60.0	23.25	23.5	6.25	17.00	30.3	0.01297	12.5	0.0059	28.4
9:12:00	120.0	20.75	23.5	6.25	14.50	25.8	0.01297	13.0	0.0043	24.2
11:12:00	240.0	18.75	23.5	6.25	12.50	22.2	0.01297	13.3	0.0031	20.9
15:12:00	480.0	17.50	24.0	6.25	11.25	20.0	0.01282	13.5	0.0021	18.8
7:12:00	1440.0	15.00	24.0	6.25	8.75	15.6	0.01282	13.8	0.0013	14.6

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: N. Edlebeck Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-006 #6 12.5'-14.5'	(ML) SILT, some sand, trace gravel, light brown						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-006 #6 12.5'-14.5'	19.10	0.02	0.014	0.006		5.9	10.5	57.4	26.2

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine to medium, some gravel
Remarks:

Job No.: GL 191059F2
Boring No.: PD-006
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	10.1	3.9	96.1
4M	4.76	18.5	7.1	89.0
10M	2.00	21.6	8.3	80.7
20M	0.85	4.16	7.2	92.8 / 74.9
40M	0.42	5.27	9.1	83.7 / 67.5
60M	0.25	7.62	13.2	70.5 / 56.9
100M	0.149	8.04	13.8	56.7 / 45.8
140M	0.106	3.38	5.8	50.9 / 41.1
200M	0.074	3.34	5.8	45.1 / 36.4
LBW		26.02	44.9	
Pan		0.1	0.2	

Wet weight = - gm
Dry Initial weight = 57.93 gm
Moisture Content _____ %

Tested By: Jeanne Johnson / Taylor Follrath
Laboratory: Iron Mountain
Submitted By: R. Edlebeck

Date: 8/22/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-006

Soil Description: (SM) Silty sand, fine to medium, some gravel

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 3

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	80.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.25 g	57.93 g

Starting Date: 8/17/22 Starting Time: 7:00:00 Sedimentation Cylinder No.: HYD 1

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:01:00	1.0	27.50	23.5	6.25	21.25	36.3	0.01297	11.9	0.0447	29.3
7:02:00	2.0	25.25	23.5	6.25	19.00	32.5	0.01297	12.2	0.0320	26.2
7:04:00	4.0	25.00	23.5	6.25	18.75	32.0	0.01297	12.2	0.0227	25.9
7:15:00	15.0	24.75	23.5	6.25	18.50	31.6	0.01297	12.4	0.0118	25.5
7:30:00	30.0	18.00	23.5	6.25	11.75	20.1	0.01297	13.3	0.0086	16.2
8:00:00	60.0	16.25	23.5	6.25	10.00	17.1	0.01297	13.7	0.0062	13.8
9:00:00	120.0	15.00	23.5	6.25	8.75	15.0	0.01297	13.8	0.0044	12.1
11:00:00	240.0	13.50	23.5	6.25	7.25	12.4	0.01297	14.2	0.0032	10.0
15:00:00	480.0	13.00	24.0	6.25	6.75	11.5	0.01282	14.2	0.0022	9.3
7:00:00	1440.0	12.00	24.0	6.25	5.75	9.8	0.01282	14.3	0.0013	7.9

Remarks:

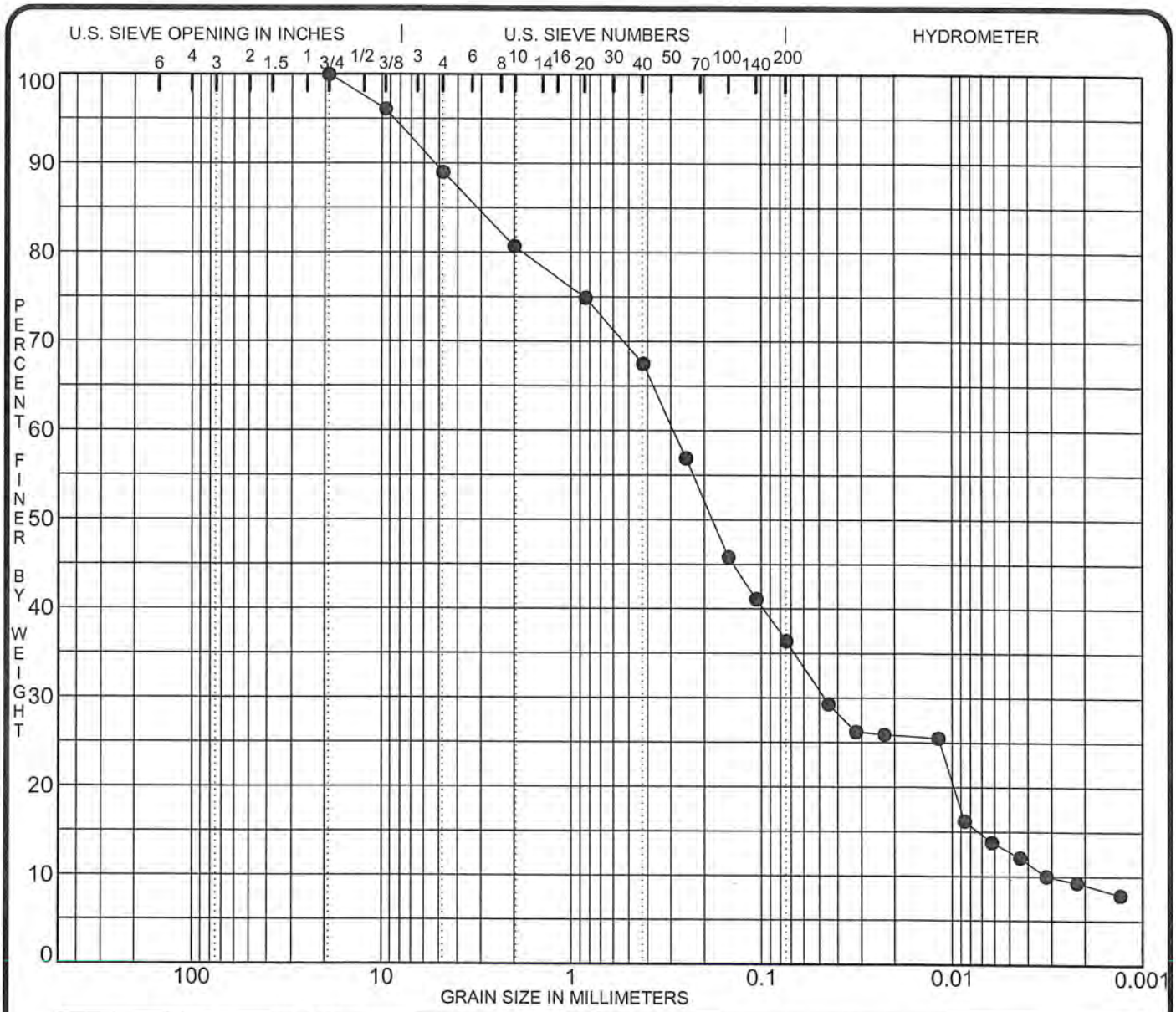
Tested By: Jeanne Johnson

Date: 8/17/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck

Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-006 #13 33'-35'**	**(SM) SILTY SAND, fine to medium, some gravel**					**2.37**	**90.9**

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-006 #13 33'-35'**	**19.10**	**0.29**	**0.181**	**0.047**	**0.0032**	**11.0**	**52.6**	**23.7**	**12.7**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine
Remarks:

Job No.: GL 191059F2
Boring No.: PD-008
Sample No.: 11
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	6.3	2.7	97.3
4M	4.76	7.6	3.2	94.1
10M	2.00	11.4	4.8	89.3
20M	0.85	2.86	4.9	95.1 / 84.9
40M	0.42	4.02	6.9	88.2 / 78.8
60M	0.25	7.58	13.0	75.2 / 67.2
100M	0.149	8.31	14.3	60.9 / 54.4
140M	0.106	3.27	5.6	55.3 / 49.4
200M	0.074	3.08	5.3	50.0 / 44.6
LBW		29.15	49.9	
Pan		0.06	0.1	

Wet weight = - gm
Dry Initial weight = 58.33 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/22/2022
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-008

Soil Description: (SM) Silty sand, fine

Sample No.: 11

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 10

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	89.3 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	58.63 g	58.33 g

Starting Date: 8/19/22 Starting Time: 7:30:00 Sedimentation Cylinder No.: HYD 11

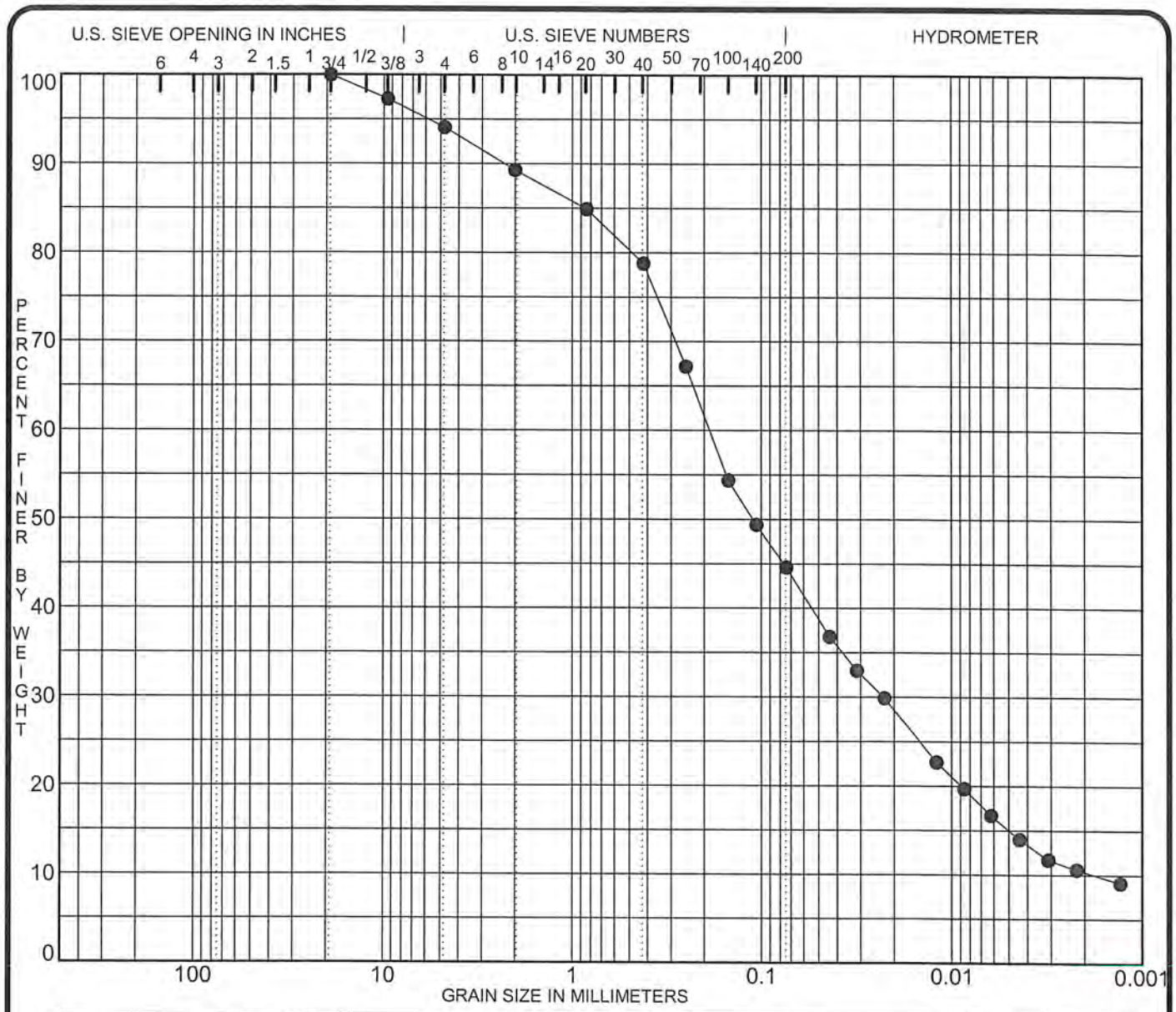
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:31:00	1.0	30.50	23.5	6.25	24.25	41.2	0.01297	11.4	0.0438	36.8
7:32:00	2.0	28.00	23.5	6.25	21.75	36.9	0.01297	11.7	0.0314	33.0
7:34:00	4.0	26.00	23.5	6.25	19.75	33.5	0.01297	12.0	0.0225	29.9
7:45:00	15.0	21.25	23.5	6.25	15.00	25.5	0.01297	12.9	0.0120	22.7
8:00:00	30.0	19.25	23.5	6.25	13.00	22.1	0.01297	13.2	0.0086	19.7
8:30:00	60.0	17.25	23.5	6.25	11.00	18.7	0.01297	13.5	0.0062	16.7
9:30:00	120.0	15.50	23.5	6.25	9.25	15.7	0.01297	13.8	0.0044	14.0
11:30:00	240.0	14.00	24.0	6.25	7.75	13.2	0.01282	14.0	0.0031	11.7
15:30:00	480.0	13.25	24.0	6.25	7.00	11.9	0.01282	14.2	0.0022	10.6
7:30:00	1440.0	12.25	23.5	6.25	6.00	10.2	0.01297	14.3	0.0013	9.1

Remarks:

Tested By: Jeanne Johnson Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: D. Edlebeck Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-008 #11 33'-35'	(SM) SILTY SAND, fine					1.55	104.8

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-008 #11 33'-35'	19.10	0.19	0.110	0.023	0.0018	5.9	49.5	29.6	15.0

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (ML) Sandy silt, light grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-009
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☑ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5	0.00	0.0	100.0
4M	4.76	0.67	0.7	99.3
10M	2.00	1.97	2.1	97.2
20M	0.85	1.45	2.6	97.4 / 94.7
40M	0.42	2.01	3.6	93.8 / 91.2
60M	0.25	2.60	4.6	89.2 / 86.7
100M	0.149	1.35	2.4	86.8 / 84.4
140M	0.106	0.61	1.1	85.7 / 83.3
200M	0.074	2.24	4.0	81.7 / 79.4
LBW		43.79	78.1	
Pan		2.03	3.6	

Wet weight = - gm
Dry Initial weight = 56.08 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/8/2022
Laboratory: Iron Mountain
Submitted By: D. Edlebeck
Date: 8/27/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-009

Soil Description: (ML) Sandy silt, light grayish brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 3

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	97.2 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.41 g	56.08 g

Starting Date: 8/4/22 Starting Time: 7:24:00 Sedimentation Cylinder No.: HYD 2

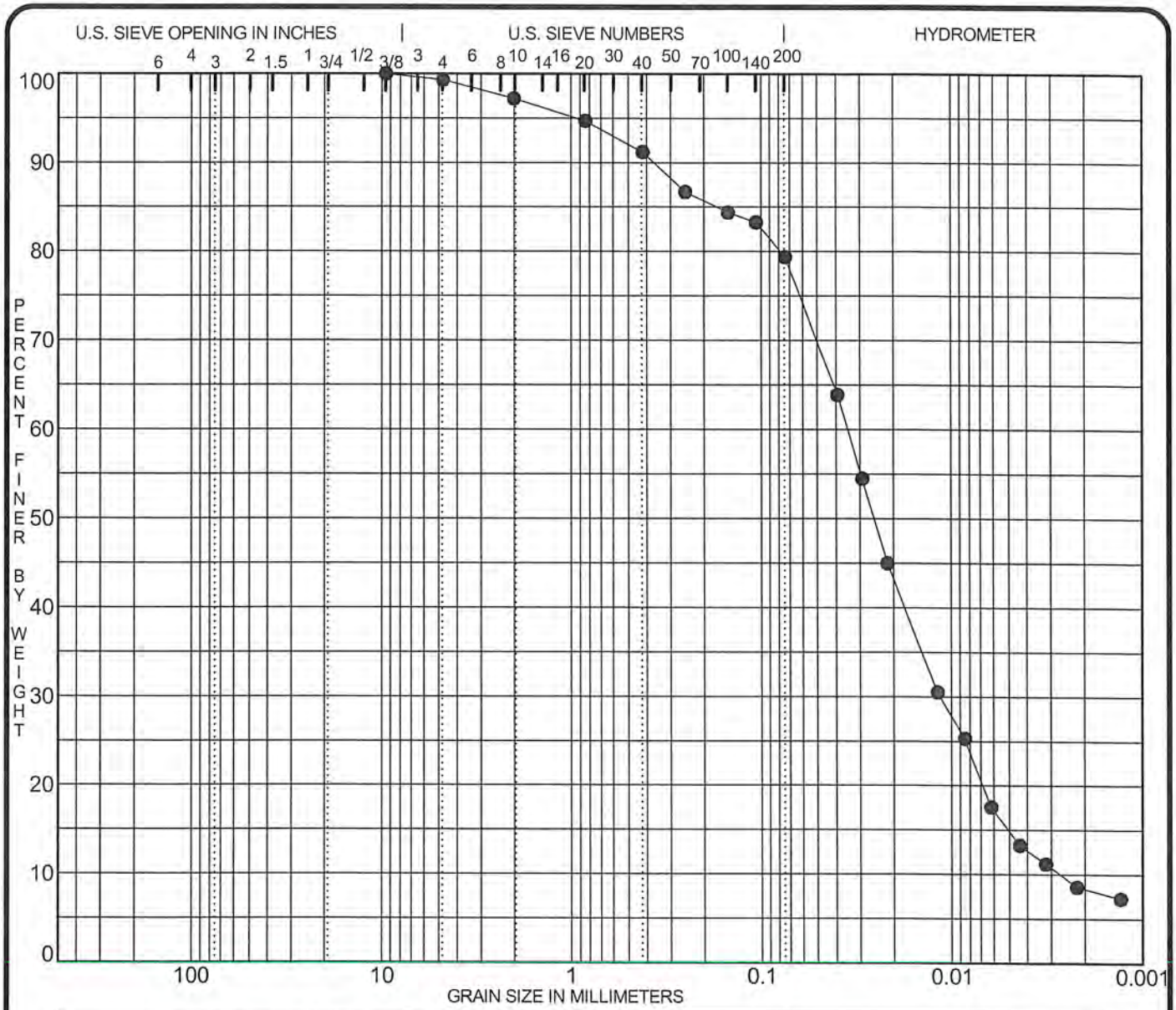
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:25:00	1.0	43.50	23.5	6.25	37.25	65.8	0.01297	9.2	0.0393	63.9
7:26:00	2.0	38.00	23.5	6.25	31.75	56.0	0.01297	10.1	0.0291	54.5
7:28:00	4.0	32.50	23.5	6.25	26.25	46.3	0.01297	11.1	0.0216	45.0
7:39:00	15.0	24.00	23.5	6.25	17.75	31.3	0.01297	12.4	0.0118	30.5
7:54:00	30.0	21.00	23.5	6.25	14.75	26.0	0.01297	12.9	0.0085	25.3
8:24:00	60.0	16.50	23.5	6.25	10.25	18.1	0.01297	13.7	0.0062	17.6
9:24:00	120.0	14.00	23.5	6.25	7.75	13.7	0.01297	14.0	0.0044	13.3
11:24:00	240.0	12.75	23.5	6.25	6.50	11.5	0.01297	14.3	0.0032	11.2
15:24:00	480.0	11.25	24.0	6.25	5.00	8.8	0.01282	14.7	0.0022	8.6
7:24:00	1440.0	10.50	24.0	6.25	4.25	7.5	0.01282	14.7	0.0013	7.3

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: D. Ellebed Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**PD-009 #6 12.5'-14.5'**	**(ML) SANDY SILT, light grayish brown**					**1.40**	**12.9**

	Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**PD-009 #6 12.5'-14.5'**	**9.50**	**0.03**	**0.025**	**0.011**	**0.0027**	**0.7**	**19.9**	**64.5**	**14.9**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE • IRON MOUNTAIN, MI 49801 • PHONE: 906-774-3440
200 EAST AYER STREET • IRONWOOD, MI 49938 • PHONE: 906-932-5048
120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Lean clay, some sand
Remarks:

Job No.: GL 191059F2
Boring No.: PD-009
Sample No.: 13
Depth: 33'-35'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	0.0	0.0	100.0
4M	4.76	0.2	0.1	99.9
10M	2.00	0.4	0.2	99.7
20M	0.85	0.15	0.3	99.7 / 99.4
40M	0.42	0.33	0.6	99.1 / 98.8
60M	0.25	0.59	1.1	98.0 / 97.7
100M	0.149	0.71	1.3	96.7 / 96.4
140M	0.106	0.38	0.7	96.0 / 95.7
200M	0.074	2.08	3.7	92.3 / 92.0
LBW		51.38	91.9	
Pan		0.20	0.4	

Wet weight = - gm
Dry Initial weight = 55.82 gm
Moisture Content - %

Tested By: Jeanne Johnson
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: D. Ellebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-009

Soil Description: (CL) Lean clay, some sand

Sample No.: 13

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 33'-35'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 8

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	99.7 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	56.59 g	55.82 g

Starting Date: 8/19/22 Starting Time: 7:42:00 Sedimentation Cylinder No.: HYD 10

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:43:00	1.0	48.00	24.0	6.25	41.75	74.0	0.01282	8.4	0.0372	73.8
7:44:00	2.0	44.25	24.0	6.25	38.00	67.4	0.01282	9.1	0.0273	67.2
7:46:00	4.0	41.25	24.0	6.25	35.00	62.1	0.01282	9.6	0.0199	61.9
7:57:00	15.0	34.75	24.0	6.25	28.50	50.5	0.01282	10.7	0.0108	50.4
8:12:00	30.0	31.00	24.0	6.25	24.75	43.9	0.01282	11.2	0.0078	43.8
8:42:00	60.0	28.00	24.0	6.25	21.75	38.6	0.01282	11.7	0.0057	38.5
9:42:00	120.0	25.50	24.0	6.25	19.25	34.1	0.01282	12.2	0.0041	34.0
11:42:00	240.0	23.25	24.0	6.25	17.00	30.2	0.01282	12.5	0.0029	30.1
15:42:00	480.0	21.50	24.0	6.25	15.25	27.0	0.01282	12.9	0.0021	27.0
7:42:00	1440.0	19.00	23.5	6.25	12.75	22.6	0.01297	13.2	0.0012	22.5

Remarks:

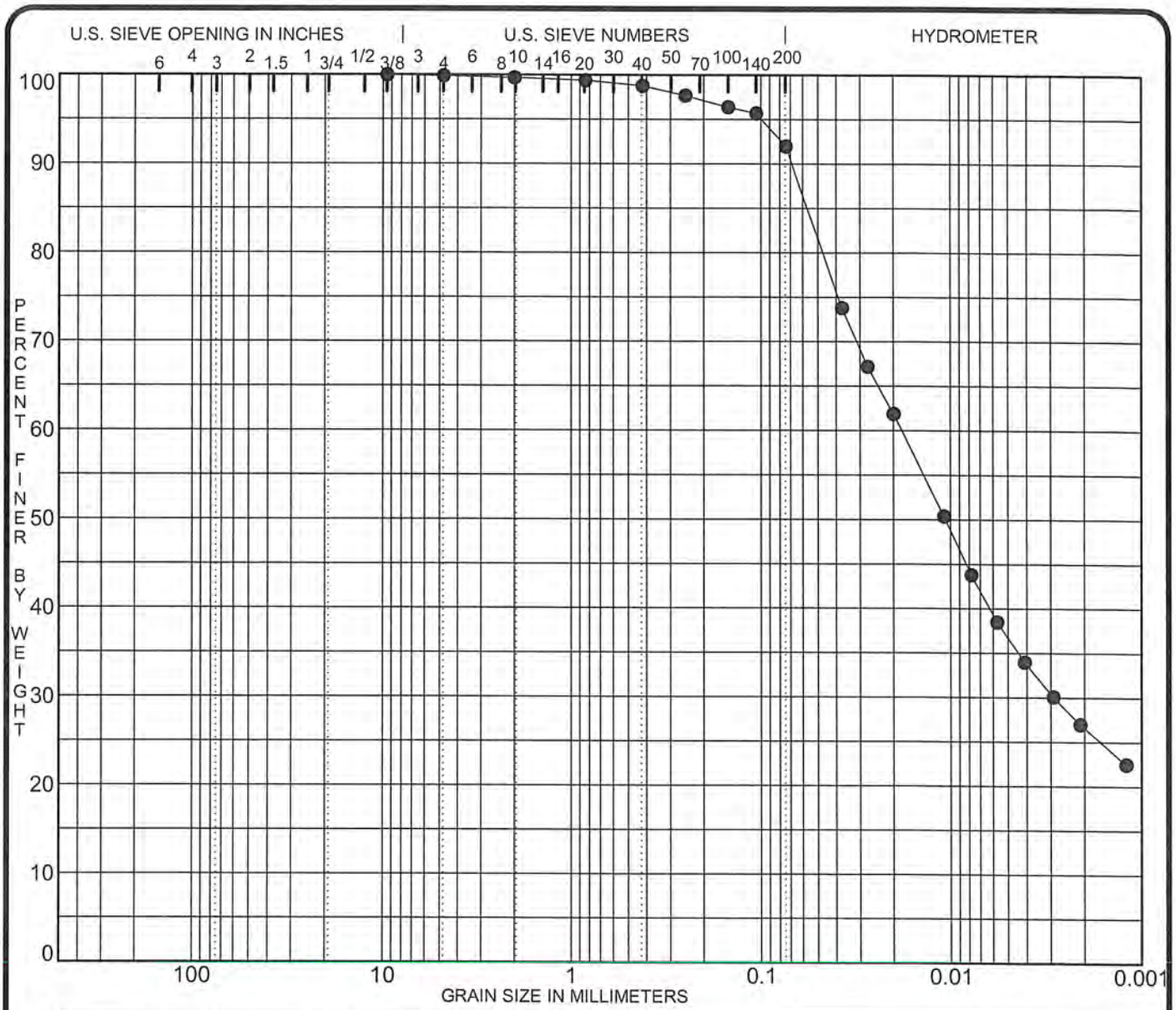
Tested By: Jeanne Johnson

Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: W. Edlebeck

Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-009 #13 33'-35'	(CL) LEAN CLAY, some sand						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-009 #13 33'-35'	9.50	0.02	0.011	0.003		0.1	7.9	55.3	36.7

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
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COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (SM) Silty sand, fine, light grayish brown
Remarks:

Job No.: GL 191059F2
Boring No.: PD-010
Sample No.: 6
Depth: 12.5'-14.5'

Prior Testing On Specimen:
Hydrometer

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1			
3/8"	9.5			
4M	4.76			
10M	2.00			
20M	0.85	0.01	0.0	100.0
40M	0.42	0.09	0.2	99.8
60M	0.25	1.19	2.1	97.7
100M	0.149	15.94	27.5	70.2
140M	0.106	12.62	21.8	48.4
200M	0.074	11.45	19.8	28.6
LBW		11.77	20.4	
Pan		4.71	8.2	

Wet weight = - gm
Dry Initial weight = 57.78 gm
Moisture Content - %

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: N. Edlebeck

Date: 8/8/2022
Date: 8/27/22

Form D6913 Revised 3/17/22

COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-010

Soil Description: (SM) Silty sand, fine, light grayish brown

Sample No.: 6

Prior Testing: [X] No [ ] Yes Type:

Depth: 12.5'-14.5'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Specimen-mixing Container ID: HB 5

Foam Inhibitor Used: [ ] Yes [X] No

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	100.0 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	57.95 g	57.78 g

Starting Date: 8/4/22 Starting Time: 7:18:00 Sedimentation Cylinder No.: HYD 4

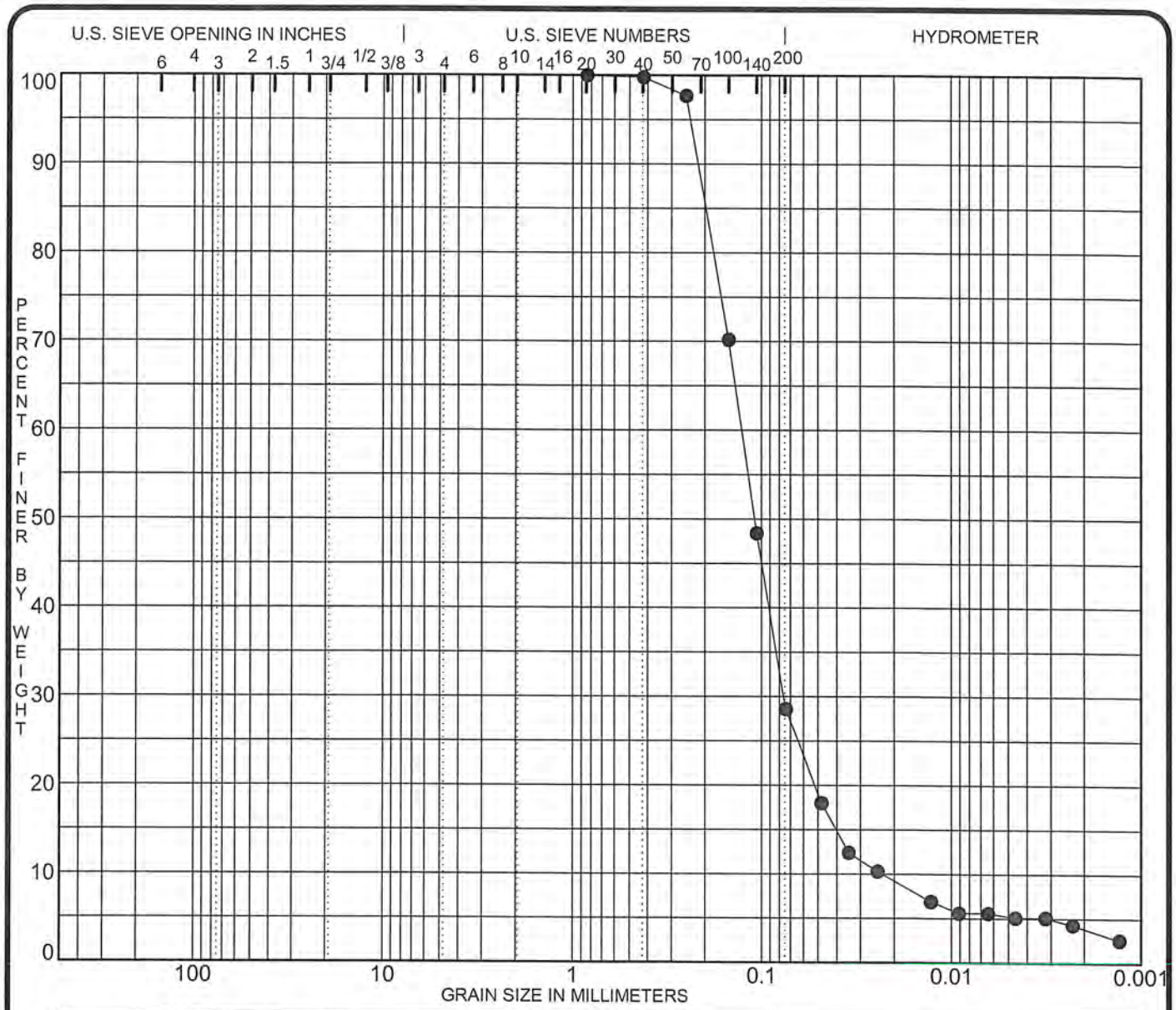
Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:19:00	1.0	16.75	23.5	6.25	10.50	18.0	0.01297	13.7	0.0480	18.0
7:20:00	2.0	13.50	23.5	6.25	7.25	12.4	0.01297	14.2	0.0346	12.4
7:22:00	4.0	12.25	23.5	6.25	6.00	10.3	0.01297	14.3	0.0245	10.3
7:33:00	15.0	10.25	23.5	6.25	4.00	6.9	0.01297	14.7	0.0128	6.9
7:48:00	30.0	9.50	23.5	6.25	3.25	5.6	0.01297	14.8	0.0091	5.6
8:18:00	60.0	9.50	23.5	6.25	3.25	5.6	0.01297	14.8	0.0064	5.6
9:18:00	120.0	9.25	23.5	6.25	3.00	5.1	0.01297	14.8	0.0046	5.1
11:18:00	240.0	9.25	23.5	6.25	3.00	5.1	0.01297	14.8	0.0032	5.1
15:18:00	480.0	8.75	24.0	6.25	2.50	4.3	0.01282	15.0	0.0023	4.3
7:18:00	1440.0	7.75	24.0	6.25	1.50	2.6	0.01282	15.2	0.0013	2.6

Remarks:

Tested By: Jeanne Johnson Date: 8/4/2022

Laboratory: Iron Mountain

Submitted By: W. Ellebedi Date: 8/27/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● PD-010 #6 12.5'-14.5'	(SM) SILTY SAND, fine, light grayish brown					1.96	5.5

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● PD-010 #6 12.5'-14.5'	0.84	0.13	0.109	0.076	0.0231	0.0	71.4	23.4	5.2

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
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COLEMAN ENGINEERING COMPANY
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120 US HWY 41 EAST, STE B • NEGAUNEE, MI 49866 • PHONE: 906-475-7489

PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

ASTM D6913

Project Name: Velsicol Chemical
Client: Jacobs
Soil Description: (CL) Sandy lean clay
Remarks:

Job No.: GL 191059F2
Boring No.: PD-010
Sample No.: 8
Depth: 23'-25'

Prior Testing On Specimen:
Hydrometer, Atterberg, Moisture

Test Method:
☑ A ☐ B

Specimen Obtained:
☐ Moist
☑ Air Dried
☐ Oven Dried

Composite Sieving Used:
☑ Y ☐ N

Separating Sieve Size:
#10

Shaking Apparatus Used:
Hand Shaking

Scale: Ohaus 8028241065

Sieve Size	Grain Diameter (mm)	Weight Retained	Percent Retained	Percent Finer
3"	76.2			
2"	50.8			
1 1/2"	37.5			
1"	25.4			
3/4"	19.1	0.0	0.0	100.0
3/8"	9.5	0.0	0.0	100.0
4M	4.76	1.0	0.4	99.6
10M	2.00	6.0	2.3	97.3
20M	0.85	1.48	2.7	97.3 / 94.7
40M	0.42	2.45	4.5	92.8 / 90.3
60M	0.25	5.27	9.6	83.2 / 81.0
100M	0.149	6.40	11.7	71.5 / 69.6
140M	0.106	2.63	4.8	66.7 / 64.9
200M	0.074	2.35	4.3	62.4 / 60.7
LBW		34.07	62.3	
Pan		0.07	0.1	

Wet weight = - gm
Dry Initial weight = 54.72 gm
Moisture Content - %

Tested By: Taylor Follrath
Date: 8/22/2022
Laboratory: Iron Mountain
Submitted By: N. Edlebeck
Date: 8/22/22

Form D6913 Revised 3/17/22

COLEMAN ENGINEERING COMPANY
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PARTICLE-SIZE ANALYSIS OF SOILS - HYDROMETER

ASTM D7928

Project Name: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.: PD-010

Soil Description: (CL) Sandy lean clay

Sample No.: 8

Prior Testing: [ ] No [X] Yes Type: Atterberg, Moisture

Depth: 23'-25'

Equipment Used: Scale: Ohaus 8028241065; Specific Gravity Bulb:43-335

Thermometer: P98989

Amount Dissolved in 100 mL Water, M_{disp}: 5.00 g

Foam Inhibitor Used: [ ] Yes [X] No

Specimen-mixing Container ID: HB 5

Flocculation?: [ ] Yes [X] No

% of Original Sample Used for Hydrometer Analysis:	97.3 %

Weight of Sample Dispersed:	Moist, M_m	Dry, M_d
	55.17 g	54.72 g

Starting Date: 8/19/22 Starting Time: 7:36:00 Sedimentation Cylinder No.: HYD 2

Time	Elasped Time Minutes (T)	Hydrometer Reading	Temperature °C	Correction (DR)	Corr. Hydrometer Reading	Percent Soil in Suspension (P)	K, Values from Table II	L, Values from Table III	Calculated Grain Diameter, mm (d)	Percent of Total Sample C.G.D.
7:37:00	1.0	38.00	23.5	6.25	31.75	57.4	0.01297	10.1	0.0412	55.9
7:38:00	2.0	35.50	23.5	6.25	29.25	52.9	0.01297	10.6	0.0299	51.5
7:40:00	4.0	34.50	23.5	6.25	28.25	51.1	0.01297	10.7	0.0212	49.7
7:51:00	15.0	30.50	23.5	6.25	24.25	43.9	0.01297	11.4	0.0113	42.7
8:06:00	30.0	28.00	23.5	6.25	21.75	39.4	0.01297	11.7	0.0081	38.3
8:36:00	60.0	25.75	23.5	6.25	19.25	34.8	0.01297	12.2	0.0058	33.9
9:36:00	120.0	23.25	23.5	6.25	17.00	30.8	0.01297	12.5	0.0042	29.9
11:36:00	240.0	21.00	24.0	6.25	14.75	26.7	0.01282	12.9	0.0030	26.0
15:36:00	480.0	20.00	24.0	6.25	13.75	24.9	0.01282	13.0	0.0021	24.2
7:36:00	1440.0	17.00	23.5	6.25	10.75	19.4	0.01297	13.5	0.0013	18.9

Remarks:

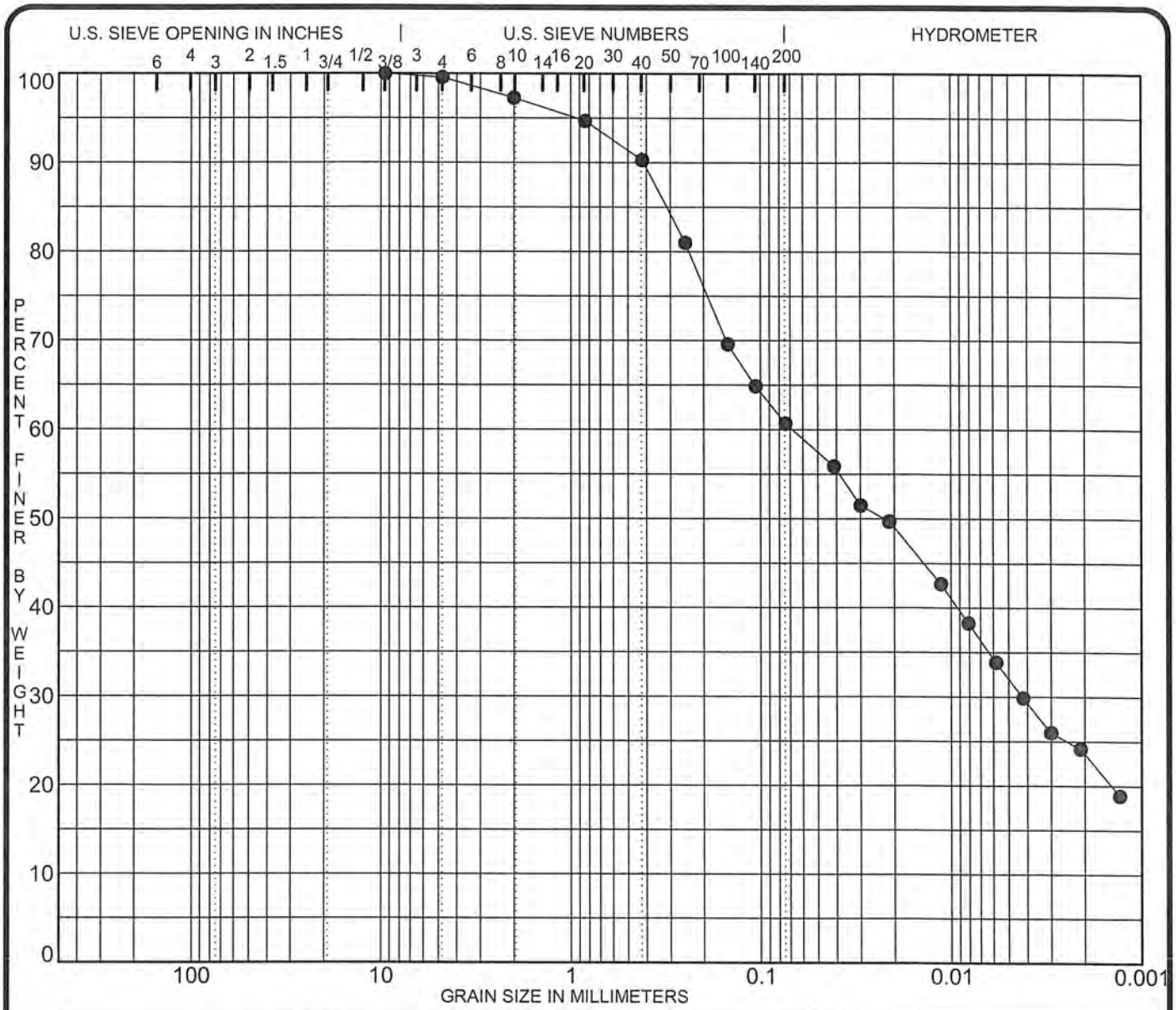
Tested By: Jeanne Johnson

Date: 8/19/2022

Laboratory: Iron Mountain

Submitted By: R. Edlebrock

Date: 8/22/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **PD-010 #8 23'-25'**	(CL) **SANDY LEAN CLAY**						

Specimen Identification	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **PD-010 #8 23'-25'**	**9.50**	**0.07**	**0.022**	**0.004**		**0.4**	**38.9**	**28.6**	**32.1**

PROJECT **Jacobs - Velsicol Chemical**

JOB NO. **191059-F2**
DATE **8/31/22**

GRADATION CURVES

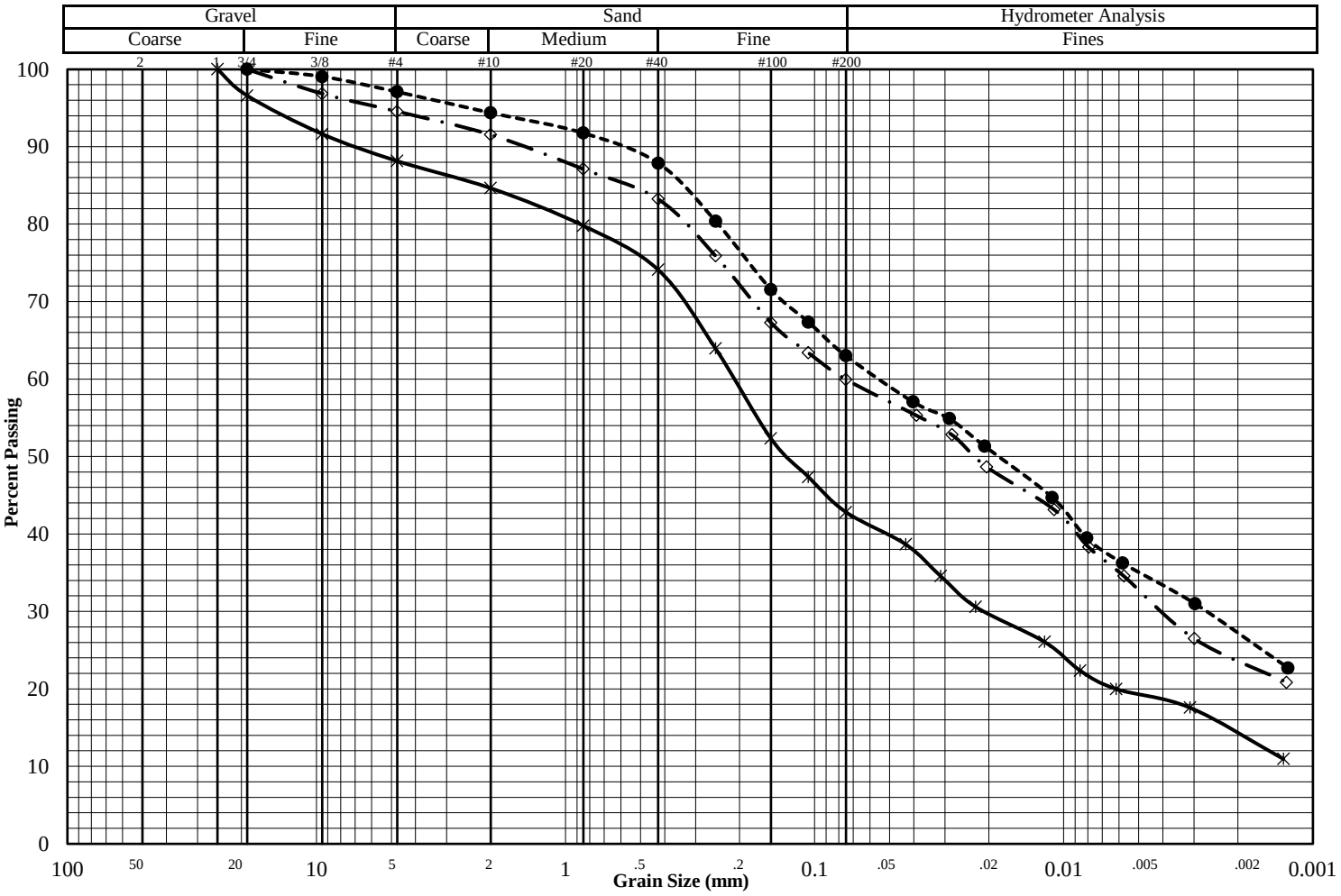
COLEMAN ENGINEERING COMPANY
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/3/22
Reported To:	Coleman Engineering Co.	Report Date:	8/8/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	PD-001		30-33	TWT	Silty Clayey Sand w/a little gravel (SC-SM)
●	PD-003		25-28	TWT	Sandy Lean Clay w/a trace of gravel (CL)
◇	PD-006		25-28	TWT	Sandy Lean Clay w/a little gravel (CL)



Additional Results	∗	●	◇
Liquid Limit	16	21	21
Plastic Limit	10	10	11
Plasticity Index ASTM:D4316	6	11	10
Water Content ASTM:D2216			
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854	2.68*	2.68*	2.68*
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing (Single Set)

	∗	●	◇
Mass (g)	470.9	350.5	303.9
1"	100.0		
3/4"	96.6	100.0	100.0
3/8"	91.6	99.1	96.9
#4	88.2	97.1	94.6
#10	84.7	94.4	91.6
#20	79.8	91.8	87.1
#40	74.1	87.9	83.2
#60	64.0	80.4	75.9
#100	52.3	71.6	67.3
#140	47.4	67.4	63.4
#200	42.8	63.0	60.0

**Sieves larger than 1" reported on page 2

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/3/22
Reported To:	Coleman Engineering Co.	Report Date:	8/8/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	PD-001		30-33	TWT	Silty Clayey Sand w/a little gravel (SC-SM)
Spec 2	PD-003		25-28	TWT	Sandy Lean Clay w/a trace of gravel (CL)
Spec 3	PD-006		25-28	TWT	Sandy Lean Clay w/a little gravel (CL)

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
3"		3"		3"	
2"		2"		2"	
1 1/2"		1 1/2"		1 1/2"	
1"	100.0	1"		1"	
3/4"	96.6	3/4"	100.0	3/4"	100.0
3/8"	91.6	3/8"	99.1	3/8"	96.9
#4	88.2	#4	97.1	#4	94.6
#10	84.7	#10	94.4	#10	91.6
#20	79.8	#20	91.8	#20	87.1
#40	74.1	#40	87.9	#40	83.2
#60	64.0	#60	80.4	#60	75.9
#100	52.3	#100	71.6	#100	67.3
#140	47.4	#140	67.4	#140	63.4
#200	42.8	#200	63.0	#200	60.0

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.043	38.7	0.040	57.1	0.039	55.3
0.031	34.6	0.029	54.9	0.028	52.8
0.023	30.6	0.021	51.4	0.020	48.7
0.012	26.1	0.011	44.7	0.011	43.1
0.009	22.4	0.008	39.5	0.008	38.3
0.006	20.0	0.006	36.2	0.006	34.6
0.003	17.6	0.003	31.0	0.003	26.5
0.001	11.0	0.001	22.7	0.001	20.8

Remarks

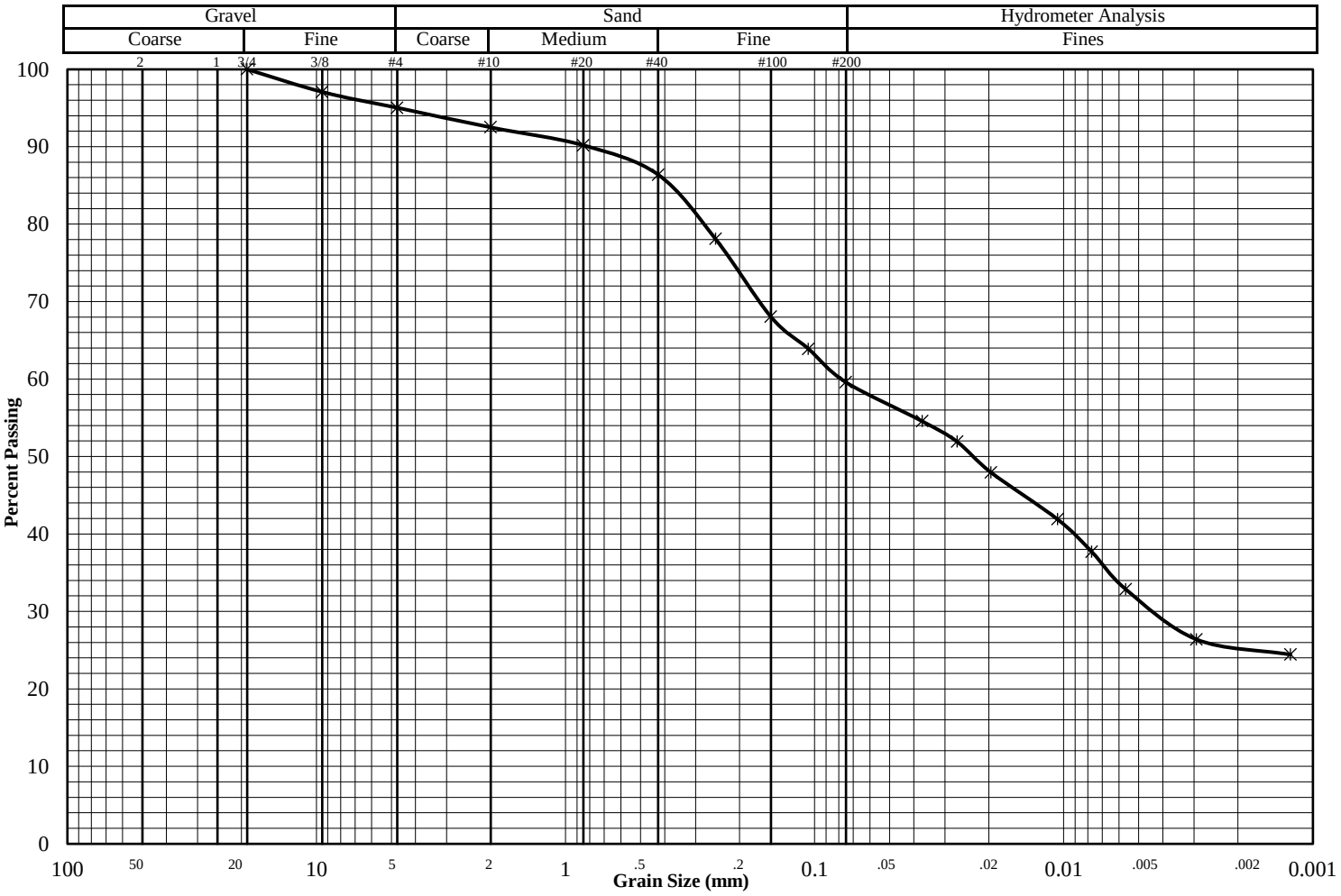
Specimen 1	Specimen 2	Specimen 3

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/10/22
Reported To:	Coleman Engineering Co.	Report Date:	8/12/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	PD-009		30-33	TWT	Sandy Lean Clay w/a little gravel (CL)
●					
◇					



Additional Results	∗	●	◇
Liquid Limit	20		
Plastic Limit	11		
Plasticity Index ASTM:D4316	9		
Water Content ASTM:D2216			
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854	2.68*		
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing (Single Set)

	∗	●	◇
Mass (g)	313.1		
1"			
3/4"	100.0		
3/8"	97.1		
#4	95.0		
#10	92.5		
#20	90.2		
#40	86.4		
#60	78.1		
#100	68.1		
#140	63.9		
#200	59.6		

**Sieves larger than 1" reported on page 2

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Grain Size Distribution ASTM D6913/D7928

Job No. : **13945**

Project:	Velsicol	Test Date:	8/10/22
Reported To:	Coleman Engineering Co.	Report Date:	8/12/22

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	PD-009		30-33	TWT	Sandy Lean Clay w/a little gravel (CL)
Spec 2					
Spec 3					

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
3"		3"		3"	
2"		2"		2"	
1 1/2"		1 1/2"		1 1/2"	
1"		1"		1"	
3/4"	100.0	3/4"		3/4"	
3/8"	97.1	3/8"		3/8"	
#4	95.0	#4		#4	
#10	92.5	#10		#10	
#20	90.2	#20		#20	
#40	86.4	#40		#40	
#60	78.1	#60		#60	
#100	68.1	#100		#100	
#140	63.9	#140		#140	
#200	59.6	#200		#200	

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.037	54.6				
0.027	51.9				
0.020	47.9				
0.011	41.9				
0.008	37.7				
0.006	32.9				
0.003	26.4				
0.001	24.4				

Remarks

Specimen 1	Specimen 2	Specimen 3

9530 James Ave South

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Bloomington, MN 55431

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

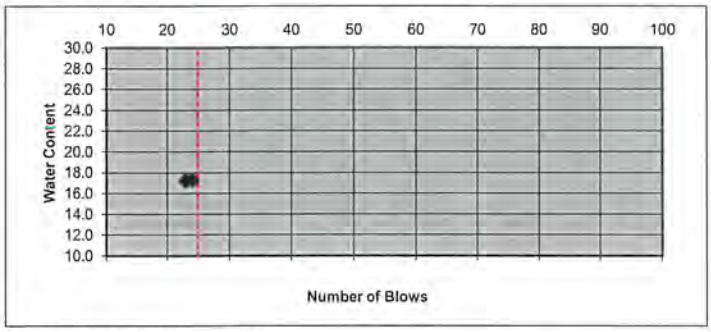
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Lean clay with sand

Job No.: GL-191059F2
Boring No.: PD-001
Sample No.: 15
Depth: 38'-40'

Liquid Limit Determination

Can No.	5	23				
Wt. of wet soil +can (g)	30.61	30.51				
Wt. of dry soil + can (g)	28.43	28.38				
Wt. of can (g)	15.82	16.01				
Wt of dry soil (g)	12.61	12.37				
Wt of moisture (g)	2.18	2.13				
* No of blows, N	**24**	**23**				
Water content, *w* %	**17.3**	**17.2**				
K Values and Corrected Average	**K=0.995 17.2**	**K=0.990 17.0**	**Avg = 17.1**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 17
Plastic limit = 10
Plasticity index I_p = 7

Plastic Limit Determination

Can no.	30	38				
Wt. of wet soil + can (g)	28.37	27.20				
Wt. of dry soil + can (g)	27.22	26.16				
Wt. of can (g)	16.15	16.00				
Wt. of dry soil (g)	11.07	10.16				
Wt. of moisture (g)	1.15	1.04				
Water content, $w\% = w_p$	10.4	10.2	Avg = 10.3			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: W. Edlebeck
Date: 8/27/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

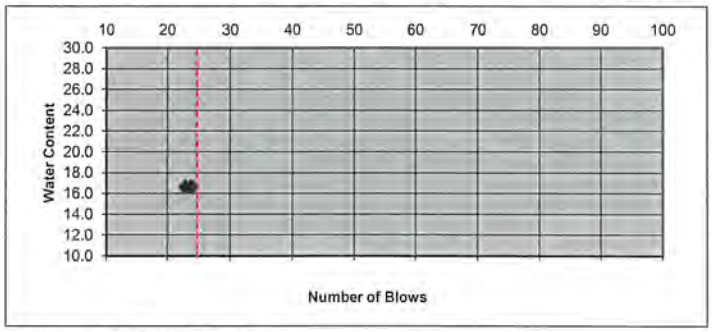
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL-ML) Silty clay, with sand, trace gravel

Job No.: GL-191059F2
Boring No.: PD-002
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	42	36				
Wt. of wet soil +can (g)	34.03	32.30				
Wt. of dry soil + can (g)	31.47	29.96				
Wt. of can (g)	16.04	15.89				
Wt of dry soil (g)	15.43	14.07				
Wt of moisture (g)	2.56	2.34				
* No of blows, N	**23**	**24**				
Water content, *w* %	**16.6**	**16.6**				
K Values and Corrected Average	**K=0.990 16.4**	**K=0.995 16.5**	**Avg = 16.4**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 16
Plastic limit = 10
Plasticity index I_p = 6

Plastic Limit Determination

Can no.	44	26				
Wt. of wet soil + can (g)	26.01	29.66				
Wt. of dry soil + can (g)	25.10	28.41				
Wt. of can (g)	15.91	16.11				
Wt. of dry soil (g)	9.19	12.30				
Wt. of moisture (g)	0.91	1.25				
Water content, w % = w_p	9.9	10.2	Avg = 10.0			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: N. Ellabes
Date: 8/27/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

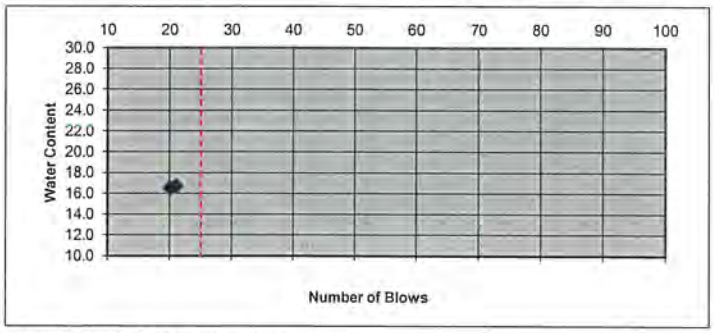
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL-ML) Silty clay with sand

Job No.: GL-191059F2
Boring No.: PD-003
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	33	37				
Wt. of wet soil +can (g)	31.65	31.00				
Wt. of dry soil + can (g)	29.41	28.87				
Wt. of can (g)	15.97	15.99				
Wt of dry soil (g)	13.44	12.88				
Wt of moisture (g)	2.24	2.13				
* No of blows, N	**21**	**20**				
Water content, *w* %	**16.7**	**16.5**				
K Values and Corrected Average	**K=0.979 16.3**	**K=0.973 16.1**	**Avg = 16.2**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 16
Plastic limit = 10
Plasticity index I_p = 6

Plastic Limit Determination

Can no.	40	45				
Wt. of wet soil + can (g)	29.23	28.85				
Wt. of dry soil + can (g)	27.96	27.67				
Wt. of can (g)	15.81	15.94				
Wt. of dry soil (g)	12.15	11.73				
Wt. of moisture (g)	1.27	1.18				
Water content, $w\% = w_p$	10.5	10.1	Avg = 10.3			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson / Dylan Bousley
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/17/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

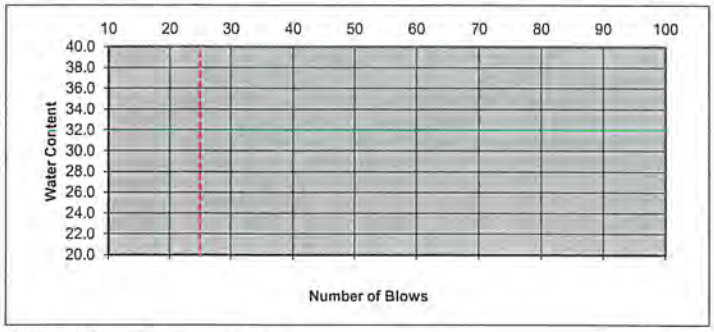
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (SM) Silty sand, fine to medium, some gravel

Job No.: GL-191059F2
Boring No.: PD-006
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.						
Wt. of wet soil +can (g)						
Wt. of dry soil + can (g)						
Wt. of can (g)						
Wt of dry soil (g)						
Wt of moisture (g)						
* No of blows, N						
Water content, *w* %						
K Values and Corrected Average						

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit =
Plastic limit =
Plasticity index I_p =

***Non Plastic**
Sample could not be rolled to 1/8 inch thread

Plastic Limit Determination

Can no.						
Wt. of wet soil + can (g)						
Wt. of dry soil + can (g)						
Wt. of can (g)						
Wt. of dry soil (g)						
Wt. of moisture (g)						
Water content, $w\,\% = w_p$						

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Date: 8/17/2022
Laboratory: Iron Mountain
Submitted By: N. Edlebeck
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

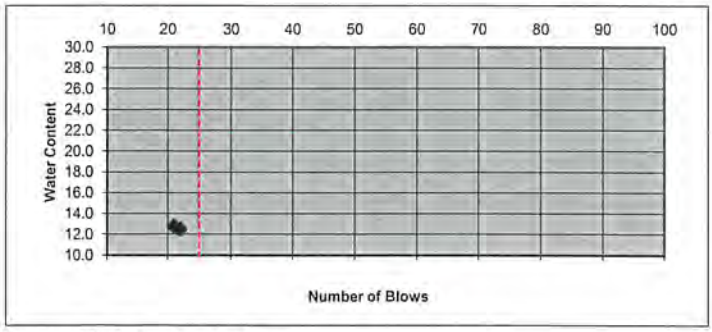
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (SM) Silty sand, fine

Job No.: GL-191059F2
Boring No.: PD-008
Sample No.: 11
Depth: 33'-35'

Liquid Limit Determination

Can No.	37	40				
Wt. of wet soil +can (g)	39.56	39.71				
Wt. of dry soil + can (g)	36.88	37.05				
Wt. of can (g)	16.01	15.82				
Wt of dry soil (g)	20.87	21.23				
Wt of moisture (g)	2.68	2.66				
* No of blows, N	**21**	**22**				
Water content, *w* %	**12.8**	**12.5**				
K Values and Corrected Average	**K=0.979 12.6**	**K=0.985 12.3**	**Avg = 12.4**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 12
Plastic limit = 11
Plasticity index I_p = 1

Plastic Limit Determination

Can no.	33	45				
Wt. of wet soil + can (g)	28.12	28.18				
Wt. of dry soil + can (g)	26.97	27.00				
Wt. of can (g)	15.97	15.92				
Wt. of dry soil (g)	11.00	11.08				
Wt. of moisture (g)	1.15	1.18				
Water content, w % = w_p	10.5	10.6	Avg = 10.6			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/18/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

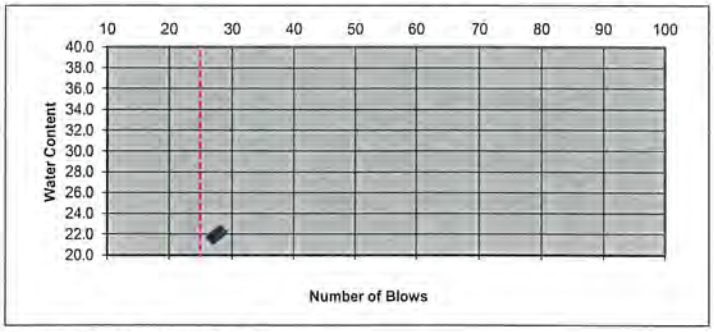
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Lean clay, some sand

Job No.: GL-191059F2
Boring No.: PD-009
Sample No.: 13
Depth: 33'-35'

Liquid Limit Determination

Can No.	42	44				
Wt. of wet soil +can (g)	29.41	29.31				
Wt. of dry soil + can (g)	26.98	26.92				
Wt. of can (g)	16.03	15.89				
Wt of dry soil (g)	10.95	11.03				
Wt of moisture (g)	2.43	2.39				
* No of blows, N	**28**	**27**				
Water content, *w* %	**22.2**	**21.7**				
K Values and Corrected Average	**K=1.014 22.5**	**K=1.009 21.9**	**Avg = 22.2**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 22
Plastic limit = 14
Plasticity index I_p = 8

Plastic Limit Determination

Can no.	5	23				
Wt. of wet soil + can (g)	26.02	26.42				
Wt. of dry soil + can (g)	24.80	25.19				
Wt. of can (g)	15.82	16.03				
Wt. of dry soil (g)	8.98	9.16				
Wt. of moisture (g)	1.22	1.23				
Water content, $w\% = w_p$	13.6	13.4	Avg = 13.5			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Edlebeck

Date: 8/18/2022
Date: 8/22/22

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

ASTM D4318

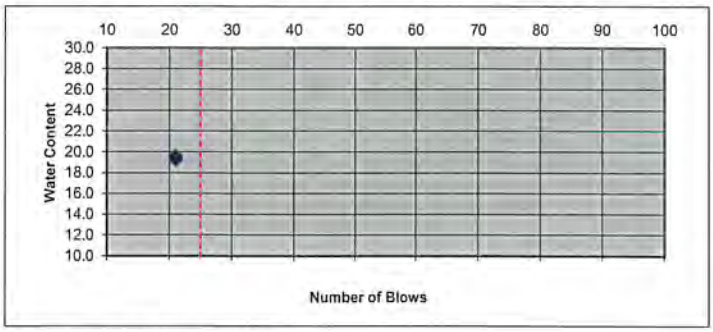
Project: Velsicol Chemical
Client: Jacobs
Description of Soil: (CL) Sandy lean clay

Job No.: GL-191059F2
Boring No.: PD-010
Sample No.: 8
Depth: 23'-25'

Liquid Limit Determination

Can No.	30	36				
Wt. of wet soil +can (g)	29.98	31.87				
Wt. of dry soil + can (g)	27.72	29.28				
Wt. of can (g)	16.15	15.88				
Wt of dry soil (g)	11.57	13.40				
Wt of moisture (g)	2.26	2.59				
* No of blows, N	**21**	**21**				
Water content, *w* %	**19.5**	**19.3**				
K Values and Corrected Average	**K=0.979 19.1**	**K=0.979 18.9**	**Avg = 19.0**			

*Blows for trials must be in the following ranges: (25-35), (20-30), (15-25)



Liquid limit = 19
Plastic limit = 11
Plasticity index I_p = 8

Plastic Limit Determination

Can no.	26	43				
Wt. of wet soil + can (g)	25.52	26.51				
Wt. of dry soil + can (g)	24.62	25.52				
Wt. of can (g)	16.10	16.19				
Wt. of dry soil (g)	8.52	9.33				
Wt. of moisture (g)	0.90	0.99				
Water content, $w\% = w_p$	10.6	10.6	Avg = 10.6			

Equipment Used: Scale: Ohaus 8028241065; Atterberg Grooving Tool: 20
Liquid Limit Device Gilson LL-3

Tested By: Jeanne Johnson
Laboratory: Iron Mountain
Submitted By: D. Eddebed

Date: 8/18/2022
Date: 8/27/22

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MOISTURE CONTENT DETERMINATION

ASTM D2216

Project: Velsicol Chemical

Job No.: GL 191059F2

Client: Jacobs

Boring No.	PD-001	PD-002	PD-003	PD-006	PD-008
Sample No.	15	13	13	13	11
Depth (ft.)	38-40	33-35	33-35	33-35	33-35
Pan No.	66	50	54	29	64
Weight-Wet Sample & Tare (g)	408.62	379.83	391.26	386.89	372.58
Weight-Dry Sample & Tare (g)	402.68	376.98	387.67	383.29	370.23
Weight of Moisture (g)	5.94	2.85	3.59	3.60	2.35
Weight of Tare (g)	341.83	341.52	342.46	340.24	341.76
Weight of Dry Soil (g)	60.85	35.46	45.21	43.05	28.47
Moisture Content (%)	9.8	8.0	7.9	8.4	8.3

Boring No.	PD-009	PD-010			
Sample No.	13	8			
Depth (ft.)	33-35	23-25			
Pan No.	59	62			
Weight-Wet Sample & Tare (g)	389.30	378.73			
Weight-Dry Sample & Tare (g)	381.90	375.35			
Weight of Moisture (g)	7.40	3.38			
Weight of Tare (g)	341.70	340.94			
Weight of Dry Soil (g)	40.20	34.41			
Moisture Content (%)	18.4	9.8			

Equipment Used: Scale: Ohaus 1124011084

Remarks:

Tested By: Dave Edlebeck

Date: 8/13/2022

Laboratory: Iron Mountain

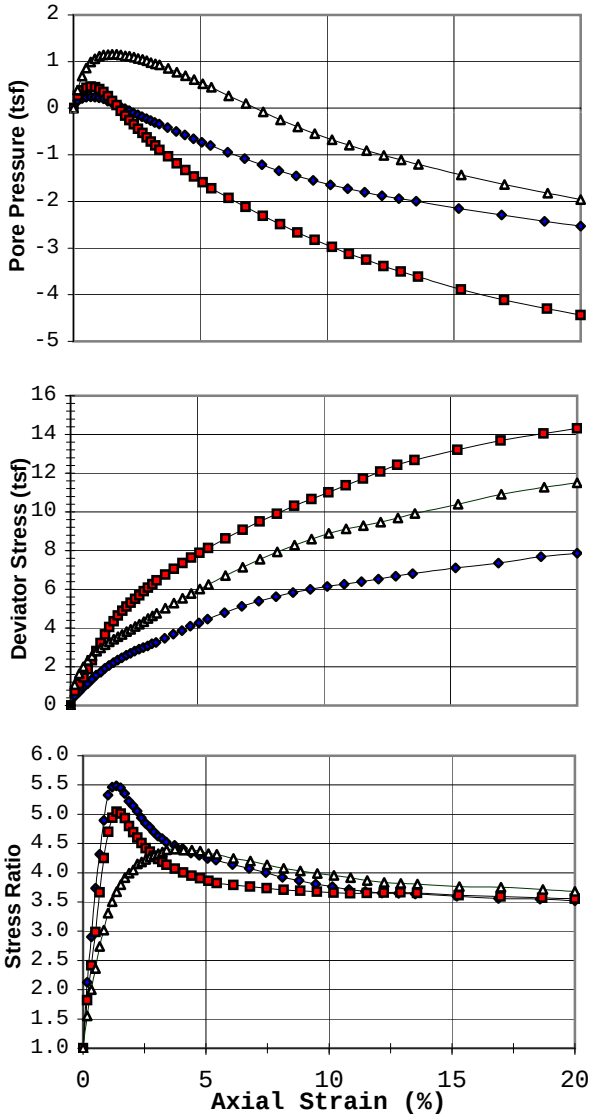
Submitted By: D. Edlebeck

Date: 8/22/22

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



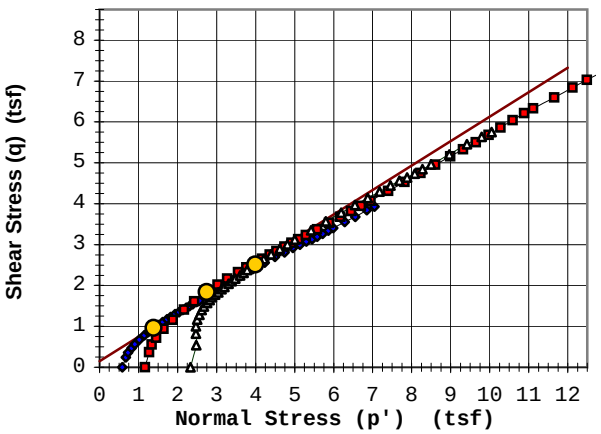
Failure Criterion:	**Max. Stress Ratio**
Angle of internal friction, **ϕ' =**	**36.7 °**
Apparent Cohesion, **c' =**	**0.19 (tsf)**

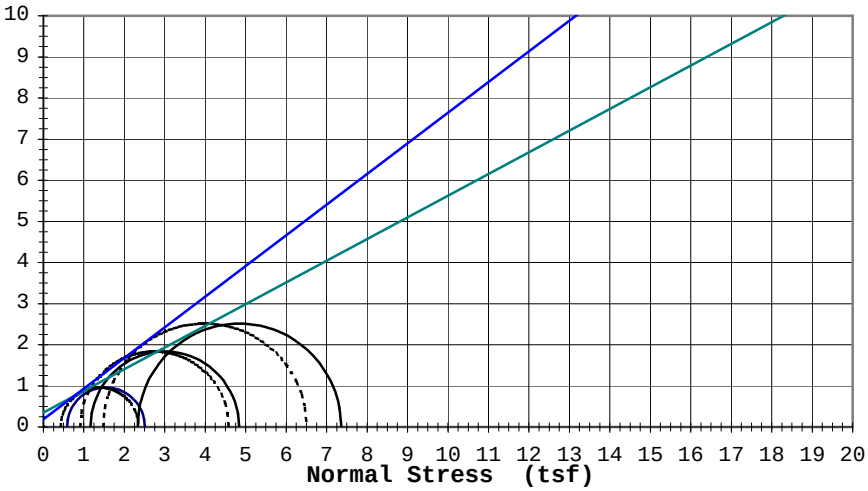
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	1.92	3.67	5.03		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.4	3.7		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 30.9 °	a = 0.2 (tsf)

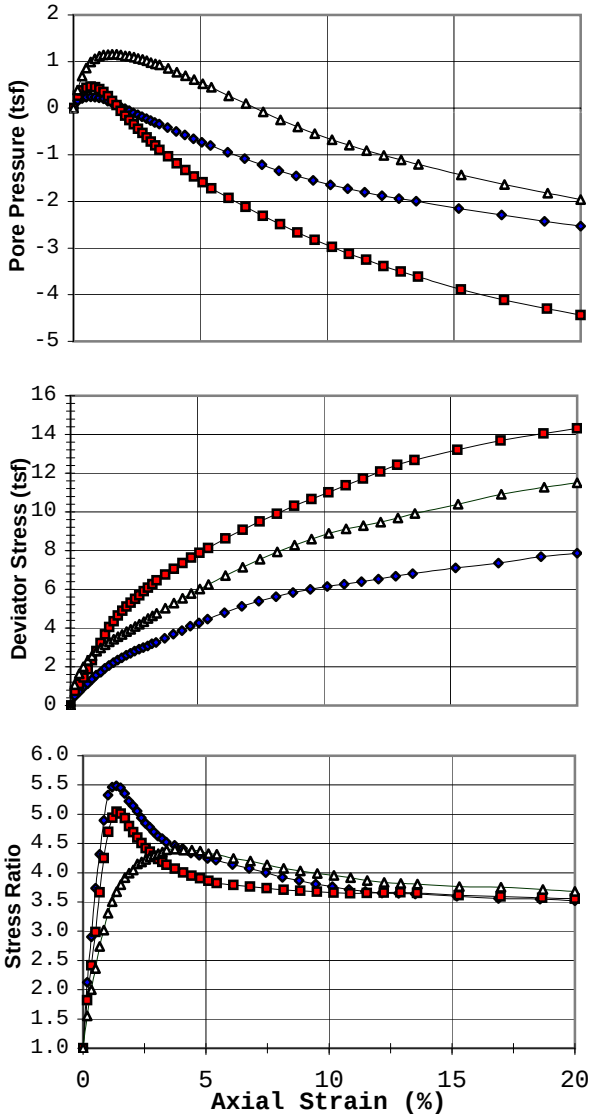
----------	Effective ϕ': 36.7 °	c'=	0.19 (tsf)
_____	Total ϕ: 27.8 °	c=	0.35 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



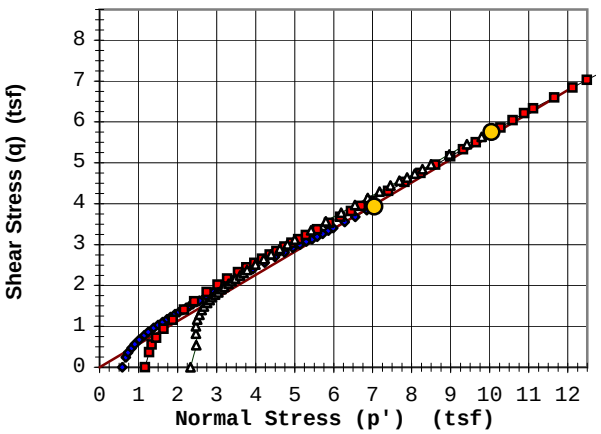
Failure Criterion:	Max. Deviator Stress
Angle of internal friction, ϕ' =	34.4 °
Apparent Cohesion, c' =	0.00 (tsf)

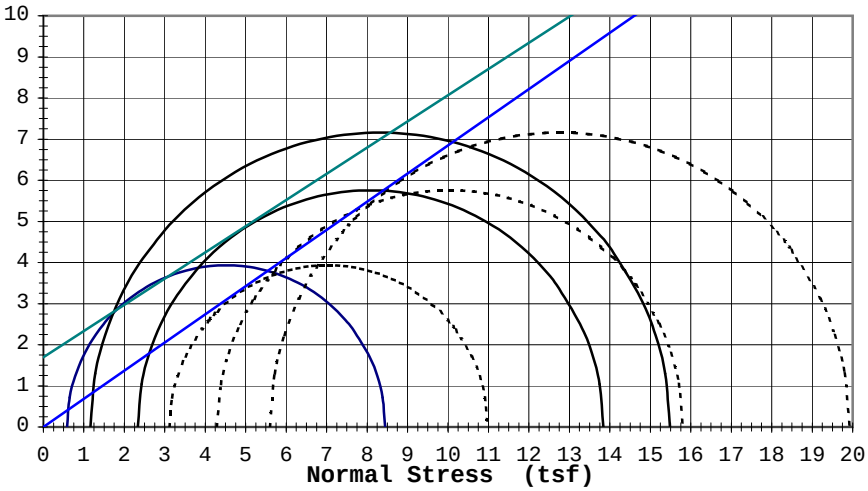
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	7.86	14.32	11.51		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	20.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress. Specimen B was not used in total friction angle determination





Rupture Envelope at Failure	
α = 29.5 °	a = 0.0 (tsf)

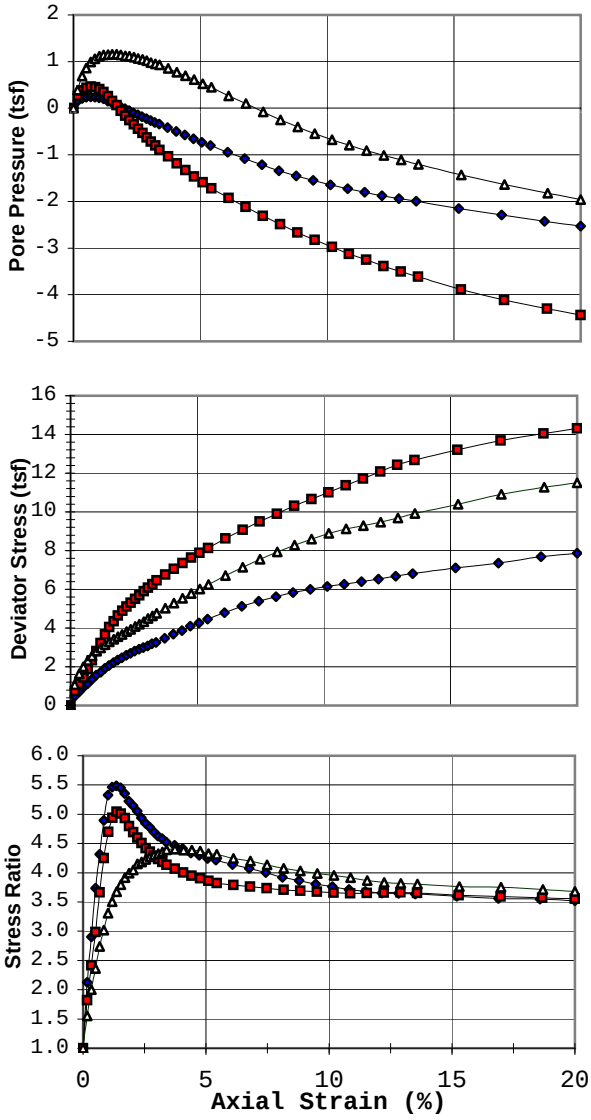
----------	Effective ϕ': 34.4 °	c'=	0.00 (tsf)
_____	Total ϕ: 32.5 °	c=	1.70 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-001** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Silty Clayey Sand w/a little gravel (SC-SM)**



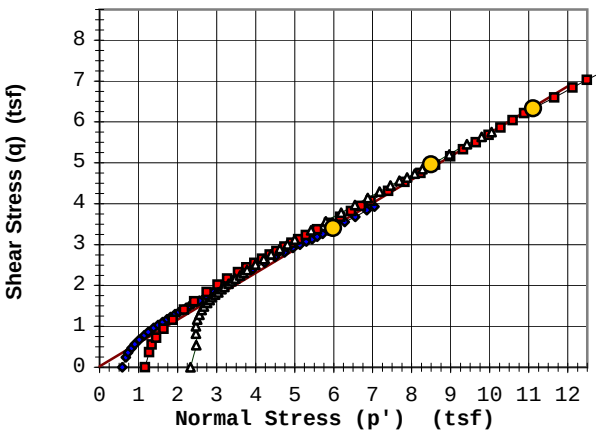
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	34.8 °
Apparent Cohesion, c' =	0.03 (tsf)

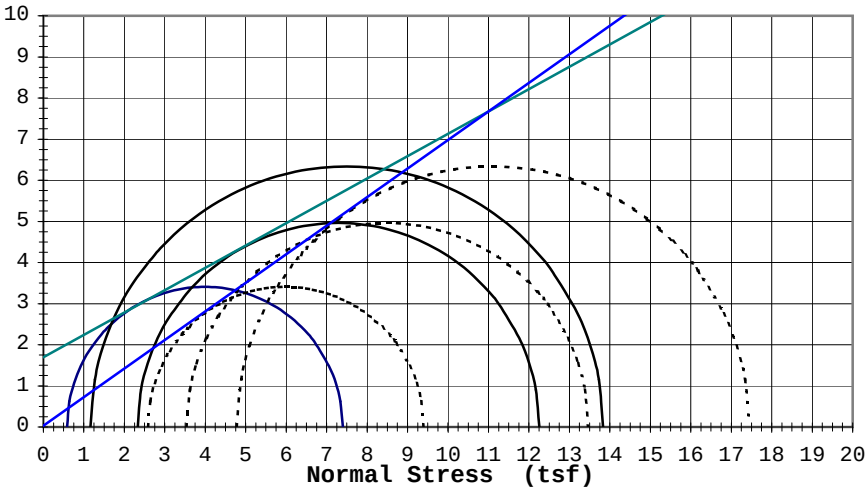
Test Date:	8/1/22	Liquid Limit:	16
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	6
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.97		
Water Content (%)	7.7	7.8	6.8		
Dry Density (pcf)	136.2	137.0	134.6		
Void Ratio	0.23	0.22	0.24		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	8.2	7.8	7.8		
Dry Density (pcf)	137.1	138.5	138.4		
Void Ratio	0.22	0.21	0.21		
Back Pressure (tsf)	4.0	6.4	5.5		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	7.86	14.32	11.51		
Ultimate Deviator Stress (tsf)	7.86	14.32	11.51		
Deviator Stress at Failure (tsf)	6.81	12.67	9.92		
Max. Pore Pressure Buildup (tsf)	0.24	0.46	1.16		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress. Specimen B was not used in total friction angle determination





Rupture Envelope at Failure	
α = 29.7 °	a = 0.0 (tsf)

----------	Effective ϕ': 34.8 °	c'=	0.03 (tsf)
_____	Total ϕ: 28.5 °	c=	1.70 (tsf)

Triaxial Data

Job: **13945**

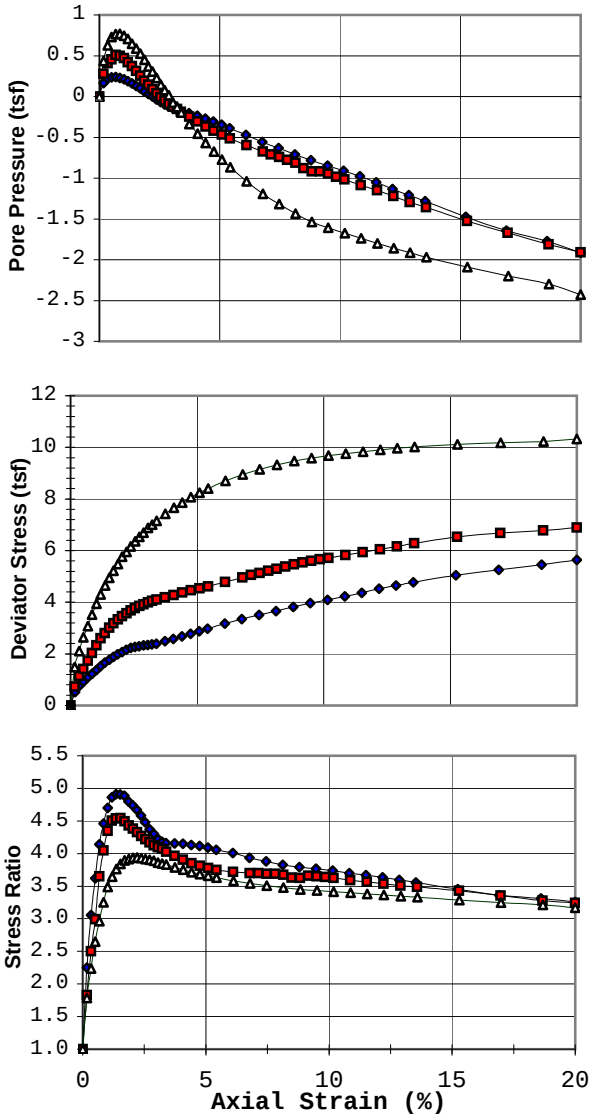
Boring: PD-001 Sample: Depth: 30-33 Date: 8/17/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.48	0.16	0.17	0.74	0.26	0.17	1.07	0.39						
0.34	0.71	0.21	0.34	1.11	0.38	0.34	1.64	0.69						
0.51	0.95	0.24	0.51	1.45	0.44	0.51	2.00	0.86						
0.68	1.13	0.24	0.68	1.87	0.46	0.68	2.33	0.99						
0.84	1.35	0.24	0.85	2.32	0.45	0.85	2.57	1.06						
1.01	1.57	0.22	1.02	2.81	0.40	1.02	2.80	1.11						
1.18	1.72	0.20	1.19	3.22	0.35	1.19	2.97	1.14						
1.35	1.92	0.16	1.36	3.67	0.26	1.36	3.15	1.15						
1.52	2.07	0.12	1.53	4.04	0.16	1.53	3.29	1.15						
1.69	2.21	0.08	1.70	4.34	0.06	1.70	3.42	1.16						
1.86	2.35	0.03	1.87	4.65	-0.06	1.87	3.55	1.14						
2.03	2.46	-0.01	2.04	4.89	-0.16	2.04	3.67	1.12						
2.20	2.59	-0.05	2.21	5.11	-0.25	2.21	3.82	1.12						
2.36	2.69	-0.10	2.38	5.31	-0.35	2.38	3.93	1.10						
2.53	2.80	-0.14	2.55	5.50	-0.44	2.55	4.08	1.07						
2.70	2.91	-0.18	2.72	5.69	-0.53	2.72	4.20	1.04						
2.87	2.99	-0.22	2.89	5.90	-0.63	2.89	4.34	1.02						
3.04	3.08	-0.26	3.06	6.08	-0.72	3.06	4.49	0.98						
3.21	3.19	-0.30	3.23	6.26	-0.80	3.23	4.62	0.95						
3.38	3.26	-0.34	3.40	6.46	-0.89	3.40	4.76	0.93						
3.72	3.47	-0.42	3.74	6.75	-1.04	3.74	5.03	0.85						
4.05	3.69	-0.50	4.08	7.06	-1.19	4.08	5.29	0.77						
4.39	3.87	-0.57	4.42	7.35	-1.33	4.42	5.53	0.70						
4.73	4.09	-0.66	4.76	7.64	-1.46	4.76	5.79	0.61						
5.07	4.27	-0.73	5.10	7.89	-1.59	5.10	6.01	0.52						
5.40	4.46	-0.80	5.44	8.13	-1.72	5.44	6.24	0.45						
6.08	4.80	-0.94	6.12	8.62	-1.92	6.12	6.70	0.26						
6.75	5.13	-1.08	6.79	9.07	-2.12	6.80	7.13	0.10						
7.43	5.39	-1.21	7.47	9.51	-2.31	7.48	7.55	-0.08						
8.11	5.63	-1.34	8.15	9.90	-2.49	8.16	7.93	-0.25						
8.78	5.84	-1.45	8.83	10.32	-2.66	8.84	8.28	-0.40						
9.46	6.00	-1.55	9.51	10.66	-2.82	9.52	8.60	-0.55						
10.13	6.15	-1.64	10.19	11.01	-2.98	10.20	8.89	-0.68						
10.81	6.27	-1.73	10.87	11.37	-3.13	10.88	9.12	-0.80						
11.48	6.39	-1.80	11.55	11.72	-3.25	11.56	9.29	-0.91						
12.16	6.52	-1.87	12.23	12.09	-3.38	12.24	9.47	-1.01						
12.83	6.68	-1.94	12.91	12.43	-3.50	12.92	9.69	-1.11						
13.51	6.81	-2.00	13.58	12.67	-3.61	13.60	9.92	-1.21						
15.20	7.10	-2.15	15.28	13.20	-3.89	15.30	10.40	-1.43						
16.89	7.36	-2.29	16.98	13.69	-4.12	17.00	10.91	-1.64						
18.58	7.68	-2.43	18.68	14.05	-4.30	18.70	11.27	-1.83						
20.00	7.86	-2.53	20.00	14.32	-4.44	20.00	11.51	-1.96						

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**



Failure Criterion: **Max. Stress Ratio**

Angle of internal friction, **ϕ' = 34.7 °**

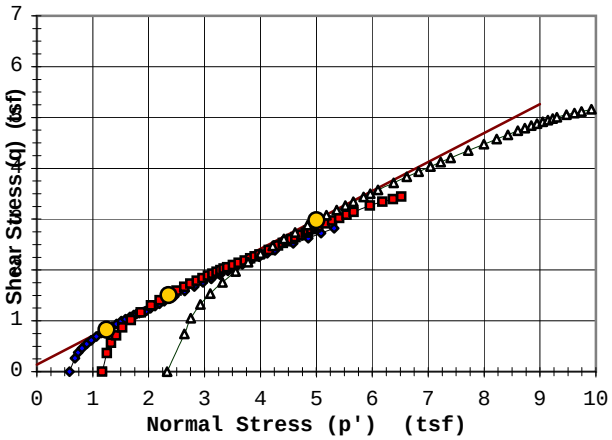
Apparent Cohesion, **c' = 0.16 (tsf)**

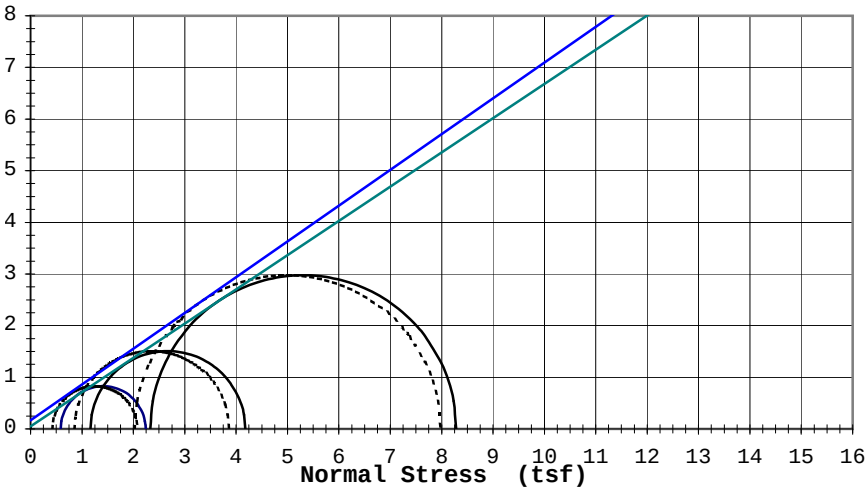
Test Date:	8/2/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	11
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	1.66	3.01	5.95		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.5	2.2		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure
α = 29.7 ° a = 0.1 (tsf)

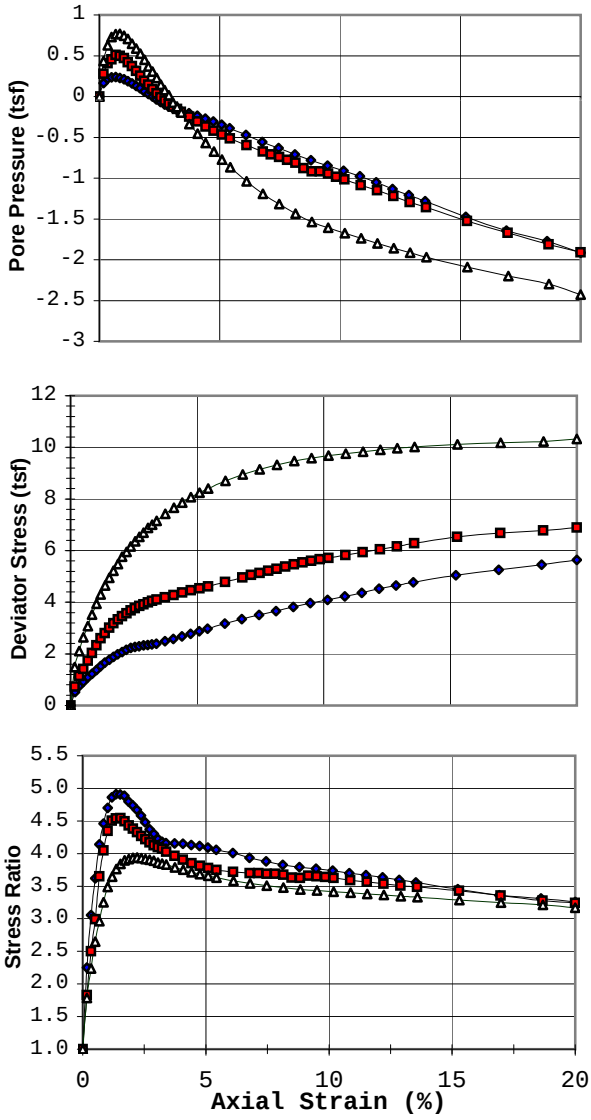
----------	Effective ϕ': 34.7 °	c'=	0.16 (tsf)
_____	Total ϕ: 33.5 °	c=	0.05 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

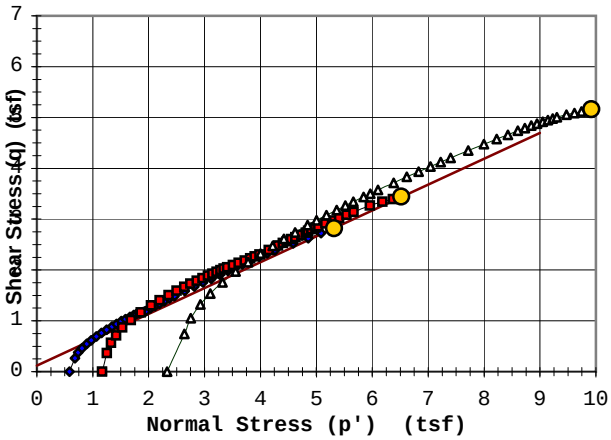
Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**

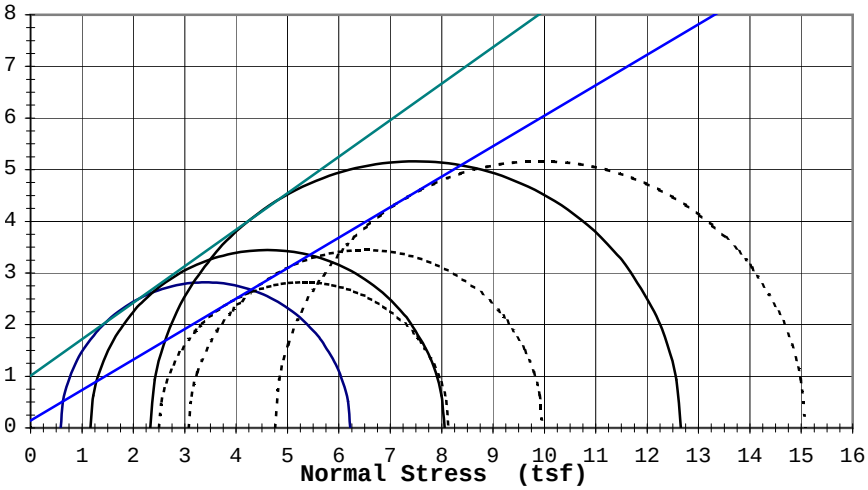


Failure Criterion:	**Max. Deviator Stress**				
Angle of internal friction, **ϕ' =**	**30.6 °**				
Apparent Cohesion, **c' =**	**0.14 (tsf)**				
Test Date: 8/2/22	Liquid Limit: 21				
Test Type: CU w/pp	Plastic Limit: 10				
Strain Rate (in/min): 0.00074	Plasticity Index: 11				
Strain Rate (%/min): 0.025	Spec. Gravity (Assumed): 2.68				
Initial Conditions	**A**	**B**	**C**	**D**	**E**
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	5.64	6.89	10.32		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	20.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.0 °	a = 0.1 (tsf)

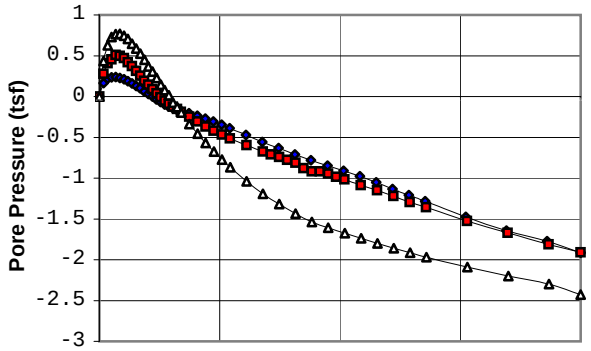
----------	Effective ϕ': 30.6 °	c'=	0.14 (tsf)
_____	Total ϕ: 35.3 °	c=	1.01 (tsf)

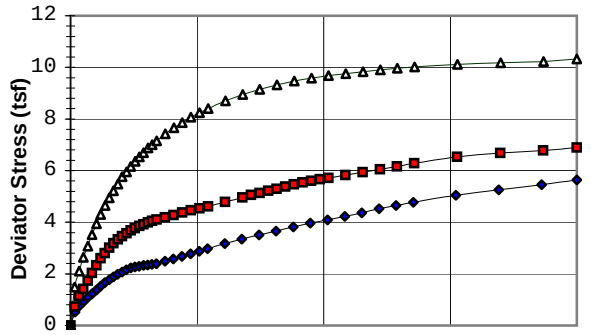
9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

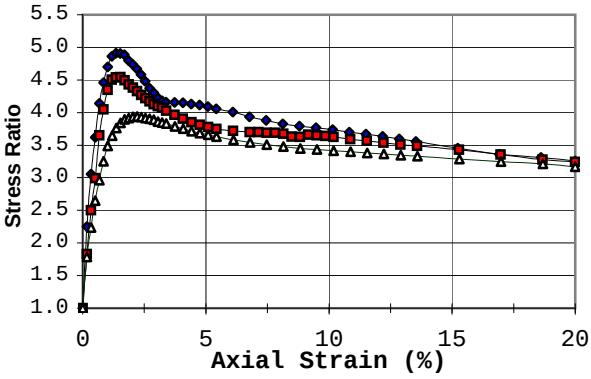
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-003** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a trace of gravel (CL)**







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X

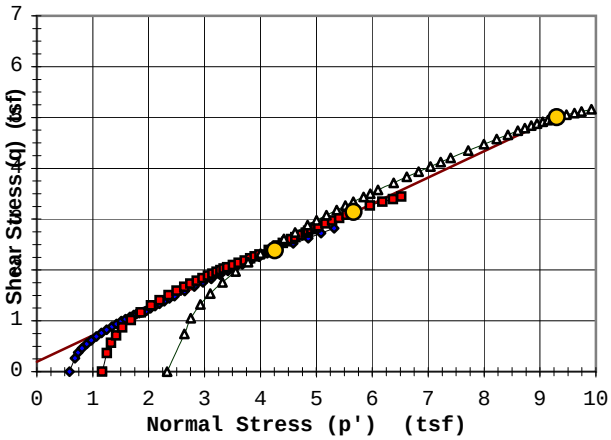
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	31.2 °
Apparent Cohesion, c' =	0.23 (tsf)

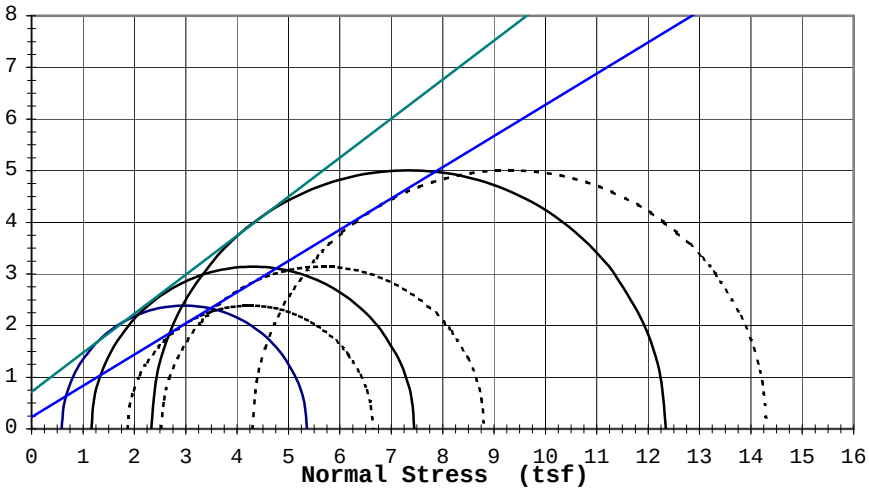
Test Date:	8/2/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	10
Strain Rate (in/min):	0.00074	Plasticity Index:	11
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.96	2.96	2.96		
Water Content (%)	10.9	10.7	11.2		
Dry Density (pcf)	128.6	128.8	128.1		
Void Ratio	0.30	0.30	0.31		
After Consolidation					
Diameter (in)	1.44	1.43	1.43		
Height (in)	2.96	2.95	2.94		
Water Content (%)	10.9	10.5	10.5		
Dry Density (pcf)	129.4	130.6	130.6		
Void Ratio	0.29	0.28	0.28		
Back Pressure (tsf)	5.3	4.0	4.0		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.64	6.89	10.32		
Ultimate Deviator Stress (tsf)	5.64	6.89	10.32		
Deviator Stress at Failure (tsf)	4.78	6.28	10.01		
Max. Pore Pressure Buildup (tsf)	0.24	0.51	0.77		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.4 °	a = 0.2 (tsf)

----------	Effective ϕ':	31.2 °	c'=	0.23 (tsf)
_____	Total ϕ:	37.1 °	c=	0.72 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

Triaxial Data

Job: **13945**

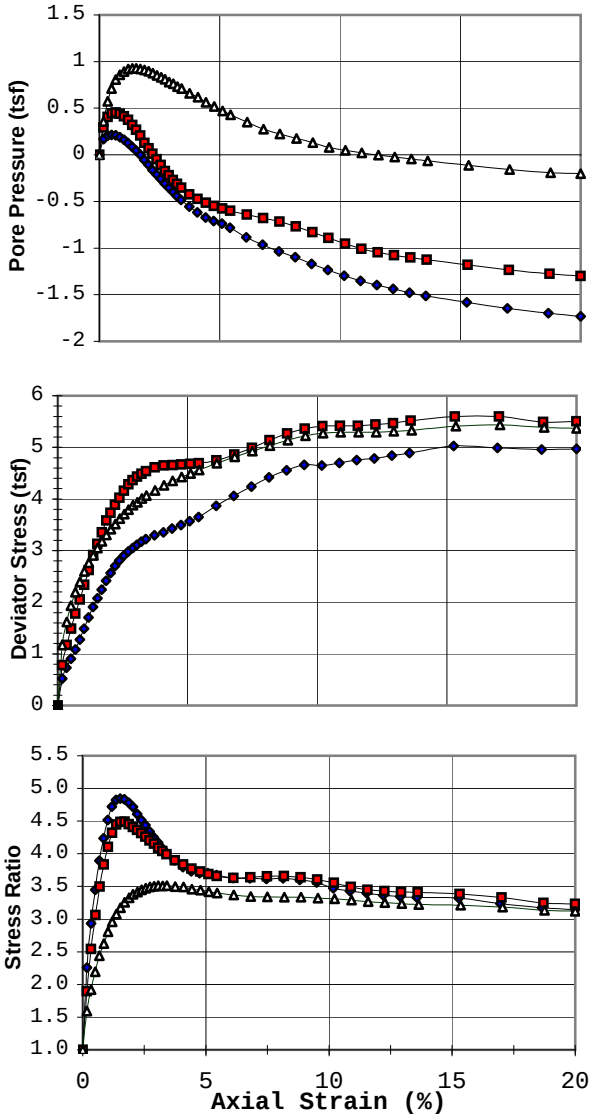
Boring: PD-003 Sample: Depth: 25-28 Date: 8/16/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.53	0.16	0.17	0.73	0.28	0.17	1.49	0.44						
0.34	0.75	0.22	0.34	1.14	0.41	0.34	2.11	0.63						
0.51	0.91	0.24	0.51	1.42	0.45	0.51	2.64	0.73						
0.68	1.09	0.24	0.68	1.74	0.51	0.68	3.07	0.77						
0.85	1.23	0.23	0.85	2.03	0.50	0.85	3.52	0.77						
1.02	1.38	0.21	1.02	2.33	0.47	1.02	3.94	0.75						
1.19	1.53	0.19	1.19	2.61	0.42	1.19	4.30	0.70						
1.36	1.66	0.16	1.36	2.81	0.37	1.36	4.64	0.65						
1.53	1.78	0.13	1.53	3.01	0.31	1.53	4.95	0.59						
1.69	1.88	0.10	1.70	3.18	0.25	1.70	5.23	0.52						
1.86	1.98	0.06	1.87	3.33	0.19	1.87	5.48	0.45						
2.03	2.07	0.03	2.04	3.46	0.14	2.04	5.76	0.37						
2.20	2.15	0.00	2.21	3.57	0.09	2.21	5.95	0.30						
2.37	2.23	-0.04	2.38	3.68	0.04	2.38	6.16	0.23						
2.54	2.26	-0.07	2.55	3.77	-0.01	2.55	6.36	0.15						
2.71	2.30	-0.10	2.72	3.86	-0.05	2.72	6.53	0.08						
2.88	2.33	-0.12	2.89	3.92	-0.09	2.89	6.69	0.01						
3.05	2.35	-0.14	3.06	4.00	-0.13	3.06	6.88	-0.07						
3.22	2.37	-0.16	3.23	4.05	-0.15	3.23	7.01	-0.13						
3.38	2.39	-0.17	3.39	4.10	-0.19	3.40	7.16	-0.20						
3.72	2.49	-0.20	3.73	4.19	-0.25	3.74	7.43	-0.34						
4.06	2.58	-0.23	4.07	4.28	-0.31	4.08	7.66	-0.45						
4.40	2.67	-0.27	4.42	4.37	-0.37	4.42	7.87	-0.57						
4.74	2.77	-0.31	4.75	4.46	-0.42	4.76	8.07	-0.68						
5.08	2.88	-0.35	5.09	4.54	-0.47	5.10	8.25	-0.77						
5.42	2.98	-0.39	5.43	4.61	-0.51	5.44	8.41	-0.87						
6.09	3.17	-0.47	6.11	4.78	-0.59	6.12	8.70	-1.04						
6.77	3.35	-0.56	6.79	4.96	-0.67	6.80	8.95	-1.19						
7.45	3.51	-0.63	7.13	5.06	-0.71	7.48	9.15	-1.32						
8.12	3.66	-0.71	7.47	5.13	-0.74	8.15	9.32	-1.43						
8.80	3.82	-0.78	7.81	5.22	-0.78	8.83	9.48	-1.54						
9.48	3.97	-0.85	8.15	5.29	-0.81	9.51	9.58	-1.61						
10.15	4.09	-0.91	8.49	5.38	-0.88	10.19	9.68	-1.67						
10.83	4.22	-0.98	8.83	5.46	-0.92	10.87	9.76	-1.74						
11.50	4.37	-1.05	9.17	5.54	-0.92	11.55	9.84	-1.80						
12.18	4.53	-1.13	9.51	5.60	-0.95	12.23	9.90	-1.86						
12.86	4.65	-1.21	9.84	5.67	-0.98	12.91	9.96	-1.91						
13.53	4.78	-1.28	10.19	5.72	-1.01	13.59	10.01	-1.97						
15.23	5.05	-1.48	10.86	5.83	-1.09	15.29	10.11	-2.09						
16.92	5.25	-1.64	11.54	5.94	-1.15	16.99	10.17	-2.20						
18.61	5.45	-1.77	12.22	6.05	-1.22	18.69	10.23	-2.30						
20.00	5.64	-1.91	12.90	6.17	-1.29	20.00	10.32	-2.43						
			13.58	6.28	-1.36									
			15.28	6.54	-1.53									
			16.97	6.69	-1.67									
			18.67	6.79	-1.81									
			20.00	6.89	-1.91									

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



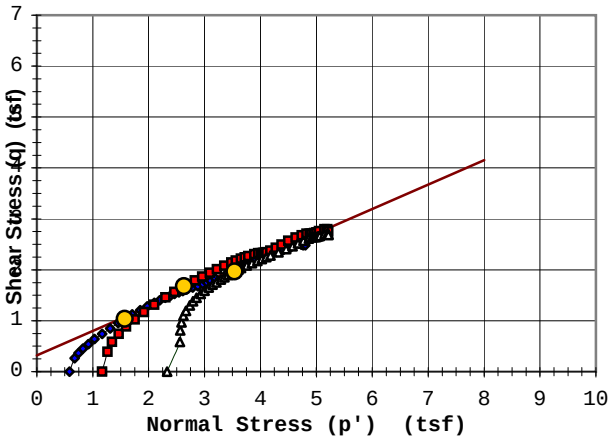
Failure Criterion:	**Max. Stress Ratio**
Angle of internal friction, **ϕ' =**	**28.6 °**
Apparent Cohesion, **c' =**	**0.37 (tsf)**

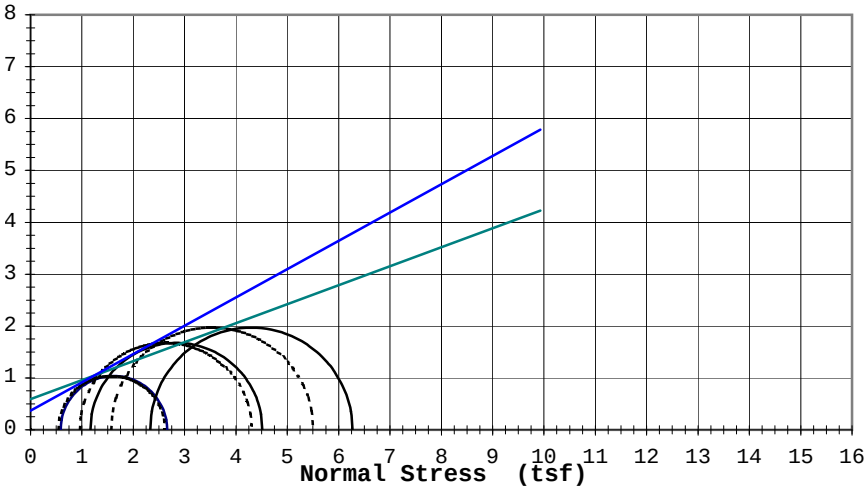
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	2.07	3.35	3.94		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.5	1.7	3.1		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





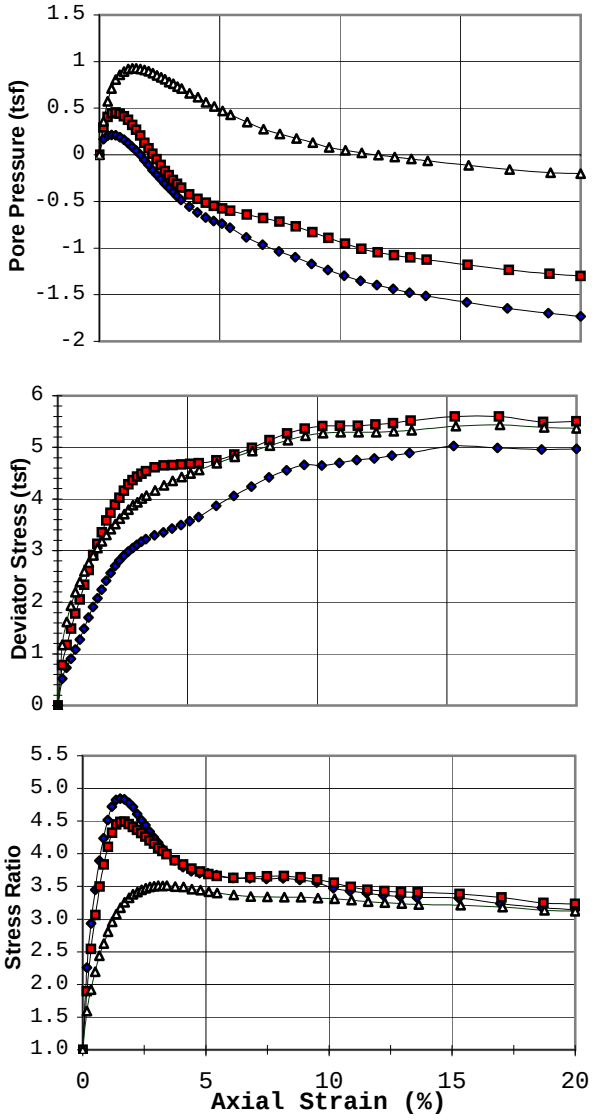
Rupture Envelope at Failure	
α = 25.6 °	a = 0.3 (tsf)

----------	Effective ϕ': 28.6 °	c'=	0.37 (tsf)
_____	Total ϕ: 20.1 °	c=	0.59 (tsf)

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



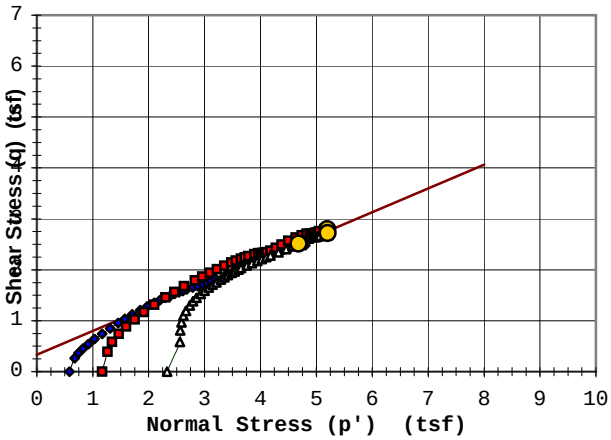
Failure Criterion:	**Max. Deviator Stress**
Angle of internal friction, **ϕ' =**	**27.8 °**
Apparent Cohesion, **c' =**	**0.37 (tsf)**

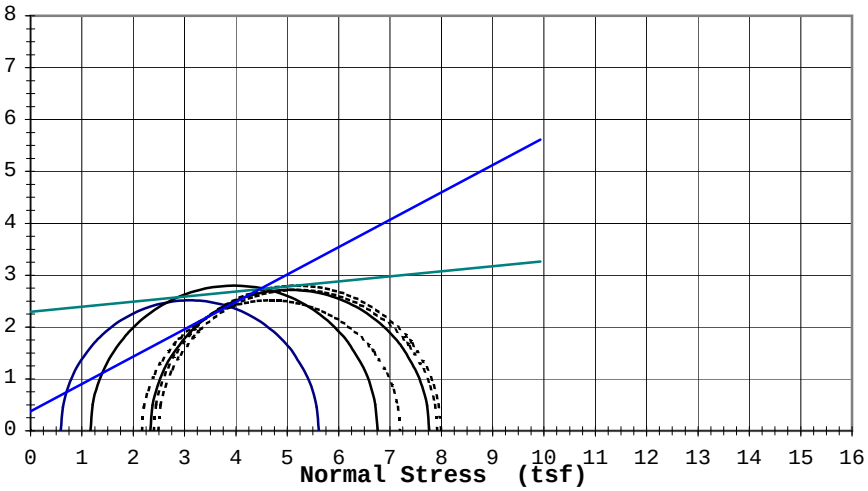
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	5.03	5.60	5.44		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.3	17.0	17.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 25.0 °	a = 0.3 (tsf)

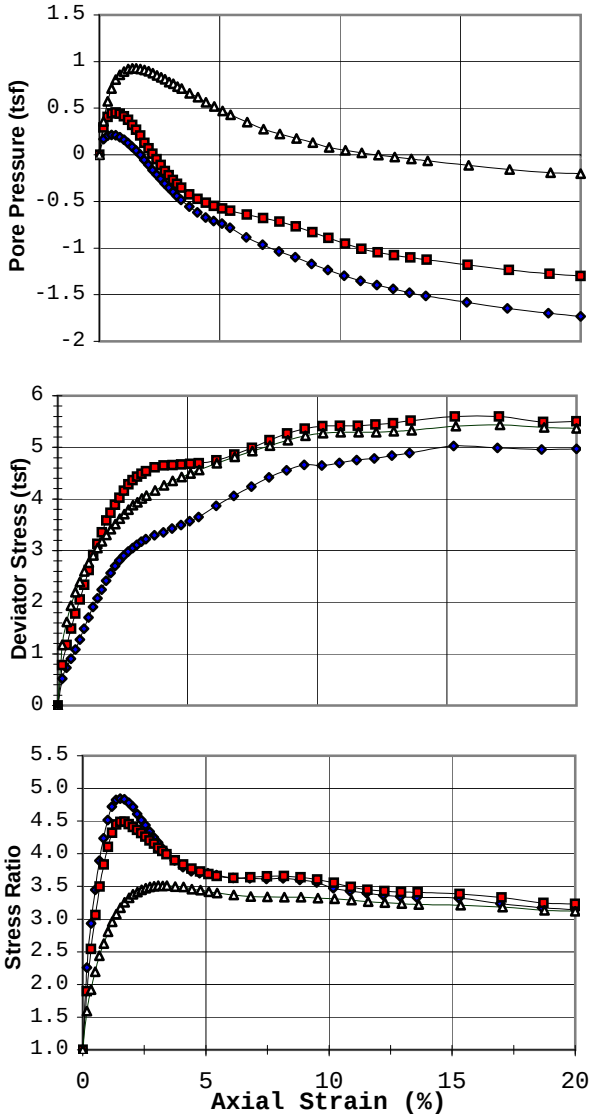
----------	Effective ϕ': 27.8 °	c'=	0.37 (tsf)
_____	Total ϕ: 5.5 °	c=	2.30 (tsf)

9530 James Avenue South
SOIL ENGINEERING TESTING, INC.
Bloomington, Minnesota 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/16/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-006** Sample #: Type: **3T** Depth (ft): **25-28**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



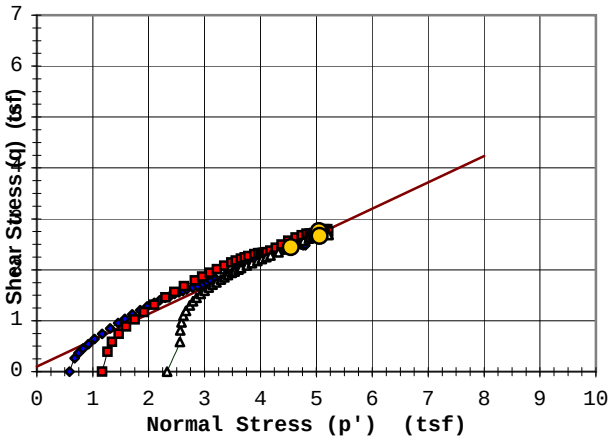
Failure Criterion:	**Given Strain of: 15%**
Angle of internal friction, **ϕ' =**	**31.1 °**
Apparent Cohesion, **c' =**	**0.11 (tsf)**

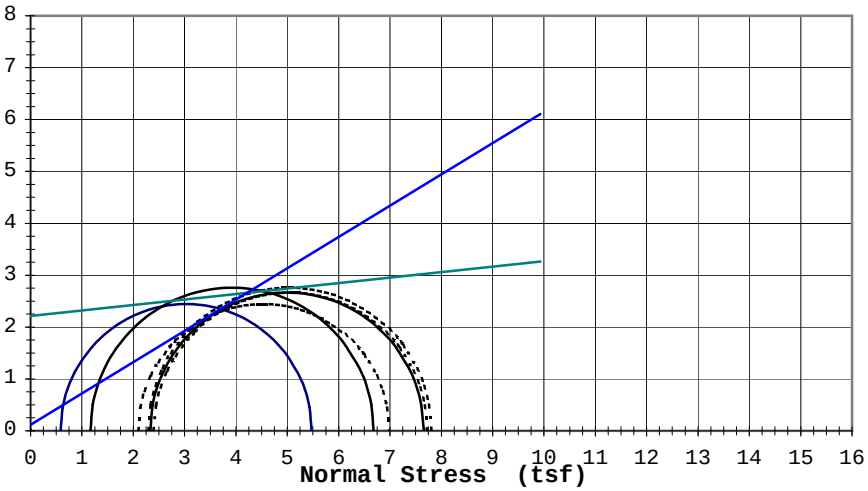
Test Date:	8/9/22	Liquid Limit:	21
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000738	Plasticity Index:	10
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	11.4	12.6	12.3		
Dry Density (pcf)	127.5	125.4	125.4		
Void Ratio	0.31	0.33	0.33		
After Consolidation					
Diameter (in)	1.43	1.42	1.42		
Height (in)	2.95	2.94	2.93		
Water Content (%)	11.3	11.4	10.8		
Dry Density (pcf)	128.3	128.3	129.7		
Void Ratio	0.30	0.30	0.29		
Back Pressure (tsf)	6.6	6.4	6.2		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	5.03	5.60	5.44		
Ultimate Deviator Stress (tsf)	4.97	5.50	5.37		
Deviator Stress at Failure (tsf)	4.89	5.52	5.33		
Max. Pore Pressure Buildup (tsf)	0.21	0.45	0.93		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.3 °	a = 0.1 (tsf)

----------	Effective ϕ': 31.1 °	c'=	0.11 (tsf)
_____	Total ϕ: 6.0 °	c=	2.22 (tsf)

Triaxial Data

Job: **13945**

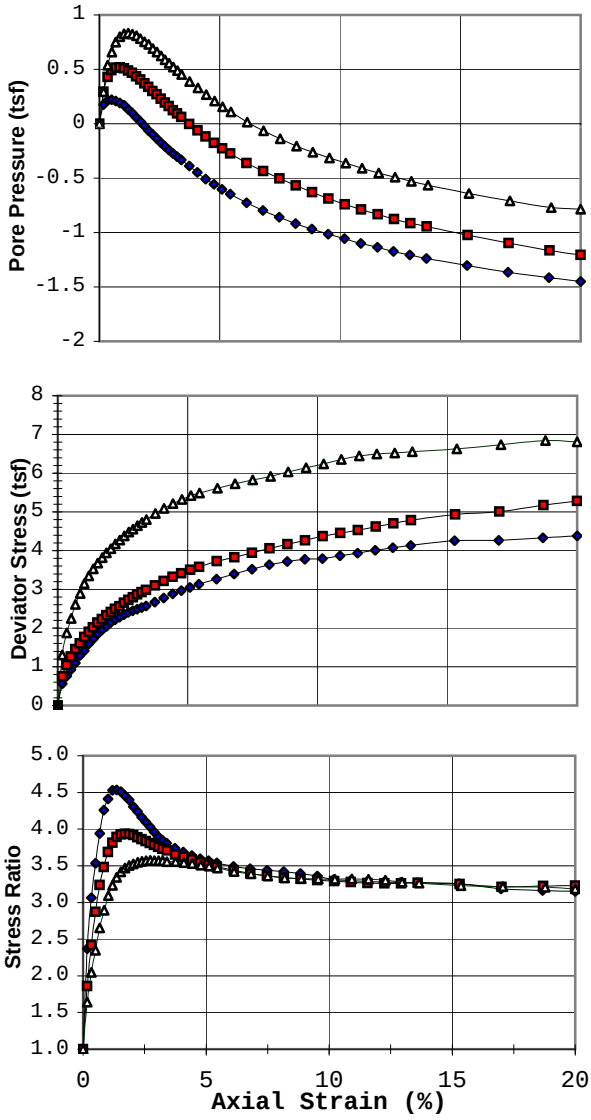
Boring: PD-006 Sample: Depth: 25-28 Date: 8/16/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.52	0.17	0.17	0.78	0.29	0.17	1.17	0.36						
0.34	0.73	0.21	0.34	1.17	0.41	0.34	1.62	0.57						
0.51	0.91	0.21	0.51	1.48	0.44	0.51	1.94	0.71						
0.68	1.09	0.21	0.68	1.78	0.45	0.68	2.19	0.81						
0.85	1.28	0.19	0.85	2.05	0.44	0.86	2.39	0.86						
1.02	1.49	0.16	1.02	2.34	0.41	1.03	2.60	0.89						
1.19	1.70	0.13	1.19	2.62	0.37	1.19	2.77	0.92						
1.36	1.91	0.09	1.36	2.91	0.32	1.36	2.91	0.93						
1.53	2.07	0.05	1.53	3.13	0.27	1.53	3.05	0.93						
1.70	2.24	0.00	1.70	3.35	0.21	1.71	3.18	0.92						
1.87	2.42	-0.05	1.87	3.58	0.13	1.88	3.30	0.91						
2.03	2.57	-0.11	2.04	3.73	0.07	2.05	3.41	0.90						
2.20	2.70	-0.16	2.21	3.89	0.01	2.22	3.51	0.88						
2.37	2.81	-0.21	2.38	4.02	-0.05	2.39	3.62	0.85						
2.54	2.90	-0.26	2.55	4.16	-0.11	2.56	3.71	0.83						
2.71	2.98	-0.31	2.72	4.28	-0.17	2.73	3.79	0.81						
2.88	3.05	-0.35	2.89	4.36	-0.22	2.90	3.88	0.78						
3.05	3.11	-0.40	3.06	4.43	-0.27	3.07	3.94	0.76						
3.22	3.17	-0.44	3.23	4.49	-0.31	3.24	4.01	0.73						
3.39	3.22	-0.48	3.40	4.54	-0.35	3.41	4.07	0.71						
3.73	3.30	-0.55	3.74	4.61	-0.42	3.75	4.17	0.66						
4.07	3.36	-0.62	4.08	4.65	-0.47	4.09	4.27	0.62						
4.41	3.43	-0.67	4.42	4.65	-0.52	4.43	4.35	0.56						
4.75	3.50	-0.71	4.76	4.67	-0.55	4.78	4.42	0.52						
5.09	3.57	-0.74	5.10	4.68	-0.57	5.11	4.49	0.47						
5.43	3.65	-0.78	5.44	4.69	-0.60	5.46	4.56	0.43						
6.10	3.87	-0.89	6.12	4.75	-0.64	6.14	4.69	0.35						
6.78	4.06	-0.96	6.81	4.86	-0.68	6.82	4.81	0.28						
7.46	4.24	-1.04	7.49	4.99	-0.72	7.50	4.93	0.22						
8.14	4.42	-1.10	8.17	5.14	-0.77	8.19	5.03	0.17						
8.82	4.56	-1.17	8.85	5.27	-0.83	8.87	5.14	0.13						
9.49	4.66	-1.23	9.53	5.36	-0.89	9.55	5.23	0.08						
10.17	4.65	-1.30	10.21	5.41	-0.95	10.23	5.28	0.05						
10.85	4.70	-1.35	10.89	5.42	-1.01	10.91	5.30	0.02						
11.53	4.75	-1.40	11.57	5.42	-1.05	11.59	5.29	0.00						
12.21	4.79	-1.44	12.25	5.44	-1.08	12.27	5.30	-0.02						
12.89	4.84	-1.48	12.93	5.47	-1.10	12.96	5.31	-0.05						
13.56	4.89	-1.51	13.61	5.52	-1.13	13.64	5.33	-0.07						
15.26	5.03	-1.58	15.31	5.60	-1.18	15.35	5.41	-0.11						
16.96	4.99	-1.65	17.02	5.60	-1.23	17.05	5.44	-0.16						
18.65	4.96	-1.70	18.71	5.49	-1.28	18.75	5.39	-0.19						
20.00	4.97	-1.73	20.00	5.50	-1.30	20.00	5.37	-0.20						

TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**



Failure Criterion: **Max. Stress Ratio**

Angle of internal friction, **ϕ' = 31.8 °**

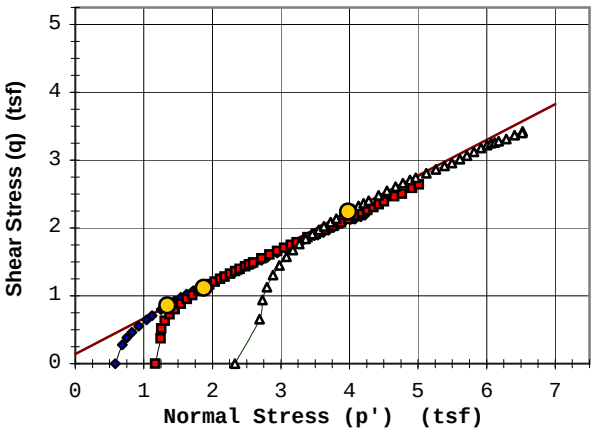
Apparent Cohesion, **c' = 0.17 (tsf)**

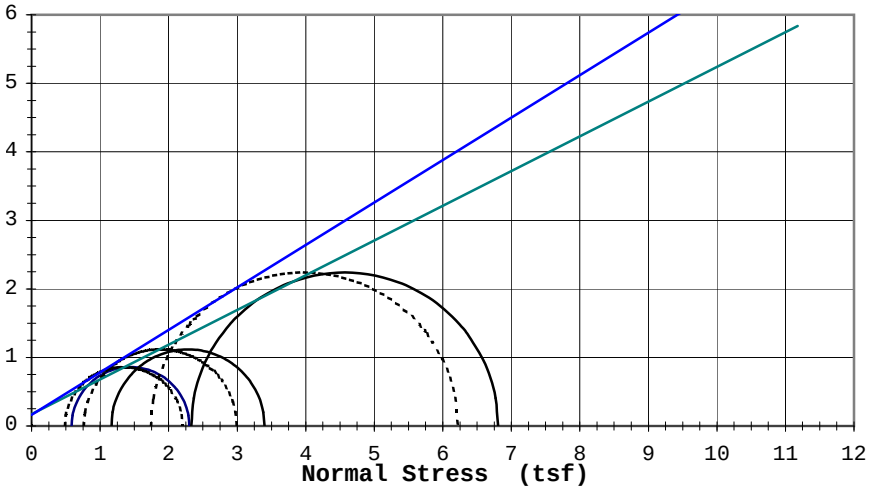
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	1.72	2.23	4.48		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	1.4	1.7	2.7		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





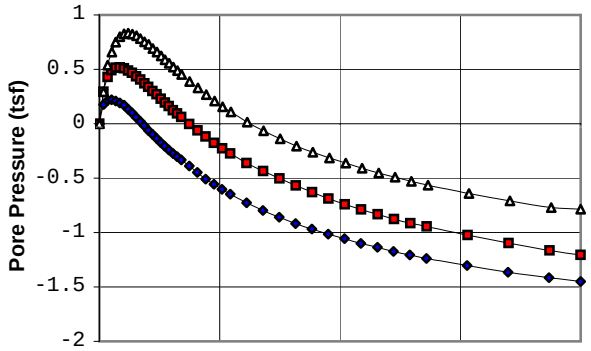
Rupture Envelope at Failure
α = 27.8 ° a = 0.1 (tsf)

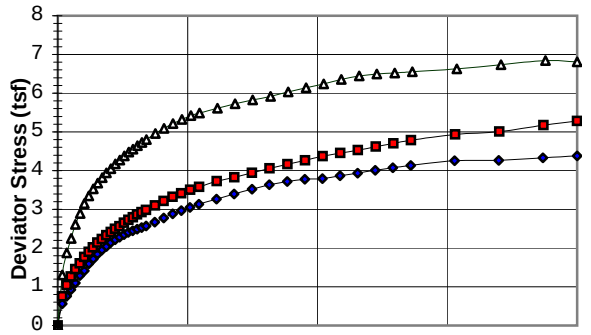
---------- Effective ϕ': 31.8 ° c'= 0.17 (tsf)
_____ Total ϕ: 26.9 ° c= 0.17 (tsf)

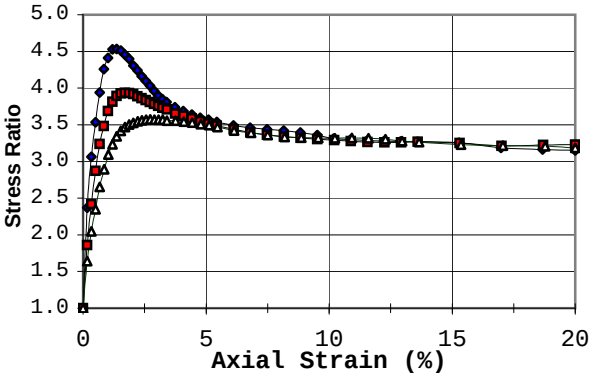
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**







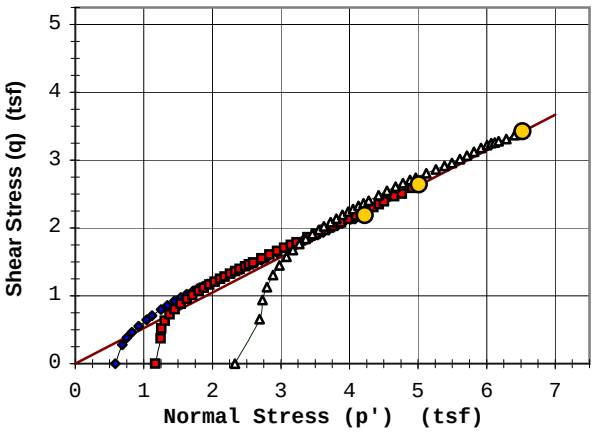
Failure Criterion:	Max. Deviator Stress
Angle of internal friction, ϕ' =	31.6 °
Apparent Cohesion, c' =	0.00 (tsf)

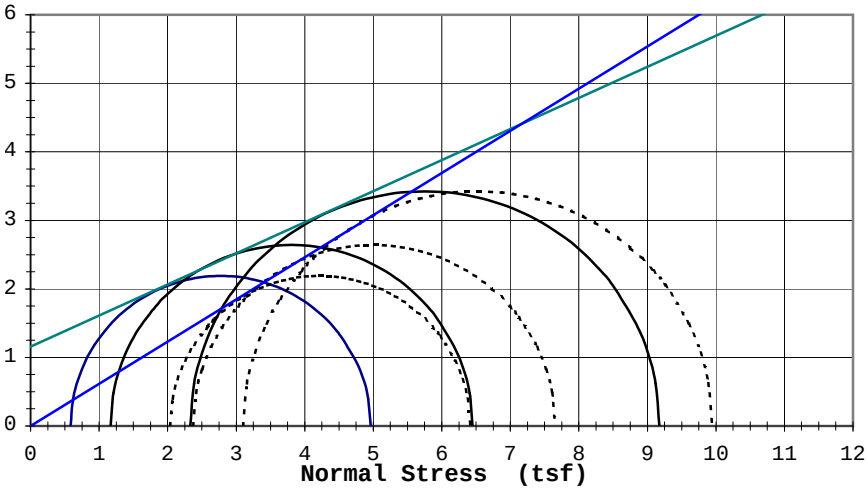
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	4.38	5.28	6.85		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	20.0	20.0	18.8		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





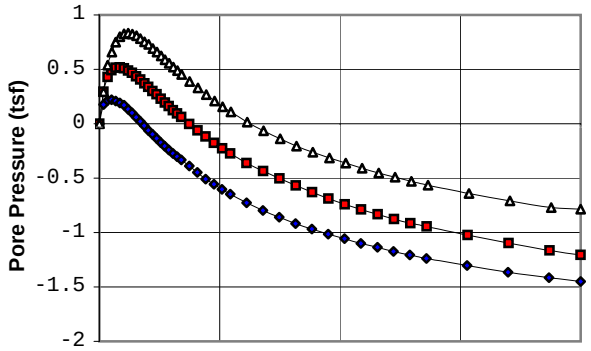
Rupture Envelope at Failure	
α = 27.7 °	a = 0.0 (tsf)

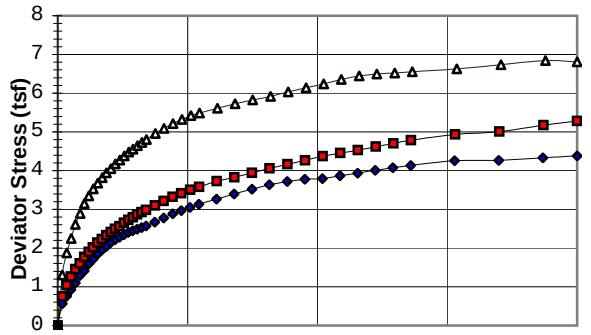
----------	Effective ϕ': 31.6 °	c'=	0.00 (tsf)
_____	Total ϕ: 24.4 °	c=	1.16 (tsf)

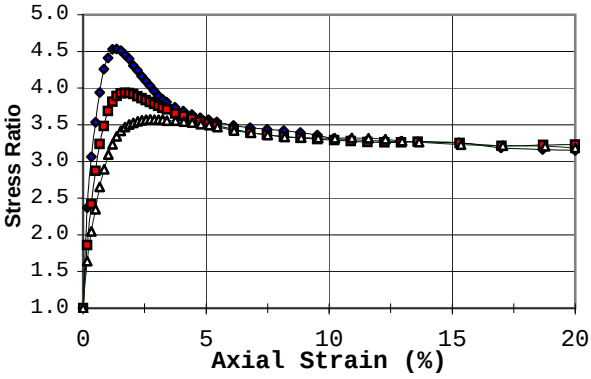
TRIAXIAL TEST ASTM: D 4767

Job No. **13945**
Date: **8/17/22**

Project: **Velsicol / Coleman Engineering Co.**
Boring #: **PD-009** Sample #: Type: **3T** Depth (ft): **30-33**
Soil Type: **Sandy Lean Clay w/a little gravel (CL)**







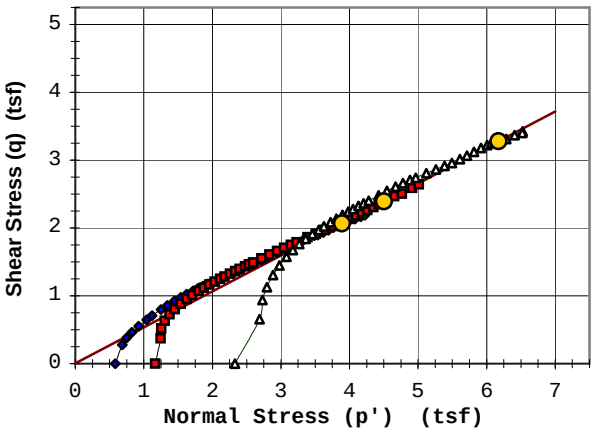
Failure Criterion:	Given Strain of: 15%
Angle of internal friction, ϕ' =	32.0 °
Apparent Cohesion, c' =	0.01 (tsf)

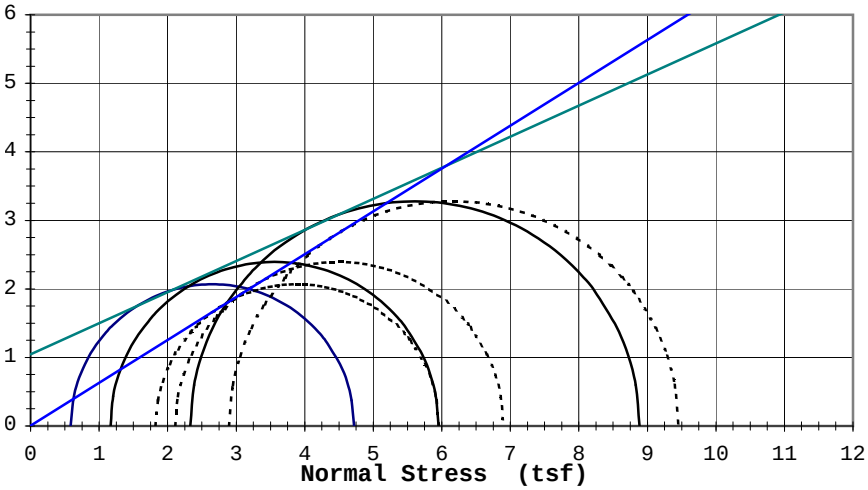
Test Date:	8/5/22	Liquid Limit:	20
Test Type:	CU w/pp	Plastic Limit:	11
Strain Rate (in/min):	0.000736	Plasticity Index:	9
Strain Rate (%/min):	0.025	Spec. Gravity (Assumed):	2.68

Initial Conditions	A	B	C	D	E
Diameter (in)	1.44	1.44	1.44		
Height (in)	2.95	2.95	2.95		
Water Content (%)	10.4	10.4	10.6		
Dry Density (pcf)	129.3	129.7	129.2		
Void Ratio	0.29	0.29	0.29		
After Consolidation					
Diameter (in)	1.44	1.44	1.42		
Height (in)	2.94	2.94	2.93		
Water Content (%)	10.7	10.6	9.6		
Dry Density (pcf)	129.9	130.2	133.2		
Void Ratio	0.29	0.28	0.26		
Back Pressure (tsf)	5.8	7.1	5.7		
Minor Principal Stress (tsf)	0.59	1.17	2.33		
Max. Deviator Stress (tsf)	4.38	5.28	6.85		
Ultimate Deviator Stress (tsf)	4.38	5.28	6.81		
Deviator Stress at Failure (tsf)	4.13	4.79	6.56		
Max. Pore Pressure Buildup (tsf)	0.22	0.52	0.83		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Specimen trimmed to given condidtions with drainage strips applied; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared. A correction for membrane stiffness was applied to the deviator stress.





Rupture Envelope at Failure	
α = 27.9 °	a = 0.0 (tsf)

----------	Effective ϕ': 32.0 °	c'=	0.01 (tsf)
_____	Total ϕ: 24.4 °	c=	1.04 (tsf)

Triaxial Data

Job: **13945**

Boring: PD-009 Sample: Depth: 30-33 Date: 8/17/22

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.17	0.56	0.18	0.17	0.75	0.29	0.17	1.31	0.29						
0.34	0.76	0.21	0.34	1.04	0.43	0.34	1.88	0.54						
0.51	0.92	0.22	0.51	1.26	0.49	0.51	2.25	0.66						
0.68	1.10	0.21	0.68	1.46	0.51	0.68	2.61	0.75						
0.85	1.29	0.19	0.85	1.61	0.52	0.86	2.90	0.80						
1.02	1.41	0.17	1.02	1.77	0.51	1.02	3.15	0.83						
1.19	1.60	0.13	1.19	1.90	0.49	1.19	3.35	0.83						
1.36	1.72	0.10	1.36	2.02	0.47	1.37	3.53	0.82						
1.53	1.85	0.06	1.53	2.14	0.43	1.54	3.68	0.81						
1.70	1.95	0.02	1.70	2.23	0.40	1.71	3.82	0.78						
1.87	2.05	-0.02	1.87	2.33	0.37	1.88	3.95	0.75						
2.04	2.14	-0.06	2.04	2.41	0.34	2.05	4.05	0.73						
2.21	2.21	-0.10	2.21	2.50	0.30	2.22	4.17	0.69						
2.38	2.28	-0.14	2.38	2.56	0.27	2.39	4.28	0.66						
2.55	2.35	-0.17	2.55	2.65	0.23	2.56	4.38	0.62						
2.72	2.40	-0.21	2.72	2.73	0.19	2.73	4.48	0.59						
2.89	2.44	-0.24	2.89	2.79	0.16	2.90	4.56	0.56						
3.06	2.49	-0.27	3.06	2.87	0.12	3.07	4.65	0.52						
3.23	2.53	-0.30	3.23	2.93	0.09	3.24	4.73	0.49						
3.40	2.57	-0.33	3.40	2.99	0.06	3.41	4.80	0.45						
3.74	2.67	-0.39	3.74	3.10	0.00	3.75	4.96	0.39						
4.08	2.77	-0.45	4.08	3.21	-0.06	4.10	5.09	0.33						
4.42	2.88	-0.51	4.42	3.32	-0.12	4.44	5.22	0.27						
4.75	2.96	-0.56	4.76	3.41	-0.18	4.78	5.32	0.21						
5.09	3.05	-0.60	5.10	3.50	-0.23	5.12	5.42	0.16						
5.44	3.13	-0.65	5.44	3.58	-0.27	5.46	5.48	0.11						
6.11	3.27	-0.73	6.12	3.72	-0.36	6.14	5.61	0.01						
6.79	3.40	-0.80	6.80	3.83	-0.43	6.83	5.73	-0.07						
7.47	3.52	-0.86	7.48	3.94	-0.50	7.51	5.83	-0.14						
8.15	3.64	-0.92	8.16	4.06	-0.57	8.19	5.92	-0.21						
8.83	3.72	-0.97	8.84	4.16	-0.63	8.87	6.03	-0.26						
9.51	3.78	-1.01	9.52	4.26	-0.69	9.56	6.14	-0.31						
10.19	3.80	-1.06	10.20	4.37	-0.74	10.24	6.24	-0.36						
10.87	3.87	-1.10	10.88	4.45	-0.79	10.92	6.35	-0.41						
11.55	3.94	-1.14	11.56	4.53	-0.83	11.61	6.45	-0.45						
12.23	4.00	-1.17	12.24	4.62	-0.88	12.29	6.50	-0.49						
12.91	4.07	-1.21	12.92	4.70	-0.91	12.97	6.52	-0.53						
13.59	4.13	-1.24	13.60	4.79	-0.95	13.65	6.56	-0.57						
15.28	4.26	-1.30	15.30	4.93	-1.02	15.36	6.63	-0.64						
16.98	4.26	-1.36	17.01	5.01	-1.10	17.07	6.74	-0.71						
18.68	4.33	-1.41	18.71	5.18	-1.16	18.77	6.85	-0.77						
20.00	4.38	-1.45	20.00	5.28	-1.21	20.00	6.81	-0.79						

Appendix D
Soil Design Parameters

Soil Design Parameters

Till Properties

Undrained Shear Strength (Su)	5000	psf
Unit Weight (γ)	140	pcf
Soil Strain Parameter (E50)	0.005	

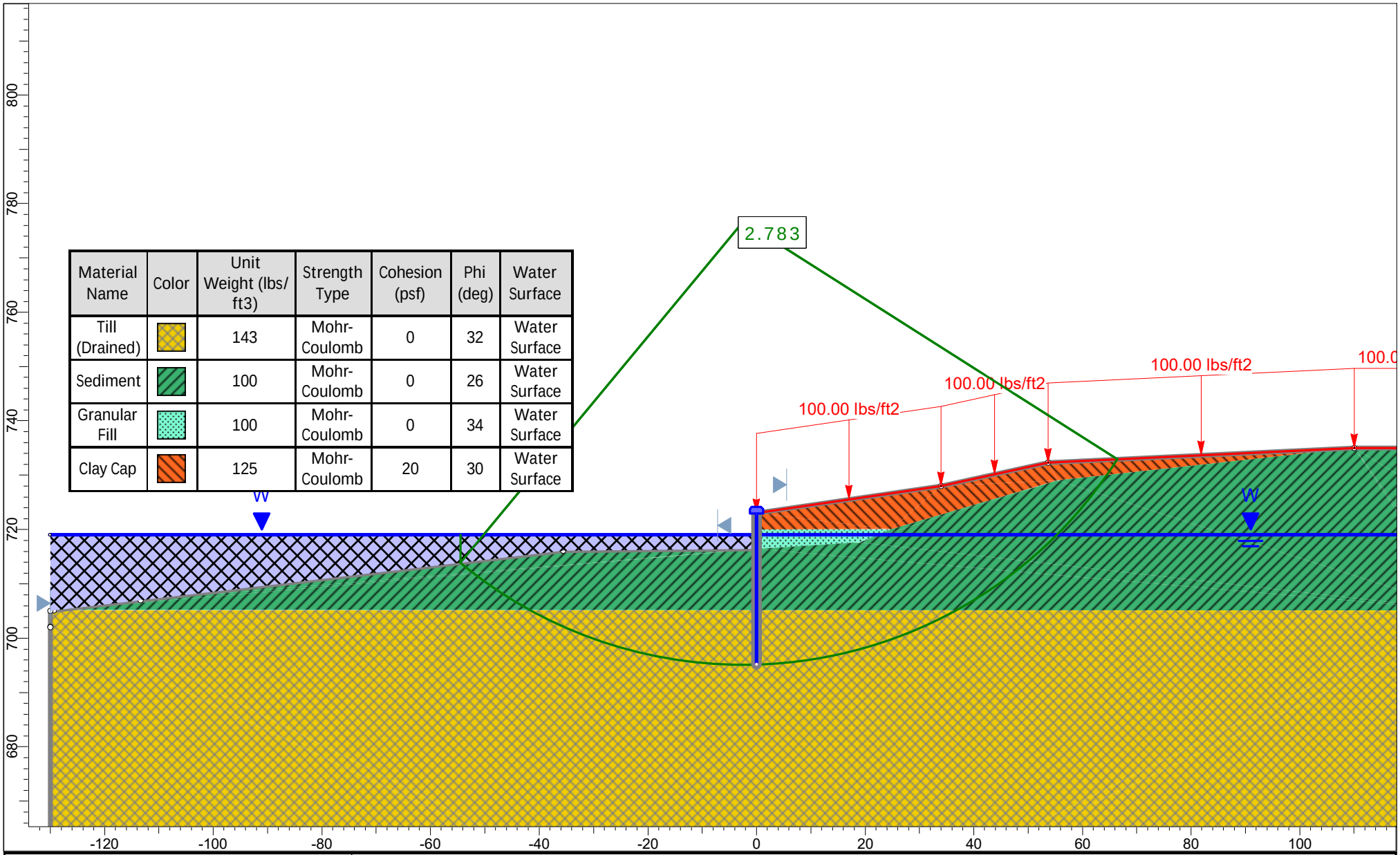
Sediment Properties

Effective Friction Angle (ϕ')	34	deg
Effective Cohesion (c')	0	psf
Unit Weight (γ)	100	pcf
Soil Modulus Parameter (k(py))	25	pci

Fill Properties

Effective Friction Angle (ϕ')	30	deg
Effective Cohesion (c')	0	psf
Unit Weight (γ)	115	pcf
Soil Modulus Parameter (k(py))	50	pci

Appendix E
Global Stability Analysis Results



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Till (Drained)		143	Mohr-Coulomb	0	32	Water Surface
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface

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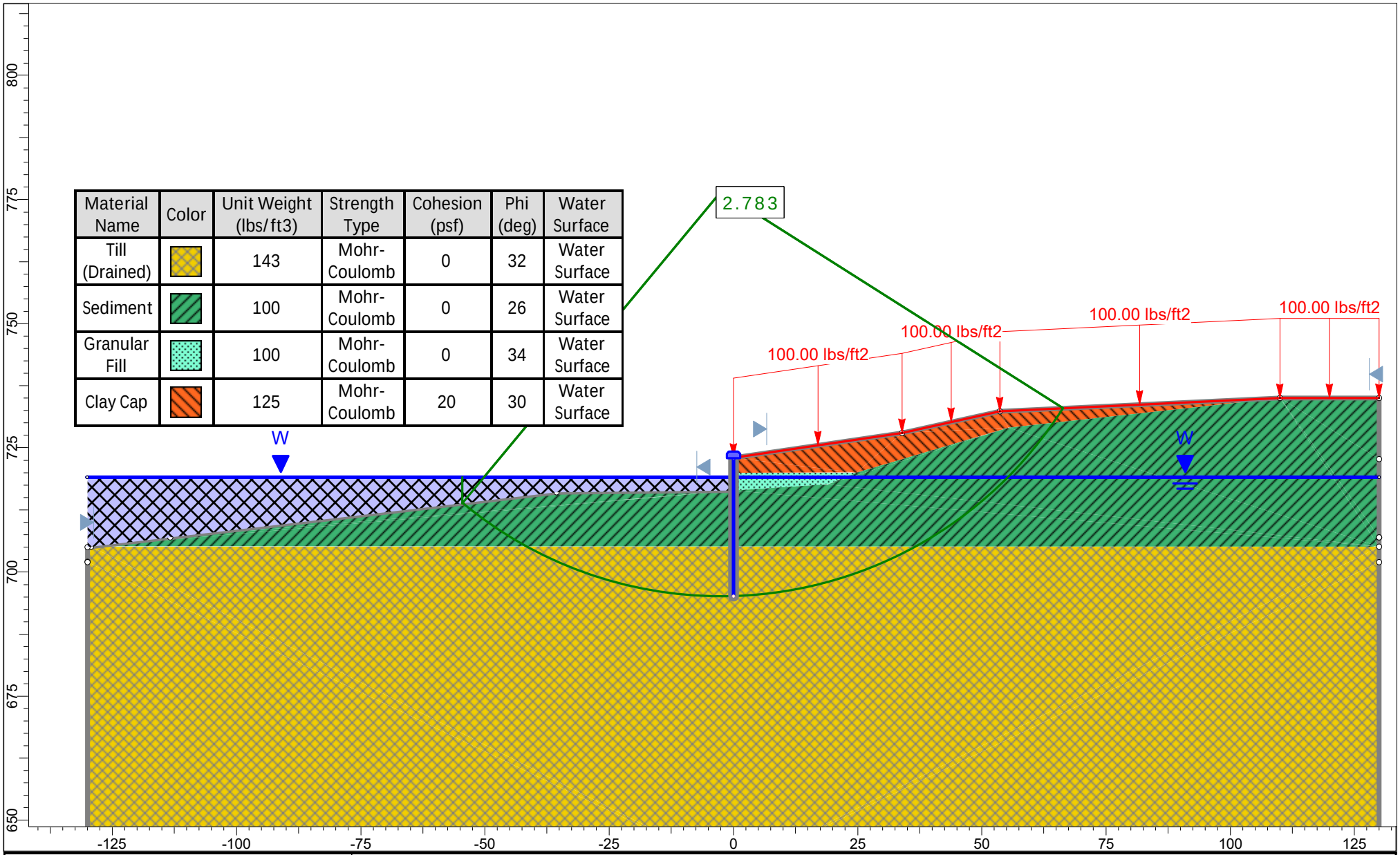
SLIDEINTERPRET 9.017

Project	Veliscol - DGVBW Design		
Analysis Description	Station 15+00		
Drawn By	C. Winter	*Scale* 1:293	*Company* Jacobs
Date	11/3/2022, 12:46:02 PM		*File Name* VelsicolDGVBW_Profile1_15+00.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Till (Drained)		143	Mohr-Coulomb	0	32	Water Surface
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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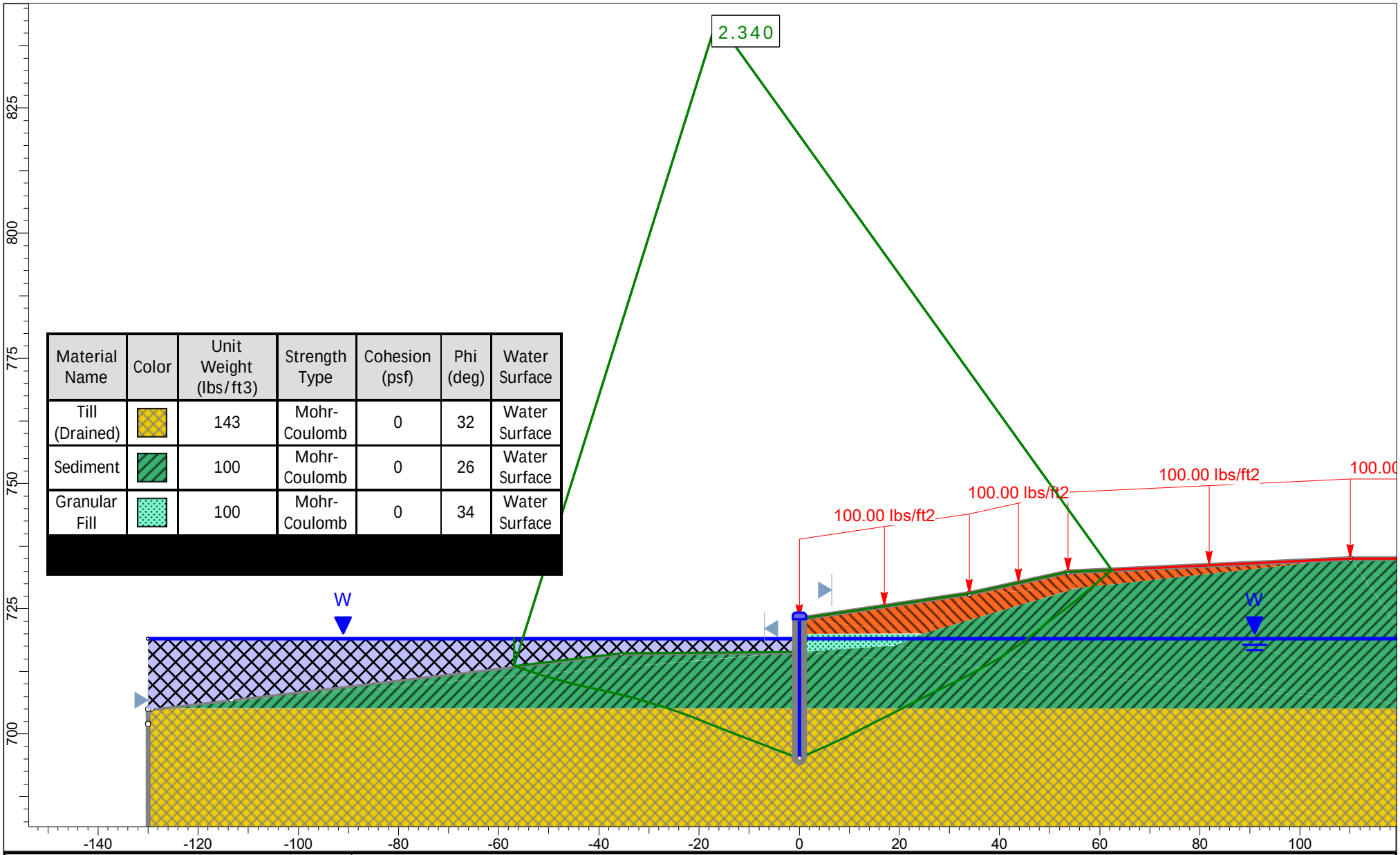
SLIDEINTERPRET 9.017

Project	Veliscol - DGVBW Design		
Analysis Description	Station 15+00		
Drawn By	C. Winter	Scale	1:321
Company	Jacobs		
Date	11/3/2022, 12:46:02 PM	File Name	VelsicolDGVBW_Profile1_15+00.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Till (Drained)		143	Mohr-Coulomb	0	32	Water Surface
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface

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SLIDEINTERPRET 9.017

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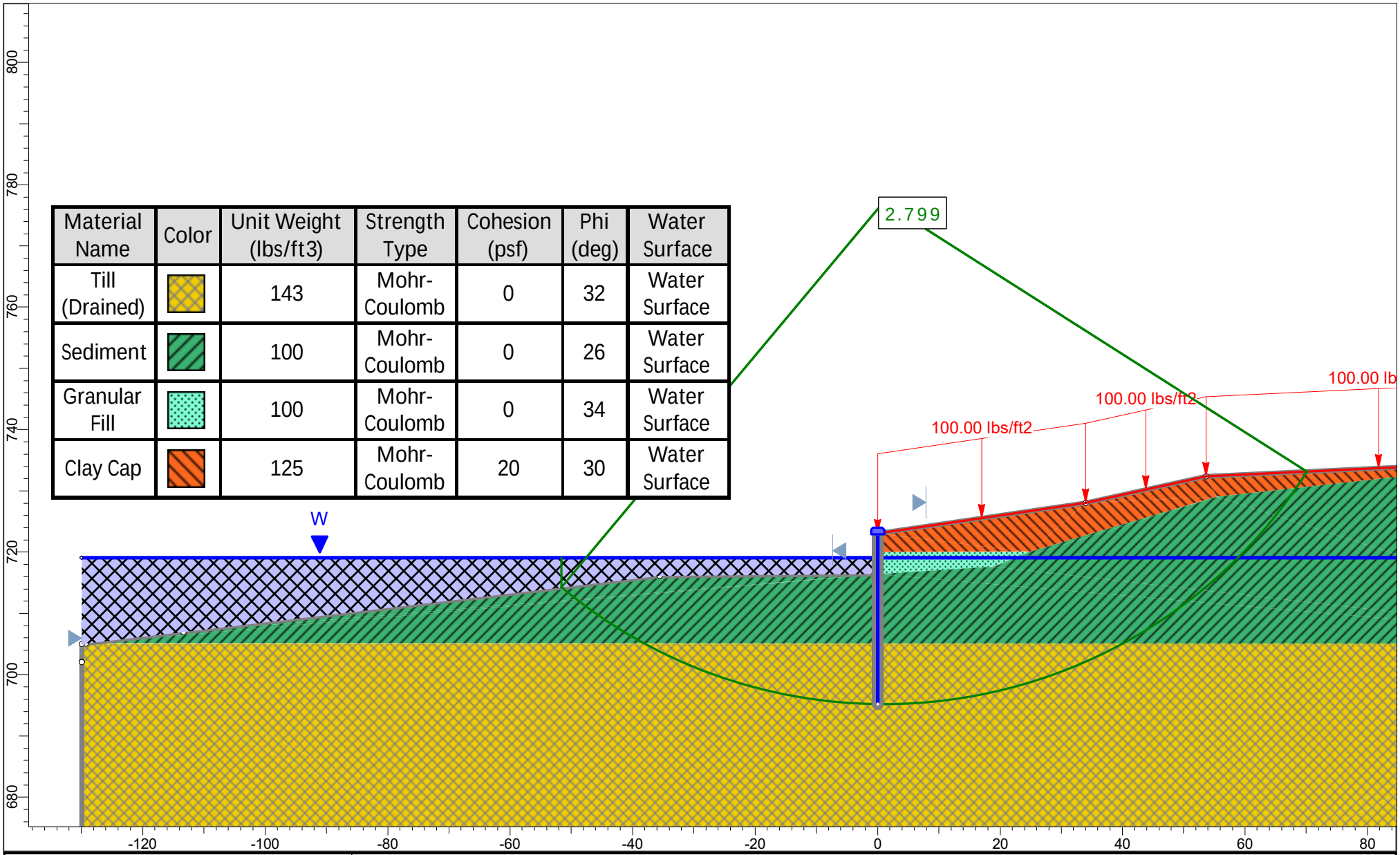
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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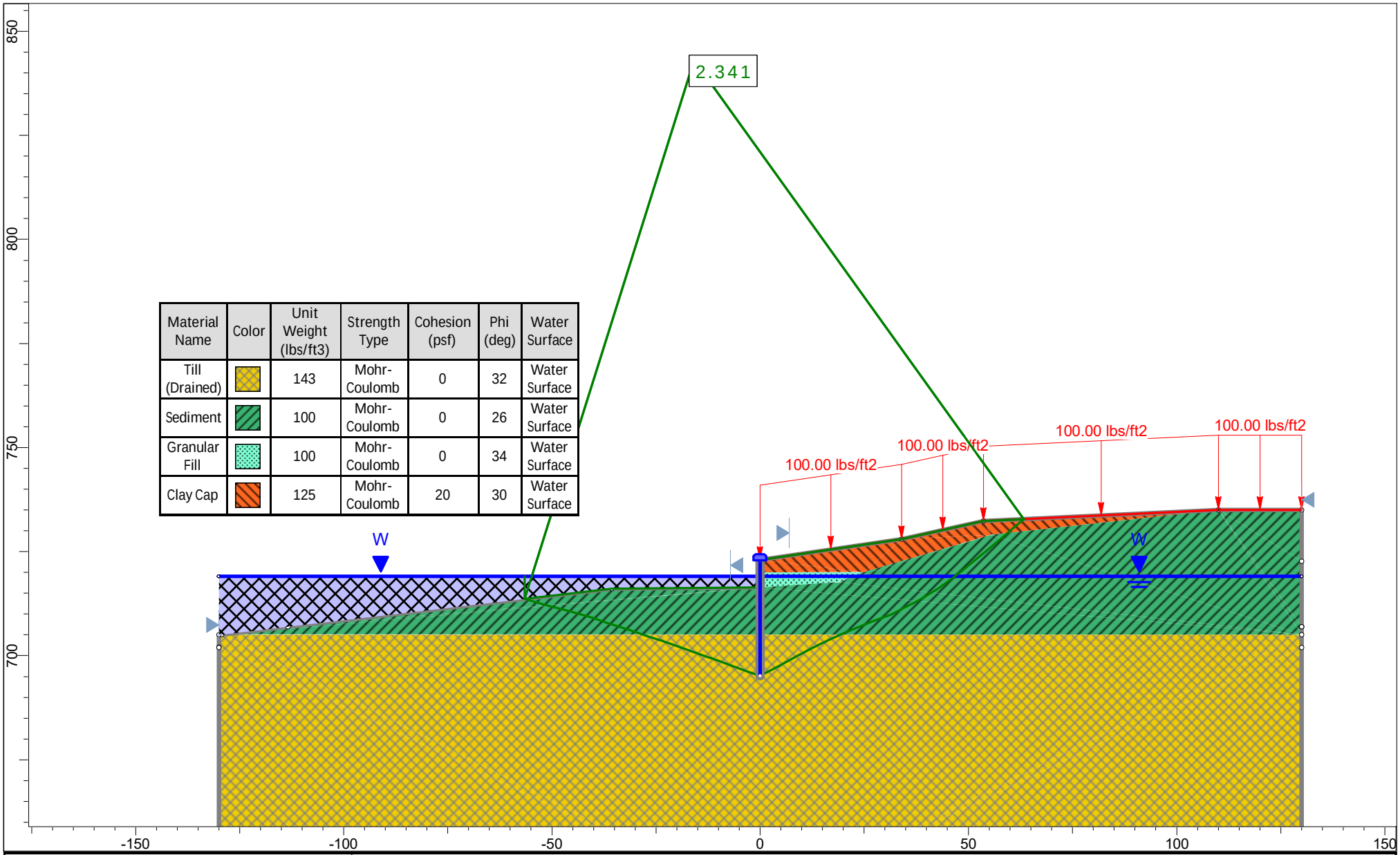

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Till (Drained)		143	Mohr-Coulomb	0	32	Water Surface
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface

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SLIDEINTERPRET 9.017

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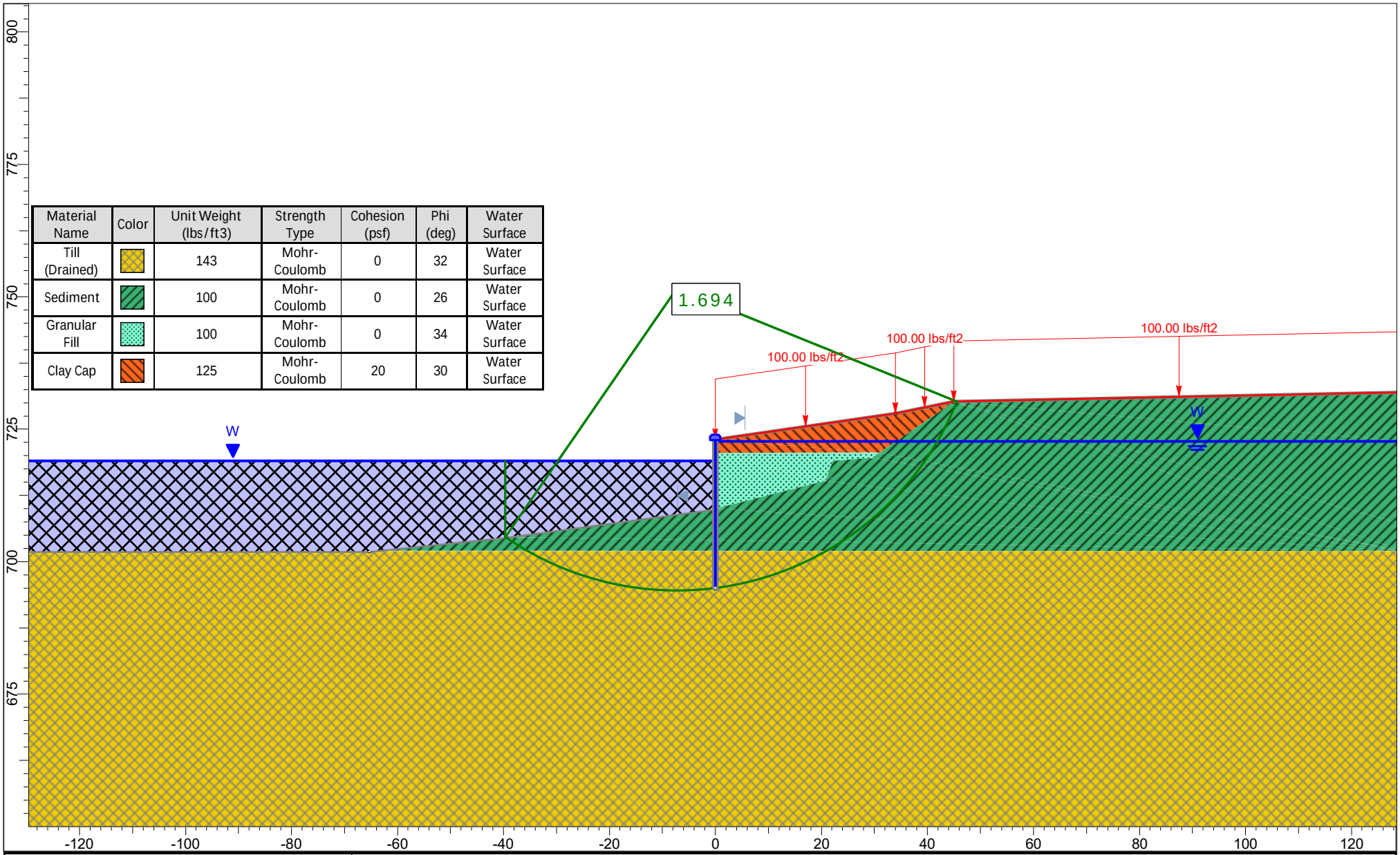
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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SLIDEINTERPRET 9.017

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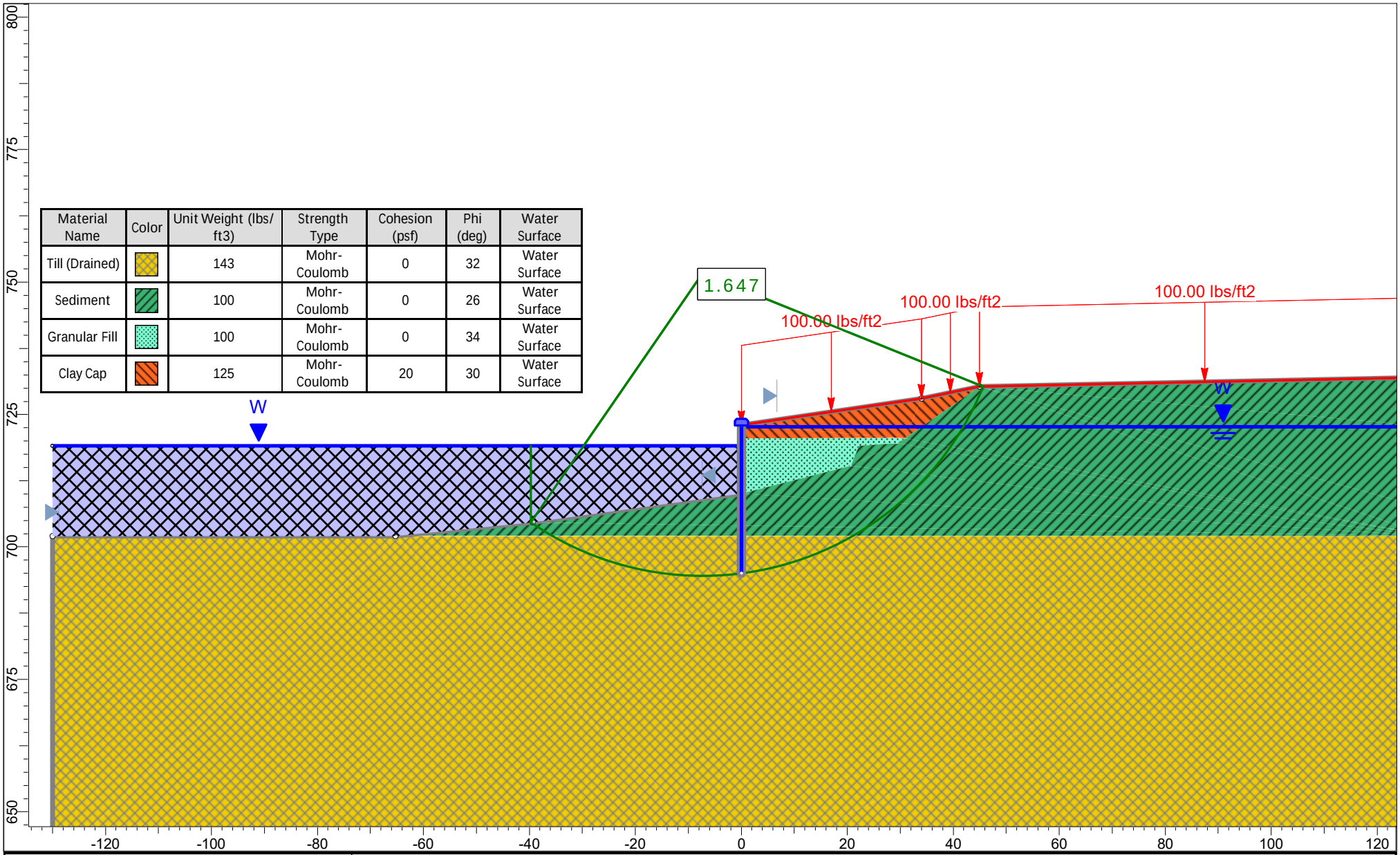
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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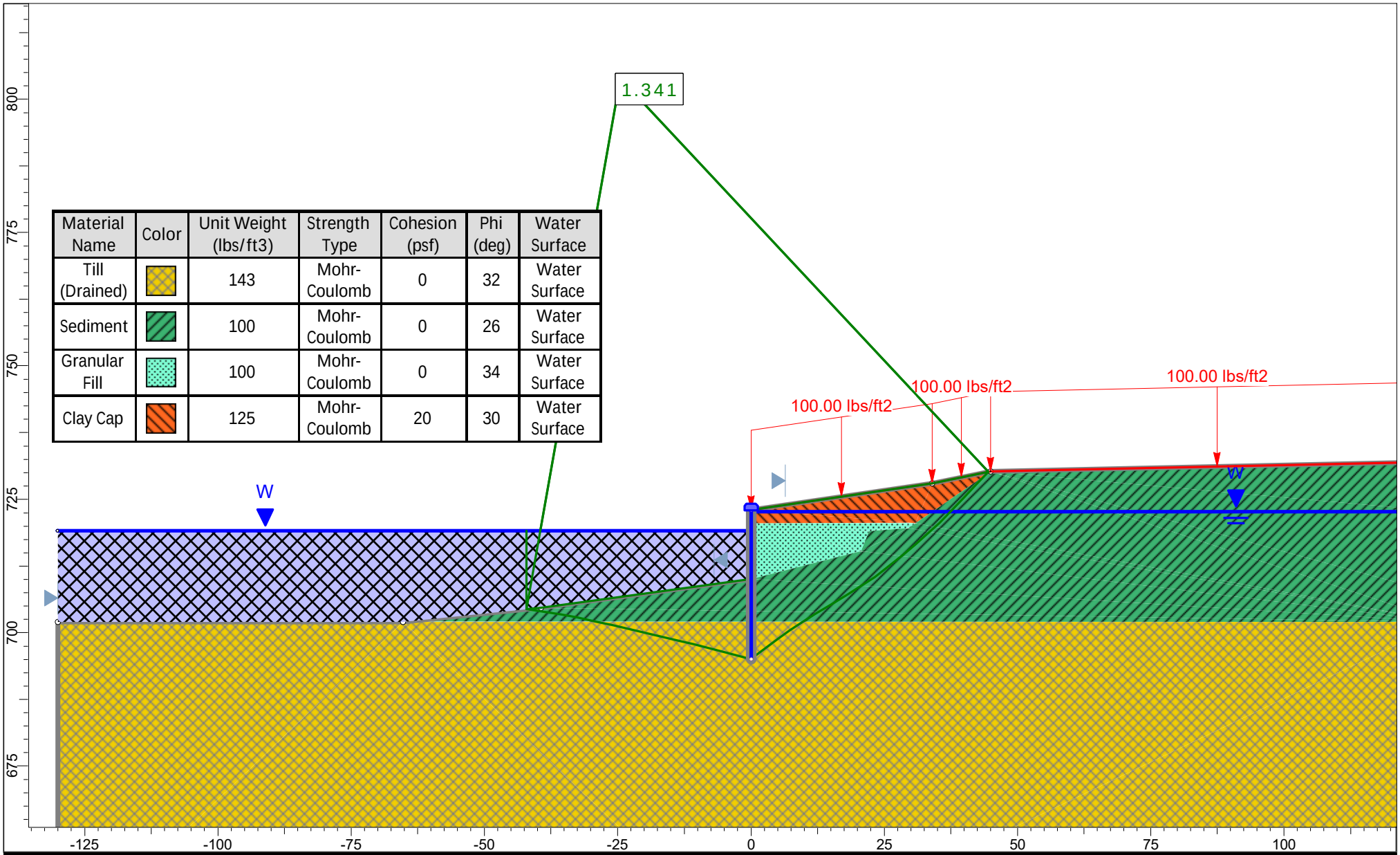

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Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface

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SLIDEINTERPRET 9.017

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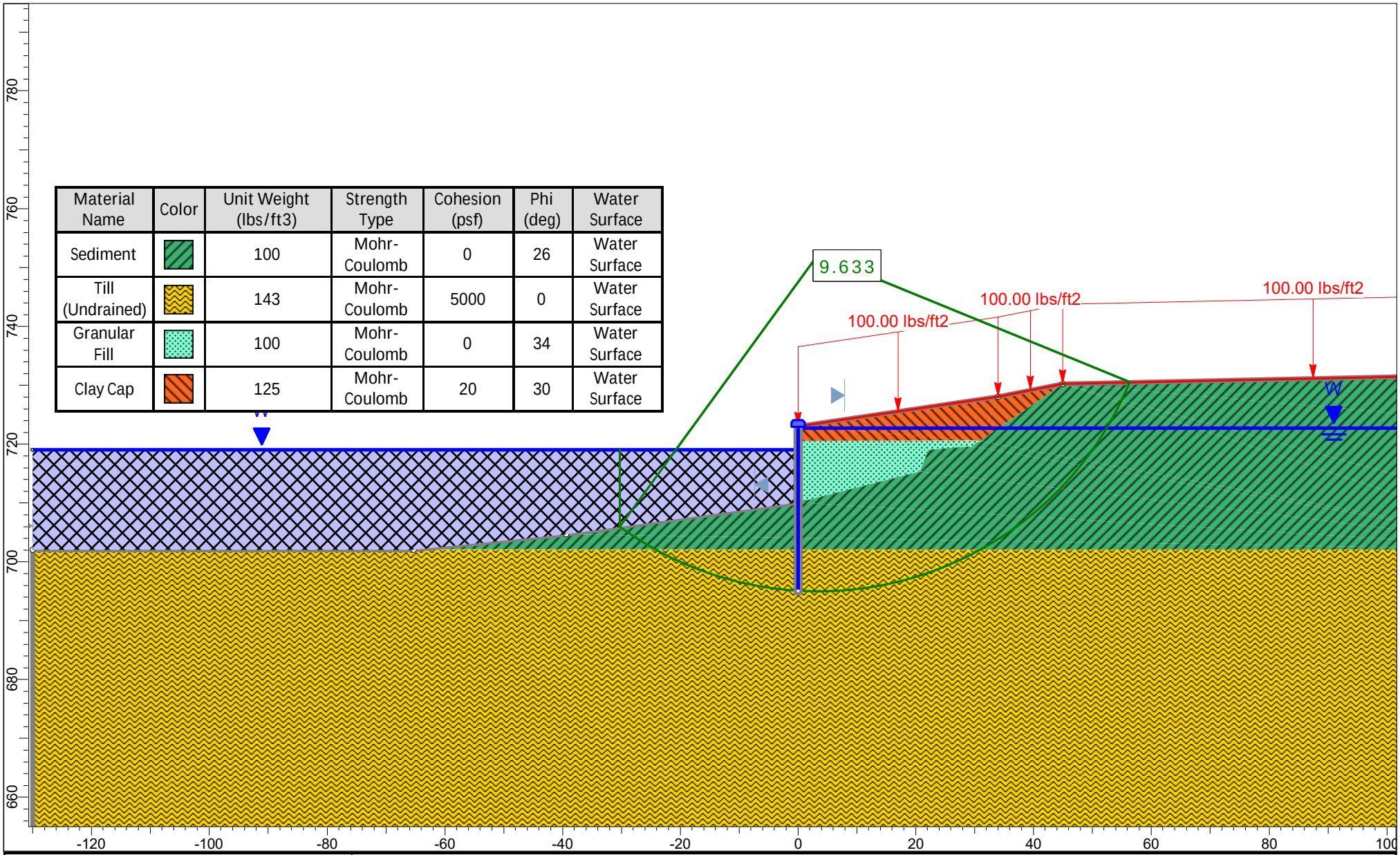
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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SLIDEINTERPRET 9.017

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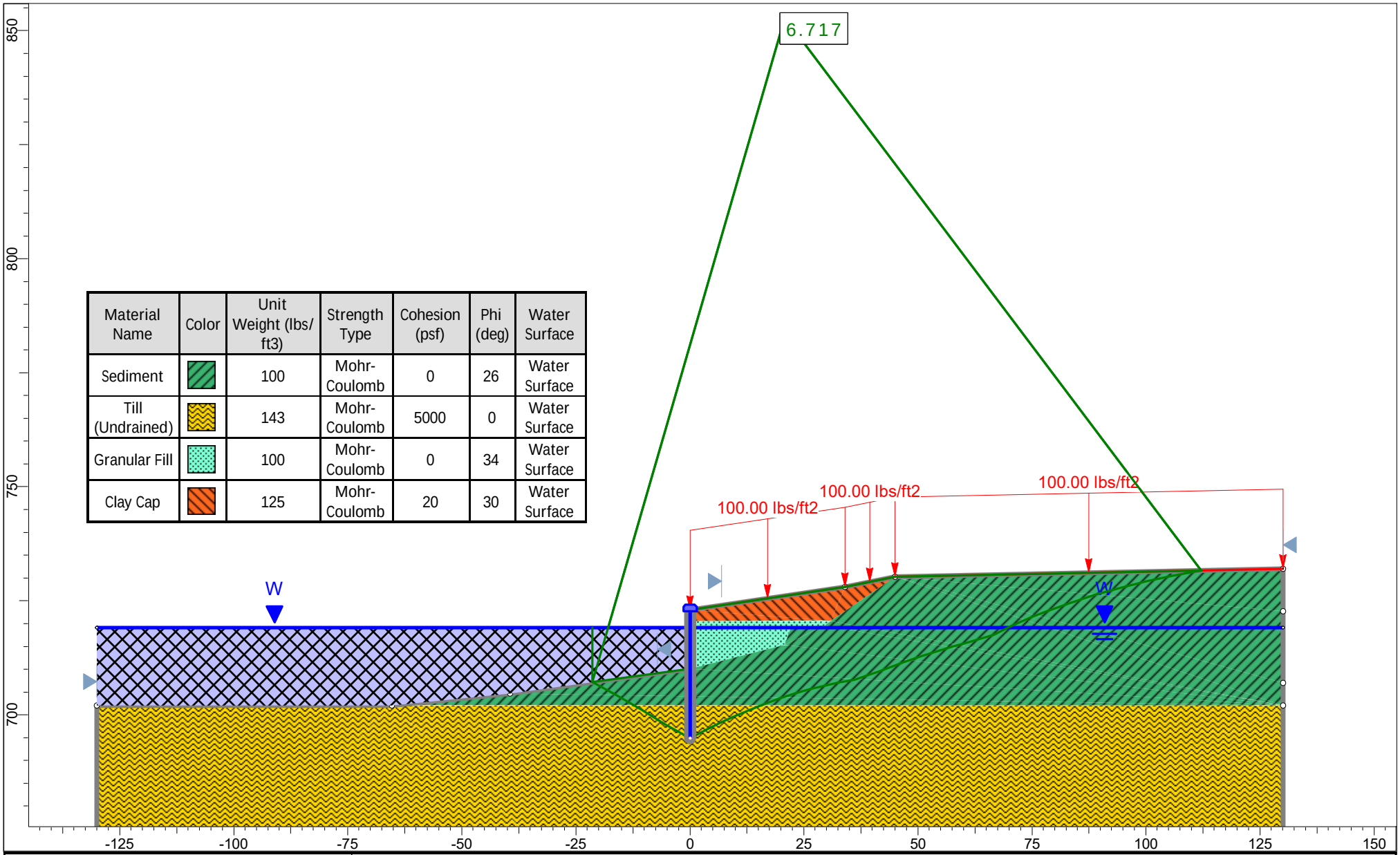

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Till (Undrained)		143	Mohr-Coulomb	5000	0	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface

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SLIDEINTERPRET 9.017

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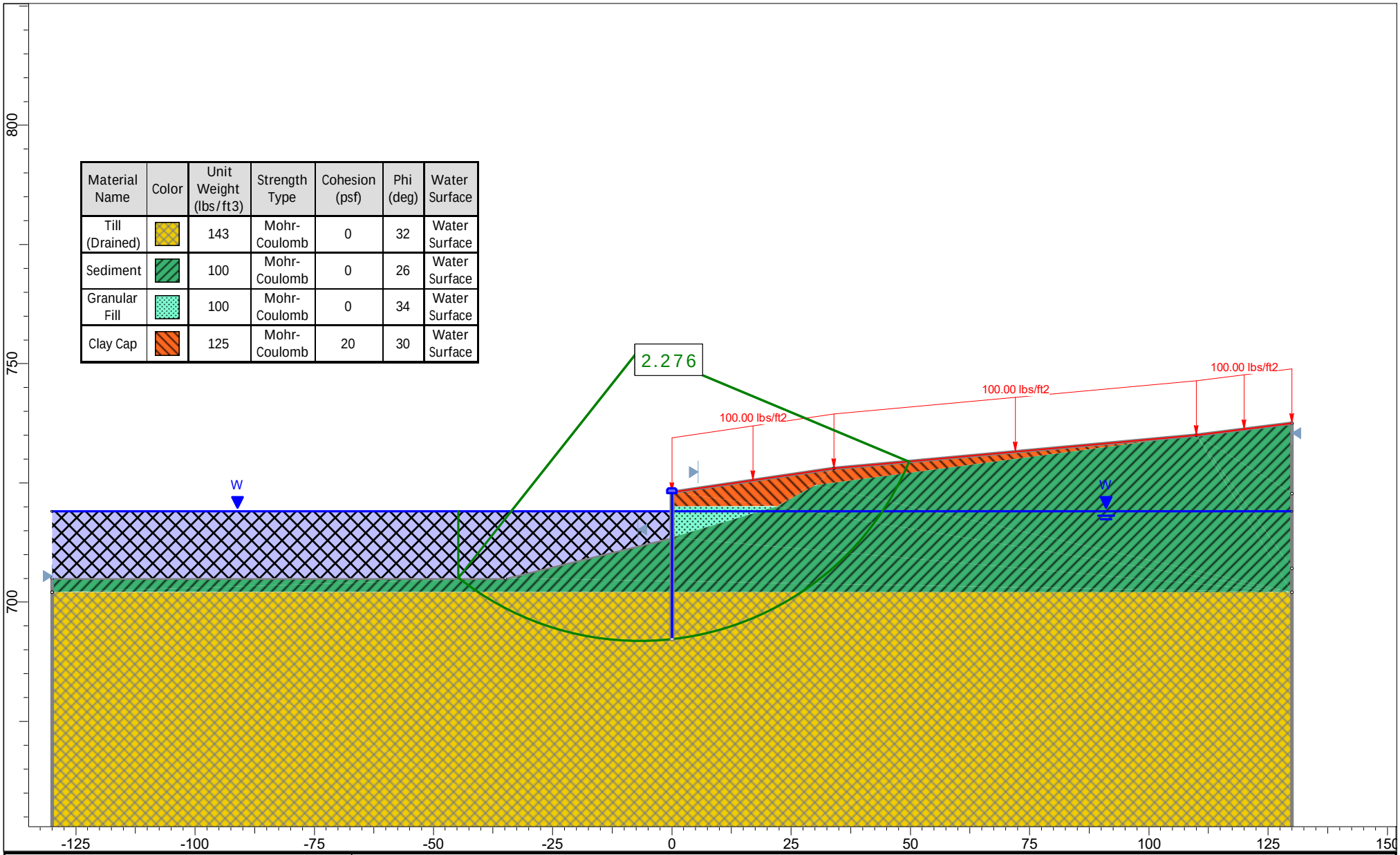
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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SLIDEINTERPRET 9.017

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Date	11/3/2022, 12:46:02 PM	File Name	VelsicolDGVBW_Profile1_37+40.slmd

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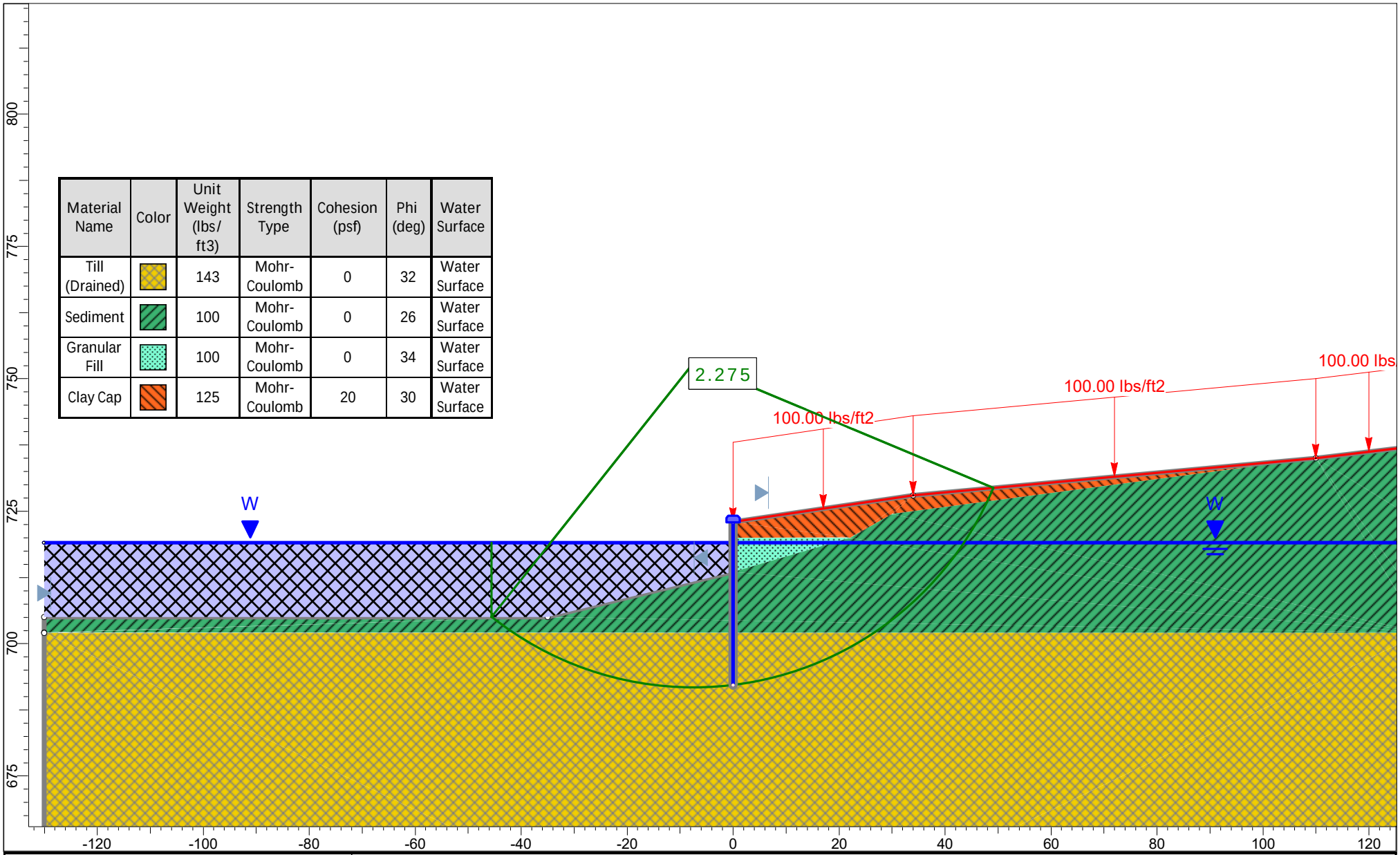
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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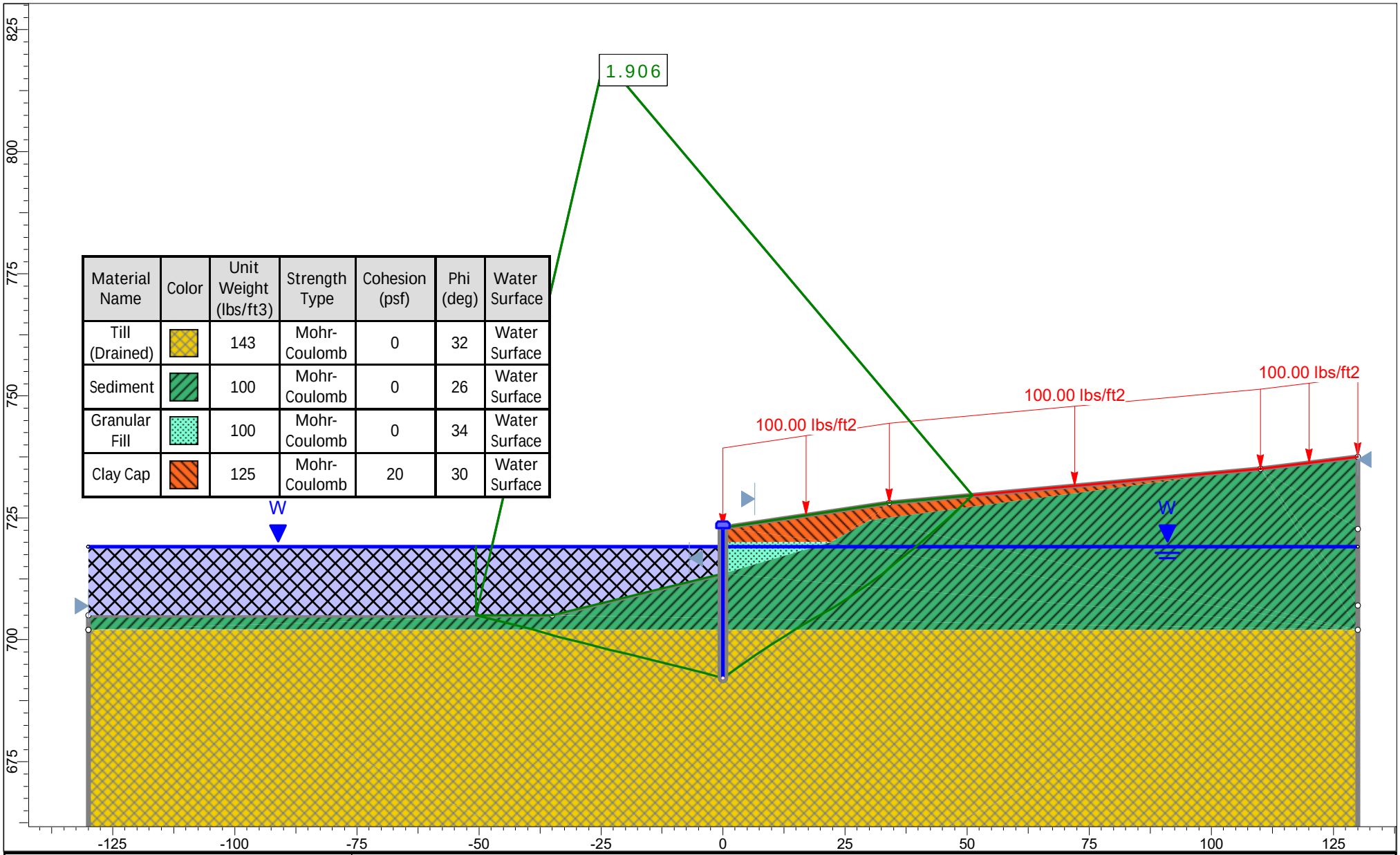

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Sediment		100	Mohr-Coulomb	0	26	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface

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SLIDEINTERPRET 9.017

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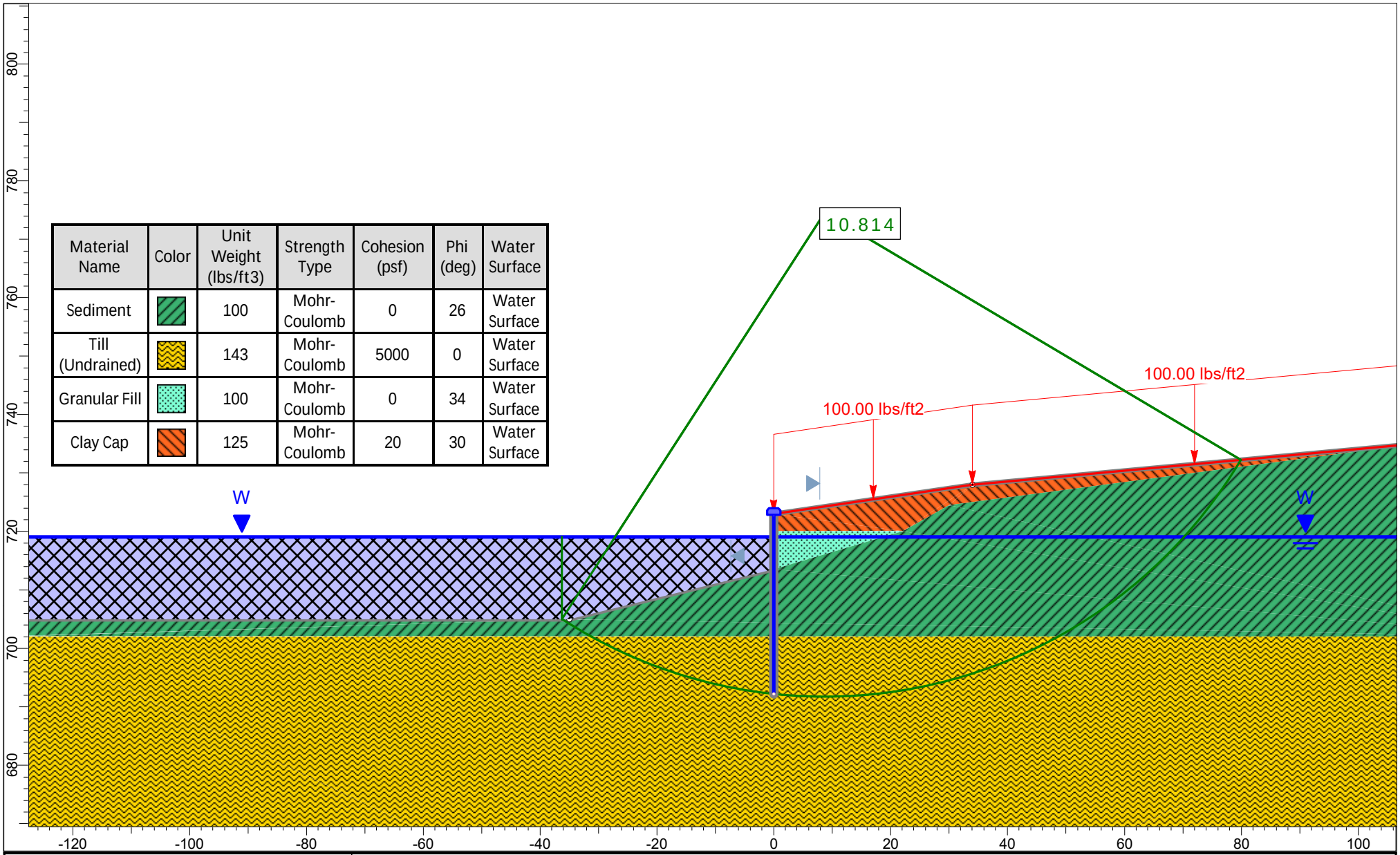
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Till (Undrained)		143	Mohr-Coulomb	5000	0	Water Surface
Granular Fill		100	Mohr-Coulomb	0	34	Water Surface
Clay Cap		125	Mohr-Coulomb	20	30	Water Surface



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SLIDEINTERPRET 9.017

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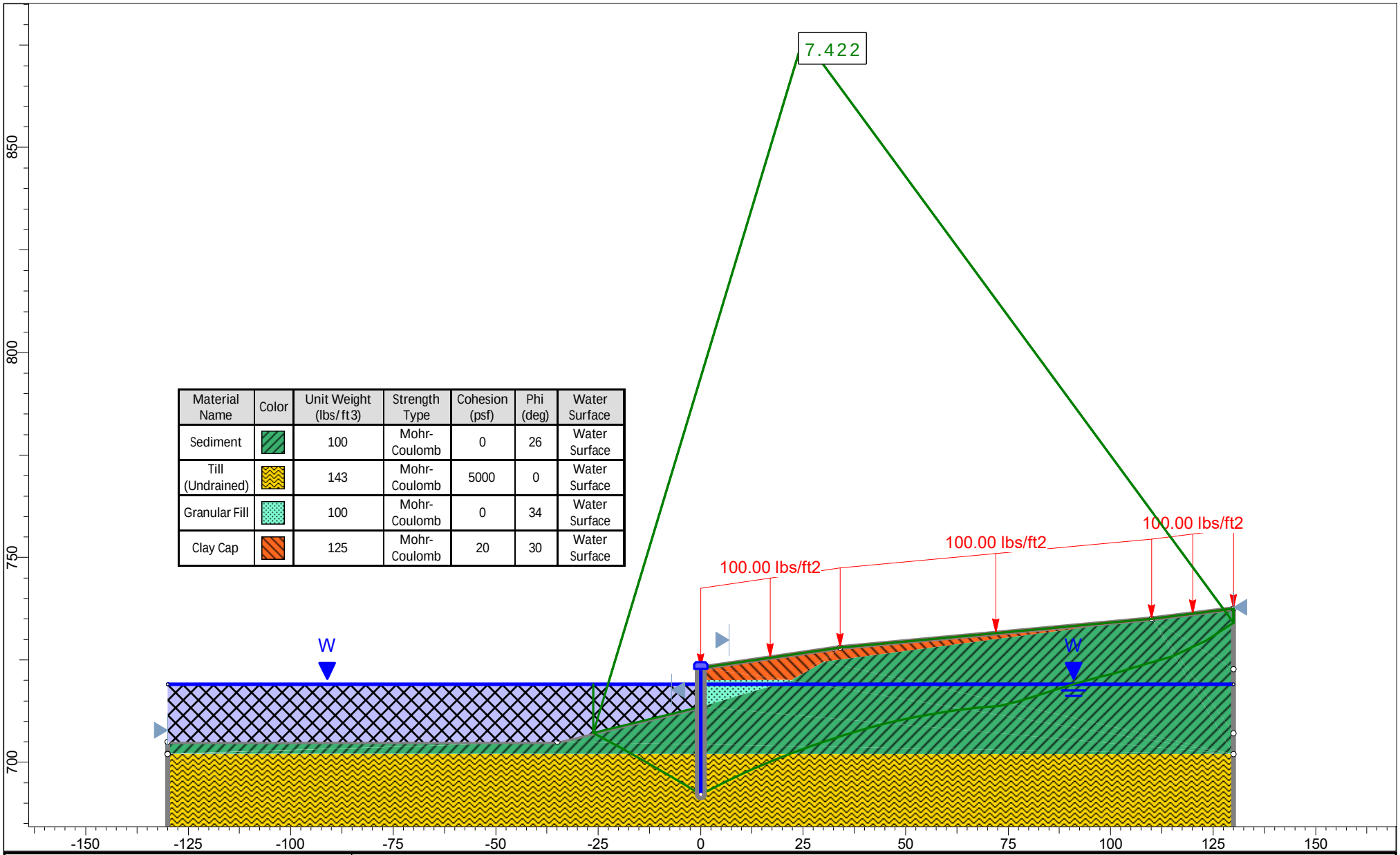
Company	Jacobs		
Date	11/3/2022, 12:46:02 PM	File Name	VelsicolDGVBW_Profile1_37+40.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sediment		100	Mohr-Coulomb	0	26	Water Surface
Till (Undrained)		143	Mohr-Coulomb	5000	0	Water Surface
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SLIDEINTERPRET 9.017

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Analysis Description	Station 37+40		
Drawn By	C. Winter	*Scale* 1:389	*Company* Jacobs
Date	11/3/2022, 12:46:02 PM		*File Name* VelsicolDGVBW_Profile1_37+40.slmd

Appendix J
Construction Quality Assurance Plan

Construction Quality Assurance Plan

Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall

St. Louis, Michigan

Prepared for:

United States Environmental Protection Agency – Region 5

Prepared by:

CH2M HILL, Inc.
A wholly owned subsidiary of Jacobs Engineering Group Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

U.S. Environmental Protection Agency
Contract Number 68HE0519D0007
Task Order Number 68HE0521F0106
DCN: GLAES-R5-21F0106-02026

September 2023

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Figure

1-1 Study Areas and Operable Units

Acronyms and Abbreviations

3POC	Three Phases of Control
AHA	activity hazard analysis
ANP	adjacent and nearby properties
bgs	below ground surface
BMP	best management practice
BODR	Basis of Design Report
CH2M	CH2M HILL, Inc.
CM	Construction Manager
cm/s	centimeter(s) per second
COC	contaminant of concern
CQAP	Construction Quality Assurance Plan
CQM	Construction Quality Manager
CRA	Conestoga-Rovers and Associates Limited
DDT	dichlorodiphenyl trichloroethane
DFOW	definable feature of work
DGVBW	downgradient vertical barrier wall
DNAPL	dense nonaqueous phase liquid
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EPA	U.S. Environmental Protection Agency
FPS	Former Plant Site
FS	feasibility study
GLAES	Great Lakes Architect Engineer Services
GWCS	groundwater collection system

GWECT	groundwater elevation collection trench
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HSM	Health and Safety Manager
MCC	Michigan Chemical Corporation
OU	operable unit
PBB	polybrominated biphenyl
PM	Project Manager
PM_{10}	particulate matter less than 10 micrometers in aerodynamic diameter
QA	quality assurance
QC	quality control
QCM	Quality Control Manager
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFI	request for information
RI	remedial investigation
ROD	Record of Decision
site	Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan
T&E	threatened and endangered
TOCOR	Task Order Contracting Officer's Representative
TRIS	tris(2,3-dibromopropyl)phosphate
Weston	Weston Solutions of Michigan, Inc.

Glossary

Construction Quality Assurance Plan (CQAP)—Establishes the guidelines and requirements to be used for project delivery to meet client objectives and achieve the standards. The primary objective of the CQAP is to document requirements, procedures, and methodology for quality assurance and quality control during construction of this project.

Quality Assurance (QA)—Refers to the overall quality process. It is the assurance that the construction effort is conducted in a manner consistent with the design and meets the requirements of the project objectives.

Quality Control (QC)—Refers to a planned system for monitoring, controlling, and documenting the quality of materials, supplies, and workmanship in a manner consistent with the execution plan and the drawings and specifications. Monitoring, controlling, and documenting are the active tasks associated with quality management. This document does not specifically address QC requirements.

Project Instructions—Provide management instructions for construction operations, documentation, and reporting for work to be performed. The instructions provide guidance to the project team and clarify the Site Manager's expectations regarding personnel assignments (including level of effort, responsibilities, accountability, project goals, direction, processes, and procedures through the construction phase of the project). The project instructions define parameters for the implementation of the CQAP.

Construction Quality Submittals—Refers to submittals generated during or immediately before construction to demonstrate compliance with the project plans, drawings, and specifications. Construction quality submittals include daily reports, shop drawings, schedules, sample documentation, calibration records, photographs, product data, samples, field change request documentation, administrative and closeout submittals, and additional technical support data presented for review and approval.

1. Introduction

The purpose of this Construction Quality Assurance Plan (CQAP) is to provide the quality processes and procedures for conducting remedial action (RA) at Operable Unit (OU) 1 of the Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan (site). Specifically, this CQAP addresses RA construction activities associated with the installation of a downgradient vertical barrier wall (DGVBW) to contain the Former Plant Site (FPS), which is part of the overall site remedy described in the Record of Decision (ROD; EPA, 2012). In accordance with the ROD, the DGVBW will consist of interlocking, sealed sheet piles and king piles to decrease the potential for dense nonaqueous phase liquid (DNAPL) and dissolved-phase contaminants to directly discharge to the Pine River from the shallow outwash unit (EPA, 2012). This CQAP includes processes and procedures for the following activities:

- Observing construction activities
- Following sampling and testing protocol
- Documenting that construction has been completed in general accordance with the plans and specifications in the Performance Work Statement and with quality assurance (QA) procedures outlined in this plan

An RA Contractor will be selected by the U.S. Environmental Protection Agency (EPA) to perform the RA. The remedial design (RD) was performed under the Great Lakes Architect Engineer Services (GLAES) II Contract 68HE0519D0007, Task Order 68HE0521F0106. The RA will be completed under a different contract and in accordance with the *Remedial Design/Remedial Action Handbook* (EPA, 1995).

1.1 Site Description

The site (National Superfund Database Identification Number MID00722439) encompasses a 52-acre land parcel commonly referred to as the FPS and includes the adjacent and nearby properties (ANP). A chemical plant once occupied the FPS, which is in a predominantly residential area. The Pine River flows along the western and northern boundary of the FPS into Mill Pond, where a hydroelectric dam is located (about 0.25 mile east of the FPS). The boundary of the 52-acre FPS is fenced, and access is controlled through a lockable main gate. Figure 1-1 shows the FPS location and the surrounding OUs.

Project stakeholders for the site include the Michigan Department of Environment, Great Lakes, and Energy (EGLE[1]), Weston Solutions of Michigan, Inc. (Weston; EGLE Contractor), and the City of St. Louis, Michigan, and are referred to collectively in this CQAP as "stakeholders." EGLE was the lead agency for the remedial investigation (RI)/feasibility study (FS). EPA is the lead agency for the RD and RA.

The site consists of four OUs, as follows:

- OU1—FPS and ANP, for which RD and RA activities are in progress
- OU2—Pine River and Mill Pond sediment adjacent and upstream from the St. Louis hydroelectric dam, for which RA activities were completed in 2006
- OU3—Pine River sediments stretching from the St. Louis hydroelectric dam to approximately 1.25 miles downstream of the dam, for which a Proposed Plan was completed in August 2022

[1] Effective April 22, 2019, Michigan Department of Environmental Quality was reorganized and renamed as the Michigan Department of Environment, Great Lakes, and Energy.

- OU4—Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee Rivers, for which RI activities are ongoing

The activities described in this CQAP will support the DGVBW RA, which is part of the overall OU1 remedy.

1.1.1 Site History

The FPS was used for industrial operations beginning in the mid-1800s until 1977. Historical operations at the site included a lumber mill, oil refinery, salt-processing plant, and chemical manufacturing plant. The FPS included numerous buildings that housed manufacturing, maintenance operations, administrative functions, and laboratories for product research and development. Storage facilities for raw and finished products, including warehouses and storage tanks constructed above- and belowground, were also integrated throughout the FPS. Historical documents identify several lagoons that are either known or presumed to be associated with waste disposal practices.

In 1935, Michigan Chemical Corporation (MCC) purchased the property and operated a chemical manufacturing business. In 1965, Velsicol Chemical Corporation gained a controlling interest in MCC. MCC manufactured a wide variety of products at the FPS from 1936 through 1977, including various salts, magnesium oxide, rare earth chemicals, dichlorodiphenyl trichloroethane (DDT), and fire retardants, such as polybrominated biphenyl (PBB) and tris(2,3-dibromopropyl)phosphate (TRIS).

In 1977, MCC production operations at the FPS were terminated. Following plant closure, in 1978, MCC began decommissioning the facility, which included the demolition of all aboveground structures and subsequent burial of building debris, rail lines, storage tanks, and process piping. Building and tank foundations were not removed. Thus, a significant volume of debris remains buried at the FPS.

1.1.2 Existing Site Conditions

The following subsections describe existing conditions at the site.

1.1.2.1 Sitewide Geology

Weston performed an RI from 2002 through 2005 and defined the site geology. There are three naturally occurring unconsolidated deposits sitewide: shallow outwash unit, till unit, and lower outwash unit. On the FPS, two human-made units are also present, including a clay cap and fill.

The clay cap was constructed as part of the 1982 Consent Judgment and ranges from 2 to 10 feet in thickness. A sand layer is present directly above the clay cap, and a layer of topsoil is present above the sand layer. The thickness of these two layers has been observed to be up to 2.5 feet.

The shallow outwash unit is composed of fill, alluvium, and lacustrine deposits. Debris is also present within the shallow outwash unit (for example, concrete and metal) from the operation and demolition of the FPS. The thickness of the shallow outwash unit varies between 20 and 30 feet.

The till unit thickness ranges from 30 to 80 feet and is composed of sandy silt with variable amounts of sand, gravel, and cobbles. The thickness of sand and gravel seams within the till unit range from a few inches to several feet.

The lower outwash unit extends from the base of the till unit to the top of bedrock (approximately 280 feet below ground surface [bgs]) and consists of a series of saturated sands subdivided by the two aquitards. The lower outwash unit is composed of the following:

- The upper lower outwash unit consists of the saturated sands immediately underlying the till unit. The upper lower outwash unit has been observed to be up to 10 feet thick but is typically about 2 to 4 feet thick. A granular unit is immediately under the upper lower outwash unit and is finer grained and more gradational. This portion of the lower outwash unit is referred to as the lower outwash.
- The upper aquitard is a cohesive unit of very stiff to hard, gray to grayish-brown clay or very stiff to hard, gray silt approximately 10 to 30 feet thick.
- The upper city well intake zone consists of fine to coarse saturated sand, with gravel noted at some locations.
- The lower aquitard is a cohesive unit of very stiff to hard, gray to grayish-brown clay or very stiff to hard, gray silt approximately 20 feet thick.
- The lower city well intake zone consists of saturated fine to coarse sand with some fine gravel.

1.1.2.2 Hydrology and Hydrography

Surface water runoff from the FPS flows directly into the Pine River. The Pine River is a tributary that flows to the northeast and converges into the Chippewa River, which flows into the Tittabawassee River. The *Hydrogeologic Atlas of Michigan* indicates that all surface waters within the Tittabawassee River Drainage Basin discharge into the Tittabawassee River, which flows into the Saginaw River, and ultimately into Lake Huron at Saginaw Bay (Curran et al., 1981; Weston, 2006).

In the shallow outwash unit, groundwater flow is influenced by the Pine River, St. Louis Dam, ground surface elevation, and presence of the site-perimeter slurry wall (Weston, 2006). The saturated thickness of the shallow outwash unit at the site ranges from 0.5 foot to approximately 21.0 feet (Weston, 2006). Generally, shallow outwash unit groundwater flow below the FPS is toward the Pine River. As part of the RI completed by Weston, slug tests were performed on eight monitoring wells within the shallow outwash unit. The hydraulic conductivity calculated from the slug test results averaged between 1.26 to 44.8 feet per day (4.46×10^{-4} to 1.58×10^{-2} centimeter per second [cm/s]). The geometric mean across the site was 7.31 feet per day (2.58×10^{-3} cm/s). The most recent slug testing results performed by CH2M HILL, Inc. (CH2M) in 2017 indicate that the hydraulic conductivity ranges from 3.06×10^{-5} to 8.92×10^{-3} cm/s (CH2M, 2017). Grain size analysis and falling head permeability testing results for soil samples collected between 7.0 and 25.0 feet bgs indicate that the soil types within the shallow outwash unit include fine- to medium-grained sand, silty sand, and some silt (Weston, 2006).

Regional flow conditions, local geology, and municipal well usage influence groundwater flow in the lower outwash unit (Weston, 2006). In October 2015, the Cities of St. Louis and Alma, Michigan, formed the Gratiot Area Water Authority, which began providing potable water to St. Louis residents from the combined system, resulting in the cessation of operation of the City of St. Louis's municipal supply wells. Previous interpretations of lower-unit groundwater flow indicated that groundwater primarily flowed to the northeast in the northern portion of the FPS and southeast in the southern portion of the FPS, toward the City of St. Louis municipal water supply wells. Based on groundwater elevation monitoring data collected to date, groundwater elevations in the lower outwash unit have increased by approximately 10 feet with groundwater flow in the lower outwash unit to the east to southeast.

1.1.2.3 Topography, Land Use, and Land Cover

The FPS topography consists of fairly flat to gentle rolling areas on the entire property, likely resulting from the earthwork that occurred during remedial work in the 1980s (Weston, 2006).

The FPS is bordered on the south and east by the ANP, with Washington Avenue along the southern edge. Watson and North Streets mark the eastern edge, and the Pine River and Mill Pond form the western and northern boundaries. The ANP spans approximately 12 blocks and is primarily composed of residential properties that lie south and east of the FPS boundary. A small number of commercial properties are also located south of the FPS, along M-46 and East Washington Avenue.

The FPS is currently fenced, restricting access to the public and larger animals.

1.1.2.4 Ecological Resources

Wildlife habitats at the FPS consist of clear, open areas and low vegetation. Signs of small mammals and Canada geese have been observed on the property. Other wildlife present on or directly adjacent to the FPS includes various songbirds, reptiles, fish, and amphibians common to central Michigan. The FPS is currently fenced, restricting access to larger animals; however, deer have been observed on the property (Weston, 2006). The Pine River is a warmwater fishery supporting a wide range of fish species, including smallmouth bass, carp, suckers, and several species of minnows.

1.1.2.5 Existing Site-perimeter Slurry Wall and Clay Cap

As part of the 1982 Consent Judgment with EPA and EGLE, a 2-foot-thick, low-permeability slurry wall was installed around the FPS. In addition, a clay cap was constructed over the entire FPS. The construction was completed in 1984.

The thickness of the clay cap ranges between 2 and 10 feet and extends over the entire 52-acre parcel. The cap is composed of clay with a permeability of 1×10^{-7} cm/s or less. The purpose of the clay cap is to minimize the infiltration of precipitation to the water table and enhance surface runoff.

The slurry wall runs along the entire perimeter of the FPS, more than 7,200 linear feet in length. In accordance with the Consent Judgment Technical Appendix, the slurry wall was required to be a minimum of 24 inches thick (nominal) to achieve a permeability of 1×10^{-7} cm/s or less and to be keyed in a minimum of 36 inches (nominal) into the underlying till unit.

The existing containment area (cap and slurry wall) was evaluated in the RI/FS completed by EGLE. That evaluation confirmed the presence and extent of the cap through the completion of RI soil borings and geotechnical sampling. The slurry wall was evaluated through the completion of paired piezometer installation and water level measurements, geotechnical soil borings, slurry wall sample collection for hydraulic conductivity testing, and completion of a dye tracer study. The RI concluded that several areas of the slurry wall did not meet the 1×10^{-7} cm/s hydraulic conductivity design criterion, but that the slurry wall was constructed sufficiently to influence shallow outwash unit groundwater flow patterns. During the RI, 20 samples were collected from the slurry wall for grain size and permeability analysis. The permeability test results yielded hydraulic conductivity values ranging from 1.20×10^{-7} to 4.10×10^{-6} cm/s. The RI did not document details for why the slurry wall did not meet the design specifications. The *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan* presents a full evaluation of the clay cap and slurry wall among other features of the site (such as the till unit) (Weston, 2006).

1.1.2.6 Existing DNAPL Groundwater Collection System

A DNAPL/groundwater collection system (GWCS) was installed in segments from 2003 to 2006 as part of the remedy for OU2, which addressed impacted sediment in the Pine River. The purpose of the DNAPL/GWCS is to collect the residual DNAPL that may be present within sand seams in the glacial till underneath the Pine River and to protect the river from residual contamination present on the FPS.

The DNAPL/GWCS consists primarily of collection trenches, collection laterals, and three manholes, MH-1, MH-2, and MH-3, as shown on the design drawings in Appendix A of the *Basis of Design Report, Remedial Design of the Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall, St. Louis, Michigan* (BODR; CH2M, 2023). The manholes consist of a 5-foot sump installed in the middle of each trench segment to facilitate DNAPL separation and accumulation during pumping operations. The trenches and trench laterals were constructed of 4-inch-diameter, perforated high-density polyethylene (HDPE) piping sloped back toward each manhole. The trenches were filled with 2 feet of stone fill, followed by compacted granular fill, after placement of the HDPE pipe. The conveyance piping that transports wastewater from the manholes to the frac tank is 3-inch by 6-inch, double-walled HDPE. The system is manually operated on a weekly basis by pumping water from the manholes to a storage tank on the FPS. Extracted fluids from this system are currently disposed of offsite.

1.1.2.7 Existing Groundwater Elevation Control Tile

A non-operational groundwater elevation control tile (GWECT), installed by Conestoga-Rovers and Associates Limited (CRA), is present along the perimeter of the FPS, adjacent to the Pine River. Not much is known about the historical operations of the GWECT. As shown on the CRA Securement of Plant Site as-built drawings, the GWECT is separated into a northern system and a southern system at manhole sumps 6A and 6B (CRA, 1984). Collectively, the GWECT consists of approximately 8,210 linear feet of 4-inch and 6-inch perforated clay pipe, 9 manholes, 7 manhole sumps, and 13 granular sumps.

The GWECT was operated from June 1994 through the end of 1996 (MEC, 1997). Water was pumped from the groundwater elevation control tile at manhole 9 and disposed of offsite (MEC, 1997). Through the end of 1996, a total of 4,030,000 gallons of water was removed from the FPS during three separate pumping events (MEC, 1997).

The approximate location and arrangement of the groundwater elevation control tile is presented on the CH2M design drawings (Appendix A of the BODR [CH2M, 2023]) summarizing existing site conditions.

1.2 Project Goals and Remedial Action Objectives

The BODR describes the RD for the DGVBW that is established as a part of the overall remedy for OU1 (CH2M, 2023). The new DGVBW will be installed outside of the existing perimeter slurry wall that encompasses the entire FPS. The DGVBW will be constructed of sheet piles and king piles set at varying depths into the till unit. The design drawings in Appendix A of the BODR show actual embedment depths along the length of the sheet pile wall. Backfill will be placed between the riverbank and the new DGVBW in accordance with the drawings and specifications (Appendixes A and B of the BODR, respectively). Future RDs will be developed for OU1 to address the ROD requirements that are not relevant to the DGVBW.

The DGVBW is designed to achieve the remedial action objectives (RAOs) established for the site; RAOs are goals that are specific to media or OUs for protecting human health and the environment.
The DGVBW will be installed to achieve RAOs for contaminants of concern (COCs) on the FPS in accordance with the ROD (EPA, 2012). RAOs applicable to the DGVBW are as follows:

- Prevent ingestion, inhalation, and direct contact of site-related COCs in soil to human and ecological receptors at the FPS.
- Prevent the migration of site-related COCs from unsaturated and saturated subsurface media to the groundwater or surface water beyond the point of compliance, as defined in the ROD.
- Eliminate offsite migration of DNAPL to prevent contamination of surface water and recontamination of Pine River sediments.

The overall quality control (QC) objective is to implement the final design and provide documentation that supports achieving the testing, submittal, inspection, and the systems' performance requirements in such a manner that all work performed adheres to the following objectives:

- Complies with federal, state, and local regulations.
- Protects human health and the environment.
- Provides the client with a usable product intended to meet the project RAOs (described previously).
- Is cost effective.

1.3 Scope of Work

This CQAP describes construction tasks, as well as quality management processes to be implemented at the site during installation of the DGVBW. The following are major components of these activities:

- Preconstruction
  - Prepare site-specific plans (for example, Work, Health and Safety, QC, Environmental Management, Water and Waste Management, Turbidity and Resuspension Management, Spill Response, and Soil Erosion and Sedimentation Control, and Sheet Pile Installation and Sealing Plans).
  - Identify soil borrow source(s).
  - Hold preconstruction meeting with RA Contractor, City of St. Louis, EGLE, and EPA.
- Mobilization
  - Mobilize equipment, personnel, site trailers, and sanitary facilities.
  - Conduct photographic documentation of preconstruction conditions of the site.
  - Notify the appropriate regulatory agencies.
- Site Preparation
  - Mobilize equipment; set up trailers; construct staging areas; establish physical construction limits; and conduct other activities.
  - Conduct utility locates (MISS DIG and third-party).
  - Conduct preconstruction site survey.

  - Install soil erosion controls and best management practices (BMPs), as needed.
  - Install site and environmental controls.
  - Conduct threatened and endangered (T&E) surveys as required in the specifications.
  - Limit clearing and grubbing of vegetation and implementation of erosion control measures in the disturbed areas as required.
  - Construct temporary roads, equipment, and material laydown areas.
  - Install turbidity control measures.
  - Establish site security.
- DGVBW Construction Activities
  - Install combination wall.
  - Survey.
  - Monitor dust and turbidity.
  - Conduct backfill activities between the DGVBW and existing shoreline.
  - Install interim stormwater management features.
- Sampling, Testing, and Monitoring
  - Conduct waste characterization sampling and testing.
  - Collect and analyze borrow source samples—chemical (granular fill and topsoil only) and gradation.
  - Perform erosion control system repairs.
  - Conduct associated QC testing for sheet pile installation.
- Site Restoration
  - Seed disturbed areas and conduct maintenance, as needed.
  - Maintain inspection and maintenance logs.
  - Conduct final site survey.
  - Conduct final inspections and acceptance.
- Demobilization
  - Remove all field equipment, temporary facilities, and other miscellaneous items upon completion of fieldwork and punch list items.
  - Complete final acceptance.

1.4 Critical Success Factors

The critical success factors for the project are as follows:

- Further protect the Pine River from the potential for nonaqueous phase liquid and/or contaminated groundwater to affect sediment and water quality again.

- Implement site improvements that effectively and efficiently meet project objectives and integrate safety, environmental compliance, and cost sensitivity into the design and construction.
- Maintain the integrity of existing containment features (slurry wall and clay cap) and DNAPL/GWCS.
- Complete all work safely, on time, under budget, and in compliance with the specified scope.
- Identify and document value-added opportunities.
- Identify and document health, safety, quality, and environmental lessons learned.
- Communicate effectively among RA Contract project team members and EPA.
- Follow the procedures set forth in this CQAP to ensure work is delivered with zero quality incidents.

2. Organization and Responsibilities

Section 2 describes organization and responsibilities of the project.

2.1 EPA—Superfund

EPA is responsible for the overall execution of the project. EPA will retain independent design, QA, and construction organizations to accomplish the work and will have the authority to hire and fire these organizations. EPA has the authority to accept or reject QA plans, reports, and recommendations of the engineer, and the materials and workmanship of the RA Contractor and any subcontractors. A Task Order Contracting Officer's Representative (TOCOR) will be assigned for the RA.

Table 2-1 shows the proposed RA Contractor team organizational structure for construction activities and roles and responsibilities. Wherever the job titles of Project Manager (PM), Construction Quality Manager (CQM), Health and Safety Manager (HSM), and Construction Manager (CM) are shown, it is implied these staff are employees of the RA Contractor.

Table 2-1. Proposed Remedial Action Contractor Construction Team
Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Job Title	Roles and Responsibilities
PM	▪ Meet overall project objectives and goals. ▪ Acquire and apply technical and corporate resources to meet budget and schedule constraints. ▪ Effectively charter the construction team. ▪ Oversee and manage construction activities. ▪ Oversee the preparation of the deliverables. ▪ Review the work performed on each task against project goals and objectives for quality, responsiveness, and timeliness. ▪ Hold overall responsibility for project controls. ▪ Identify and realize remediation value-added opportunities. ▪ Conduct weekly progress meetings and weekly quantity verification meetings and prepare and distribute meeting notes discussing progress problem areas and status of long-lead items.
CQM	▪ Perform inspections and surveillance of project activities as necessary to ensure the quality of service, product, and workmanship meets the requirements of the project. ▪ Ensure quality planning elements are implemented as required in this CQAP. ▪ Ensure daily reports meet project requirements and correctly implement the document control or management process. ▪ Complete daily QA/QC verification forms. ▪ Ensure all delivered materials and equipment are inspected. ▪ Ensure all equipment is calibrated and in good working condition before use. ▪ Verify corrective actions are taken when deemed appropriate. ▪ Participate in quality audit(s). ▪ Ensure required field forms and logs are completed. ▪ Advise the PM of site conditions or construction conditions that may affect the accomplishment or quality of work.

Table 2-1. Proposed Remedial Action Contractor Construction Team
Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Job Title	Roles and Responsibilities
	▪ Review results of subcontractor-submitted QC tests for compliance with contract requirements.
HSM	▪ Supervise the direct and daily safety activities of the field team to coordinate with the daily activities of the RA Contractor and subcontractor(s). ▪ Review daily inspection reports for completeness. ▪ Track all onsite project personnel hours. ▪ Collaborate with the HSM to maintain the HASP. ▪ Review project-specific information to determine personal protective equipment selection. ▪ Ensure site staff are chartered on the HASP and other required health, environment, and safety documents. ▪ Ensure subcontractors have submitted required AHAs for review and have received acceptance for AHAs before mobilization. ▪ Establish site control and appropriate decontamination processes for personnel and equipment. ▪ Ensure safety supplies and equipment required by the HASP are onsite, calibrated as appropriate, and in good working condition before initiating work in the field. ▪ Ensure all feasible controls and safe work practices are considered before returning personal protective equipment. ▪ Ensure good housekeeping at field locations. ▪ Complete all forms necessary and specified in the HASP and ensure documents are submitted for review before being filed in the project binder. ▪ Verify proper utility clearances before breaking ground. ▪ Act as the project's emergency response coordinator and perform pre-emergency planning tasks as outlined in the HASP before starting field activities. ▪ Notify PM and of all near misses, injuries, and incidents immediately. Collaborate on incident investigations. ▪ Verify project files include safety-related training and medical monitoring records, and site-specific safety procedures before beginning any RA Contractor's or subcontractor's field operations. Perform oversight and/or assessments of the RA Contractor health and safety practices in accordance with the HASP. ▪ Implement noise conservation program requirements and hearing protection requirements. ▪ Prepare and conduct site orientation sessions for field personnel. ▪ Collect subcontractor timesheets and quantity verification sheets during daily safety briefings and update tracking tools.
CM	▪ Manage all construction activities in the field. ▪ Anticipate, understand, and implement proactive management solutions as construction work packages are assembled, procured, and awarded. ▪ Describe, quantify, document, and communicate change management items. ▪ Allocate construction resources. ▪ Review and manage construction scope, schedule, and budget. ▪ Update the project schedule for all construction tasks and identify potential scheduling conflicts or schedule creep. ▪ Review subcontractor's technical and cost proposals related to construction submittals.

Table 2-1. Proposed Remedial Action Contractor Construction Team
Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Job Title	Roles and Responsibilities
	▪ Interpret the technical content of drawings with respect to deviations or requests for clarification. ▪ Review contract modifications and forward modifications to the PM for approval. ▪ Perform inspection and surveillance of field activities as necessary to ensure the quality of service, product, and workmanship meets project objectives, and describe, quantify, document, and communicate potential change management items as soon as they are anticipated as potential issues. ▪ Notify the PM if a project cannot be completed with regard to quality, schedule, or cost. ▪ Coordinate project activities to achieve conformance to construction specifications. ▪ Submit nonconformance reports and other QA documents to the project QC Manager. ▪ Document the resolution of inadequacies noted in nonconformance reports. ▪ Establish location, time, and sampling criteria for verification testing to be performed by field staff. ▪ Review results of subcontractor-submitted QC tests for compliance with contract requirements. ▪ Advise the PM/CM of conditions that may affect satisfactory completion and quality of the work. ▪ Confirm that QA and support personnel are adequately trained. ▪ Perform inspection and surveillance of field activities, as necessary, to ensure the quality of service, product, and workmanship meets project requirements. ▪ Review subcontractor's monthly payment requests and forward the requests to the PM for approval. ▪ Provide the PM with a detailed weekly construction status report containing photographs and weekly logs.

AHA = activity hazard analysis

HASP = Health and Safety Plan

Multiple field technical staff will be employed during the execution of this project because of the planned construction schedule, which will generally be limited to 7:00 a.m. to 6:00 p.m. from Monday through Friday for an estimated 14-month period.

2.2 Remedial Action Contractor

The RA Contractor's role is as follows during DGVBW installation activities:

- Safely execute the work outlined in the RA design documents.
- May hire subcontractors to provide specialized services during construction.
- Work under the oversight of the Owner (EPA) or Owner's Representative.
- Perform work in accordance with the design plans and specifications, meet the acceptance requirements detailed in the design, and certify that the products supplied conform to the plans and specifications.
- Follow construction QC requirements.

2.3 Vendors, Independent Test Companies, and Subcontractors

Vendors, independent test companies, and subcontractors are agents of the RA Contractor by way of subcontracts or similar arrangements and, as such, are responsible through the RA Contractor for the following:

- Maintain QC procedures in accordance with their contractual arrangements and the RA Contractor's QC plans.
- Provide the RA Contractor with QC data and reports necessary for submittal to the PM.

3. Quality Control Processes

Section 3 defines the reporting and documentation requirements that will be implemented during DGVBW construction activities to ensure QC of the work.

An inspection system referred to as the Three Phases of Control (3POC) will be implemented as an RA Contractor construction quality management process. The 3POC is a three-step inspection process that includes the Preparatory Phase, Initial Phase, and Follow-up Phase inspections. The process is designed to discuss the project requirements before initiating any construction work activities, assess the quality of work early in the execution of work, and monitor the work throughout the delivery until completion. The 3POC process is intended to enhance management of construction quality and formalize documentation of the quality administrators for each definable feature of work (DFOW) for the project. A DFOW is a task that is separate and distinct from other tasks and has separate control requirements. The 3POC process will be implemented for each of the following RA DFOWs:

- **Pre-mobilization, Mobilization, and Setup (DFOW 1)**
  - Provide preconstruction submittals to EPA for review and approval.
  - Notify appropriate regulatory agencies.
  - Set up preconstruction meetings.
  - Conduct preconstruction; coordination with preconstruction client or first responders; readiness review; and progress meetings.
  - Conduct photographic documentation of preconstruction conditions of the site.
  - Mobilize equipment, personnel, site trailers, and sanitary facilities.
  - Provide utility-locating service(s).
  - Conduct preconstruction site survey.
  - Install soil erosion controls and BMPs, as needed.
  - Install site and environmental controls.
  - Construct or establish temporary facilities such as material storage facilities, laydown areas, and temporary site roads.
  - Limit clearing and grubbing of vegetation and implementation of soil erosion control measures in disturbed areas as required.
  - Conduct T&E species surveys as required in specifications.
  - Install turbidity control measures.
  - Establish site security.
- **Sampling, Testing, and Monitoring (DFOW 2)**
  - Conduct progress meetings.
  - Conduct waste characterization sampling and testing.
  - Collect and analyze borrow source samples—chemical (for granular material and topsoil only) and gradation (all materials).

  - Monitor turbidity and dust.
  - Perform compaction testing of granular backfill.
  - Conduct associated QC testing for sheet pile installation.
  - Conduct concrete testing.
  - Perform rebar inspections.
  - Drive sheet piles and king piles as defined in the specifications.
  - Verify sealant is present in all interlocks from top of bulkhead to bottom in accordance with specifications and approved Sheet Pile Installation and Sealing Plan.
  - Inspect interlocks welded to cylindrical piles and welds of cover plate to piles or appurtenances.
  - Proof roll backfill placed or compacted in water.
- **Install DGVBW (DFOW 3)**
  - Conduct progress meetings.
  - Install cylindrical king piles.
  - Drill sockets for each king pile.
  - Place rebar and concrete in each king pile as shown in the drawings (Appendix A of the BODR [CH2M, 2023]).
  - Install sheet piles between the king piles.
  - Verify sealant is placed in all interlocks from top of bulkhead to bottom of sheet in accordance with specifications and approved Sheet Pile Installation and Sealing Plan.
  - Conduct surveying.
  - Monitor turbidity and dust.
  - Dewater.
  - Conduct backfill activities between DGVBW and existing shoreline.
  - Grade site and install interim stormwater management features.
  - Manage waste (that is, storage, transport, and disposal).
- **Site Restoration (DFOW 4)**
  - Conduct progress meetings.
  - Hydroseed disturbed areas and perform maintenance watering.
  - Maintain inspection and maintenance logs.
  - Conduct final site survey.
  - Complete final inspections and acceptance.

- **Demobilization (DFOW 5)**
  - Remove all field equipment, temporary facilities, and other miscellaneous items upon completion of fieldwork and punch list items.
  - Complete final acceptance.

The respective inspection phases are discussed in the following subsections.

3.1 Preparatory Phase

The Preparatory Phase is the step in delivering the project that essentially culminates the planning and design process leading up to actual fieldwork of a specific residential property. It also serves to ensure that the project delivery, QC, and safety plans are complete and ready to be implemented. The following events take place during the Preparatory Phase for each DFOW established by the CM:

1. Confirm with the CM and other field team members that the appropriate technical specifications are incorporated into the project work plans, construction drawings, and review specifications.

2. Confirm with the CM and other field team members that the appropriate RA Contract drawings are incorporated into the project work plan and review drawings.

3. Verify with the CQM that all shop drawings and preconstruction submittals (materials, HASP, project plans) have been approved by the proper approving authority (including factory test results, when required).

4. Confirm with the CM and CQM that the testing plan coincides with the project plans and that adequate testing is called for to ensure quality delivery.

5. Confirm with the CM the definition of preliminary work required at the work site and examine the work area.

6. Receive confirmation from the CM that required preliminary work has been properly completed.

7. Confirm availability of required materials and equipment. Confirm with CQM and CM that materials and equipment have been inspected. Receive confirmation from the CQM that compliance has been met by approved submittals.

8. Confirm with the HSM that the site HASP and AHAs have been reviewed and approved to verify that safety concerns are adequately addressed and applicable safety requirements have been incorporated into the plan. Confirm that the appropriate safety data sheets have been identified and properly submitted.

Discuss with the CM the construction methods to be employed during the RA. Confirm that all field team members are aware of the identified checkpoints and areas of evaluation that will allow determination that the appropriate quality of construction is being achieved. All observations will be recorded in the Preparatory Phase Report (Attachment A, Form A.1).

3.2 Initial Phase

The Initial Phase occurs at the startup of remedial activities or construction associated with a specific DFOW. Essentially, the Initial Phase confirms that the CQAP is being effectively implemented and the desired results are being achieved. With the Initial Phase, notifying the CQM that crews are ready to start a particular DFOW is required before their actual start.

Specific details associated with the Initial Phase are as follows:

1. Establish the quality of workmanship required to properly deliver the DFOW in accordance with project requirements. The CQM ensures that the CM has made the subcontractor aware of expectations associated with the construction methods established under the Preparatory Phase. This assurance is to be achieved through observation of the initial work activities, as well as through interaction with the CM.
2. Resolve conflicts. The CQM will provide support to the CM in resolving conflicts involving quality issues. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the CQM. Should the conflict not be resolved in a manner that satisfies the RA Contract requirements, the CQM will elevate the conflict to the PM. Should the issue jeopardize the results of the DFOW or put the project at risk of noncompliant performance, the PM or CQM may direct a cessation of work activity.
3. Evaluate the site HASP and AHAs against actual work conditions with the CM to ensure that the hazard analysis conducted to prepare the HASP adequately addressed field conditions. Confirm applicable safety requirements are being implemented during construction activities.
4. Observe and evaluate the performance of testing technicians. Confirm with the CQM that testing is being performed in accordance with the testing plan and that required protocols are being observed. Review reports and documentation associated with extracting, packaging, transporting, and testing samples. Note discrepancies and direct correction accordingly.

Upon completion of the Initial Phase activities, results are to be documented in the Initial Phase Checklist (Attachment A, Form A.2).

3.3 Follow-up Phase

Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase, which addresses the routine day-to-day activities on the site. Inspection activities associated with each DFOW are to be addressed within the daily report. Specific concerns associated with the Follow-up Phase include the following:

1. Inspect the work activity to ensure work complies with the contracted project tasks.
2. Evaluate and confirm that the quality of workmanship is being maintained at a level no less than that established during the Initial Phase.
3. Evaluate and confirm that required testing and surveying are being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase.
4. Confirm that nonconforming work is being corrected promptly (within 24 hours) and in accordance with the direction provided by the CM.

4. Project Communications and Meetings

Section 4 discusses project communications and meetings.

4.1 Lines of Communication

Accurate and timely communication is required to avoid construction-related conflicts and potential errors and omissions.

4.1.1 External Communications

EPA and the RA Contractor and their respective employees and staff will have an established communication network. Establishing open lines of communication is essential for maintaining strong working relationships and producing quality work. The following communication guidelines should be adhered to throughout the project:

- The RA Contractor PM is the primary contact with the EPA TOCOR.
- In-person questions (if they occur) from the EPA TOCOR should be answered honestly and directly but without speculation. Contact the PM immediately to update on conversation and unanswered questions.
- All stakeholder phone conversations must be documented. A copy of the phone memorandum should be routed to the PM, EPA, and any other project team members who could be affected.
- The PM will coordinate all formal client meetings. The CQM will prepare and distribute the minutes of all meetings within 5 days.
- The PM must review all EPA correspondence before it is sent.

Table 4-1 includes a list of the key elements of the communication plan for construction.

Table 4-1. Summary of Communications and Meetings

Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Type of Communication	Channel of Communication	Schedule
Communication with External Stakeholders	PM holds routine and as-needed call with EPA.	TBD
Prebid Meeting	EPA, PM, CM, and interested bidders should be present.	TBD
Project Chartering Meeting	EPA, PM, CQM, CM, RA Contractor construction staff, and subcontractors should be present.	TBD
Preconstruction Meeting	EPA, PM, CQM, CM, RA Contractor construction staff, and subcontractors should be present.	TBD
Coordination Meeting, Preconstruction Client Meeting, or First Responders Meeting	Meeting held to discuss construction activities and emergency response actions. EPA, stakeholders, PM, CM, CQM, and any subcontractors should be present.	TBD
Readiness Review Meeting	Checklist used to prepare for mobilization. EPA, PM, CM, CQM, RA Contractor construction staff, and subcontractors should be present.	TBD
Project Status Meetings	Meeting held to discuss construction activities progress and status. EPA, PM, CM, CQM, RA Contractor construction staff, and subcontractors should be present.	TBD

Table 4-1. Summary of Communications and Meetings

Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Type of Communication	Channel of Communication	Schedule
Problem or Work Deficiency Meetings	A special meeting may be held if a problem or deficiency is present or likely to occur. EPA, PM, CM, CQM, HSM, and affected subcontractors involved in the problem or deficiency should be present.	TBD
Field-level Communication Channel	RA Contractor CM communicates to the PM. PM will continue the communication chain as needed.	TBD

TBD = to be determined

Project-specific personnel and lines of communication will be discussed and established by all parties at the preconstruction meeting. The discussion will include the following topics:

- Communication procedures between supervisory and field staff
- Direct communication procedures between key parties for specific issues and situations
- Procedures and restrictions for secondary lines of communication within the project organization
- Procedures for information transfer and confirmation between the various parties
- Procedures for documentation of all communications
- Format for meetings, reports, submittals, and other materials

Communication will be documented, and each party will receive a copy of such documentation (for example, telephone memorandums, meeting notes). Copies will be routed to other parties that should be informed of the situation (for example, problem, change, or agreement).

Document control procedures will be established for items such as RA Contractor and subcontractor submittals, test results, and plan or specification revisions. The controls will include distribution and confirmation procedures to verify that documents are appropriately dispatched and incorporated into the project. Whenever possible, documents indicating revisions in plans, specifications, or procedures will be distributed immediately and explained to all parties at routine or special project meetings.

4.1.2 Internal Communications

The CM will communicate daily with the PM. The PM will communicate with extended team members. All construction issues will be communicated through the CM and PM. The parties will discuss and establish the project-specific personnel and lines of communication at the kickoff meeting. The discussion will include the following:

- Communication procedures between the CM and other field staff
- Direct communication procedures between key parties for specific issues and situations
- Procedures and restrictions for secondary lines of communication within the project organization
- Procedures for information transfer and confirmation between the various parties
- Procedures for documentation of communications

- Format for meetings, reports, submittals, and other materials
- Format for potential change(s) that may require quantification and management

Formal communication, including, but not limited to, weekly progress meetings, discussions with stakeholders, and discussions with the RA Contractor, that affect scope, schedule, or budget will be documented, and each party will receive a copy of such documentation (for example, telephone memorandums, meeting notes). Copies will be routed to other parties if they should be aware of the situation (for example, problem, change, or agreement).

Document control procedures will be established for items such as RA Contractor and subcontractor submittals, test results, and plan or specification revisions. All submittals will be entered into the submittal log by the CQM upon transmittal of the submittal. At the time of entry, the CQM will document who needs to perform a detailed review of the document and notify the appropriate team members. Team members will document the completion of their reviews by indicating the approval status (for example, approved or rejected) in the log with the date the review was completed. These controls will include distribution and confirmation procedures to verify documents are appropriately dispatched and incorporated into the project. Whenever possible, documents indicating revisions in plans, specifications, or procedures will be distributed immediately and explained at routine or special project meetings.

4.2 Project Meetings

Project meetings will be scheduled to promote communication between various personnel responsible for designing, constructing, managing, and observing the construction. The purpose of the routine project meetings is to keep all project staff members informed and to provide a forum for solving design, construction, and QA issues.

4.2.1 Prebid Meeting

A prebid meeting will be held to provide a forum for bidders to discuss the contract documents. At a minimum, the PM, CM, and EPA should be present to meet with interested bidders. Any specific questions that are brought up will be answered in the form of an addendum to the contract documents.

4.2.2 Project Chartering Meeting

Before mobilization, EPA, RA Contractor staff (PM, CM, CQM, and construction staff, at a minimum), and subcontractors that will be physically mobilizing to the FPS will attend a chartering meeting with all field staff. The purpose of the meeting is to familiarize the team with the project scope, implementation procedures, project objectives, and performance criteria, and will agree on key safety and environmental requirements to emphasize and reinforce expectations for safety and environmental performance. The meeting may be held over the phone or in person, depending on project needs.

4.2.3 Preconstruction Meeting

A preconstruction meeting will be held to identify project personnel, review the project and schedule, and clarify and/or resolve outstanding issues before construction startup. At a minimum, EPA, PM, CQM, CM, RA Contractor construction staff, and subcontractors should be present. The PM, CQM, and CM will be prepared to discuss the following subjects, at a minimum:

- Required schedules
- Status of bonds and insurance
- Sequencing of critical-path work items
- Progress payment procedures
- Project changes and clarification procedures
- Use of site, access, office and storage areas, and security and temporary facilities
- RA Contractor's HASP and health and safety representative
- Status of permits, license, or required approvals
- Status of submittals
- Maintenance of required records
- AHA
- RA Contractor's key personnel information and points of contact
- RA Contractor's QA/QC plan

The following will be performed by the CM and CQM during the preconstruction meeting:

- Provide each party with relevant construction and QA documents and supporting information. Supporting information may include construction drawings, specifications, and other applicable documents. The information transfer is not limited to documents distributed by the CM and CQM. All parties should use the opportunity to distribute relevant documents.
- Familiarize each party with their specific responsibilities relative to the design criteria, construction drawings, schedules, and specifications.
- Discuss the purpose of the CQAP and the documentation structure provided by the CQAP to verify that the project will be executed efficiently and in compliance with the specified design criteria and schedule.
- Review the responsibilities of each party.
- Review lines of authority and communication for each party.
- Discuss the established procedures and protocol for observations and tests, including sampling strategies.
- Discuss the established procedures and protocol for handling construction deficiencies, repairs, and retesting.
- Discuss the established procedures and protocol for handling contract modifications such as change orders and field orders.
- Review methods for documenting and reporting inspections and test data.
- Review work area security and safety protocols.
- Discuss procedures for locating and protecting construction materials and preventing damage to the materials from inclement weather or other events.

- Conduct a site walk to review construction material and equipment storage locations.
- Discuss payment for in-place work, including method of payment and unit cost work.

The CQM will document the preconstruction meeting, and minutes will be provided to all parties.

4.2.4 Coordination Meeting, Preconstruction Client Meeting, or First Responders Meeting

Before the start of site work, EPA, PM, CM, CQM, subcontractors, and stakeholders (EGLE, fire marshal, representatives of local police, utilities, and health services) will meet to develop a mutual understanding of the project details, including health and safety issues, communication procedures, evacuation or emergency procedures, scheduling work, security procedures, submittal reviewers or approvers, inspectors or approvers of major milestones of work performed, permits required, forms to be used, administration of onsite and offsite work, signature authorities for changes and waste documentation, schedule, and method for transmitting submittals. The PM will prepare meeting minutes, and the RA Contractor, EPA, and stakeholders will sign the minutes. Meeting minutes will be distributed to the parties involved in the meeting and will be placed in the project files. The meeting may be held in conjunction with other meetings (for example, preconstruction meeting).

4.2.5 Readiness Review Meeting

Before sample collection, fieldwork, and laboratory analysis, EPA, PM, CM, CQM, RA Contractor construction staff, and subcontractors will meet to confirm the procedures, personnel, equipment, and facilities are ready for environmental data to be collected according to the QA Project Plan. The CQM will document the readiness review meeting, and minutes will be provided to all parties.

4.2.6 Project Status Meetings

After the start of site work and throughout project execution, EPA, PM, CM, CQM, RA Contractor construction staff, and subcontractors will conduct project status meetings (sometimes referred to as quality meetings) at least weekly. EPA and stakeholders may attend any of the meetings. At a minimum, the following will be accomplished at each meeting:

1. Review the minutes of the previous meeting.
2. Review the schedule:
    a. Work or testing accomplished since last meeting
    b. Rework items identified since last meeting
    c. Rework items completed since last meeting
    d. Schedule delays and long-lead-time items
    e. Critical milestones
    f. Updated schedule of values

3. Review the status of submittals:
    a. Submittals reviewed and approved since last meeting
    b. Request for information (RFI) resolutions
    c. Submittals required in the near future
4. Review the work to be accomplished in the next 2 weeks and documentation required:
    a. Completion dates for rework items
    b. Inspections required
    c. Testing required
    d. Status of offsite work or testing
    e. Documentation required
5. Discuss health and safety issues, such as near misses and incidents.
6. Resolve quality issues such as nonconformance, rework, or corrective actions.
7. Resolve production problems.
8. Address items that may require revising the CQAP or other project plans:
    a. Changes in procedures
    b. Changes in design or engineering drawings and/or specifications
    c. Changes or claims for additional compensation or time

Meetings will be recorded in project status meeting minutes, prepared by the CQM. The meetings may be held in conjunction with other meetings (such as tailgate safety meetings, progress meetings, planning meetings). Meeting minutes will be sent to all personnel attending the meeting.

4.2.7 Problem or Work Deficiency Meetings

A special meeting may be held if a problem or deficiency is present or likely to occur. The meeting should at least be attended by EPA, RA Contractor PM, CM, CQM, HSM, and affected subcontractors involved in the problem or deficiency. The purpose of the meeting is to define and resolve a problem or recurring work deficiency in the following manner:

- Define and discuss the problem or deficiency.
- Review alternative solutions.
- Implement a plan to resolve the problem or deficiency.

The meetings will be documented by the CM, CQM, or a designated representative. Copies of the meeting minutes will be sent to all personnel attending the meeting and the PM, if not present.

4.3 Public Relations Plan

The CM may be approached by the general public during construction activities as a result of community knowledge of the site. If contact occurs, the CM should direct the individual(s) to contact EPA's primary public affairs contact for the site. The CM may tell the individual(s) that EPA- and EGLE-approved corrective measures construction activities are being conducted; however, no additional project information may be shared. Once the individual(s) has left the work zone, the CM will contact the PM and document the exchange in the field notes and daily report.

Primary Public Affairs Contact: U.S. Environmental Protection Agency – TOCOR (to be determined)

Public Affairs Leader: Diane Russell/U.S. Environmental Protection Agency – Community Involvement Coordinator; 989-395-3493, russel.diane@epa.gov

4.4 Regulatory Inspections

If a local, state, or federal regulatory inspector makes an unannounced visit to the site, the CM will be familiar with and follow EPA's protocol for agency inspections, which will be discussed during the preconstruction meeting.

5. Document Control and Management

Section 5 discusses document control and management.

5.1 General

The CQM for the project is responsible for implementing the procedures described in this section. A document control and management process will be implemented so that current and correct documents are available where the work is performed and project records are archived after the work has been completed. Obsolete copies will be appropriately marked and/or removed from the work site and destroyed. The CQM is also responsible for providing backup of field files to the central project files as required by these procedures.

Hard copies of the specifications, drawings, HASP, and signed AHAs will be kept on file at the RA Contractor's trailer. Hard copies will include change order or RFI resolution attachments. In addition, electronic copies will be kept on a cloud-based website provided by EPA.

The CQM will be responsible for checking that project personnel, including the RA Contractor, subcontractors, and vendors, use the correct version of project documents. In general, the CQM must receive all documents transmitted, either directly or copied in communications from other project team members. The CQM will save electronic documents in the respective subfolders on the cloud-based website provided by EPA.

5.2 Document Transmittals

Document transmittals between the project parties provide a record of communications that is necessary to keep appropriate construction and QA personnel informed of project requirements, progress, changes, and quality of the work. Transmittals should be formally communicated with proper documentation and confirmation of submittal and receipt to prevent misunderstandings and omissions.

5.2.1 Remedial Action Contract Clarification or Interpretation Requests

RA Contract RFIs (Attachment A, Form A.3) are submitted when an explanation of the intent of specific project requirements, as presented in the RA Contract documents, is required, which are generally submitted by the RA Contractor to EPA; however, EPA can also submit an RFI to the RA Contractor. All RFI communications should go through the CQM. If the CM submits an RFI to EPA, the CQM should be included on the communications.

The CQM will manage RA Contract RFIs. Interpretations of design or specifications by the engineer will be issued in writing through EPA. In special cases, the engineer may communicate a design interpretation or clarification verbally, followed by written confirmation. Responses to contract RFIs will be obtained in a timely manner to limit the impact on the project schedule. The PM is responsible for informing all parties of the design team's interpretations by distribution of documents to construction and QA personnel through the CQM, or by copying the CQM on communications, at a minimum.

5.2.2 Remedial Action Contract Modification Requests

A contract modification request (that is, change order) is made if a change to the RA Contract documents is deemed necessary for the following reasons:

- Changed site conditions
- Changed materials conditions
- Alternative design procedures proposed
- Alternative materials proposed

RA Contract modification requests are generally prepared in response to a contract RFI submitted by the RA Contractor or EPA that impacts the contract scope, schedule, or budget. RA Contract modification requests should be submitted through the CQM for coordination with the appropriate group(s) (that is, EPA or RA Contractor). The appropriate group(s) will review, negotiate, and finalize all RA Contract modification requests and forward modifications to EPA for approval. EPA will prepare RA Contract modification requests as necessary. Responses to RA Contract modification requests will be obtained in a timely manner to limit the impact on the construction schedule. The CM is responsible for transmitting all contract modification requests to the appropriate groups before the change becomes part of the project record.

Likewise, the RA Contractor or EPA may issue a field order (Attachment A, Form A.4 [275]) for clarification and interpretation of drawings in cases where an RA Contract modification is not suitable, including the CQM on communications. For example, a field order may be issued in response to an RA Contractor-initiated RFI when the clarification does not affect the design intent, schedule, or cost of the work.

5.2.3 Remedial Action Contractor Submittals

Construction QC submittals are those submittals generated by the RA Contractor (or their subcontractors) during or immediately before construction to demonstrate compliance with the project plans. Submittal requirements for these projects are tabulated in the Submittal Register (Attachment B) completed by the RA Contractor in accordance with the requirements identified in the project plans. The active Submittal Register will be maintained on a cloud-based website provided by EPA.

The CQM, with support from the PM, will log and track all submittals on the Submittal Register. Specific responsibilities regarding submittals include the following:

- Coordinate all submittal actions.
- Maintain necessary submittal records in an organized manner.
- Maintain and track submittals in the Submittal Register.
- Review and certify all submittals for compliance with the project plans, drawings, and specifications.
- Manage submittals designated to be approved by EPA and/or stakeholders.
- Check all material and equipment delivered to the project for compliance with the project plans, drawings, and specifications.
- Forward the submittal to EPA.

The PM is responsible for coordinating the submittal transmittal and approval process and following through to ensure the process does not affect the project schedule.

5.2.3.1 Technical Submittals

The RA Contract documents require that the RA Contractor submit various technical submittals to EPA for approval. The submittals will be outlined by their respective phase of work and as presented in the Submittal Register (Attachment B) completed by the RA Contractor. Documents will be submitted with a Transmittal Form (Attachment A, Form A.5 [295]) through the CQM according to the frequency and number specified in the RA Contract documents. Subcontractor and vendor submittals will be made through the RA Contractor.

As submittals are submitted and returned, the CQM will document their status on a Submittal Register. The CQM will submit the submittal to EPA for detailed review using the Velsicol Teams site. Reviewers will check the submittal for general compliance with the contract documents and will note missing information or deviations in the Submittal Review Form (Attachment A, Form A.6).

Review comments on submittals will clearly state information the reviewer considers to be lacking. Notes must be documented in the Submittal Review Form (Attachment A, Form A.6) so that deficiencies can be clearly identified by the RA Contractor. Notes will not be in the form of questions; they must state what has been omitted or what is unacceptable.

Following the detailed review, EPA will send a marked copy of the submittal and a submittal reply form to the RA Contractor. EPA will indicate on the submittal reply form whether deviations from the RA Contract documents were noted and whether additional submittals or resubmittals by the RA Contractor are required. Copies of the original submittal, review copies, and Submittal Register and reply forms will be kept in a project submittal file.

5.2.3.2 Field Testing Quality Control Submittals

Submittals are administrative and technical documents such as design drawings, shop drawings, work plans, permits, certifications, schedules, reports, and other types of documents and any accompanying samples that are required for the work.

Construction QC submittals are those generated by the RA Contractor before or during construction to demonstrate compliance with the project plans, specifications, and drawings. For materials and equipment procured directly by suppliers, the CM or CQM is responsible to check that the proper submittals are provided by the suppliers before accepting delivery. For materials and equipment supplied by the RA Contractor, the CM or CQM is responsible for checking that the proper submittals are provided and approved before delivery or installation.

The RA Contract documents require that the RA Contractor submit a QC plan, materials certifications, inspection and test data, and other materials for review and approval by EPA. The CQM will submit documents to EPA for conformance evaluation and incorporation into the records. Subcontractor vendor submittals will be made through the RA Contractor. Test data and similar submittals will be submitted with a Transmittal Form (Attachment A, Form A.5 [295]) outlining the contents of the submittal and the date submitted.

5.2.4 Nonconformance Reports and Corrective Actions

EPA will notify the RA Contractor of any detected noncompliance with the foregoing requirements. The RA Contractor will take immediate corrective action after receipt of such notice. Such notice, when delivered to the RA Contractor at the work site, will be deemed sufficient notification. If the RA

Contractor fails or refuses to comply promptly, EPA may issue an order stopping all or part of the work until satisfactory corrective action has been taken. Noncompliance notification or stop-work orders will be documented in the daily report. Corrective actions will remain open, as noted in the daily reports, until acceptable closure of the nonconformance. Verification of the corrective action and its results will be performed by EPA and documented in the daily report.

When materials, methods, or work elements are not in accordance with contract documents and immediate resolution (within 24 hours) cannot be achieved, a nonconformance report (Attachment A, Form A.7 [442]) will be prepared. Nonconformance reports initiated by EPA will be issued to the RA Contractor. EPA will check that the RA Contractor develops a corrective action plan.

The written nonconformance report will be issued as soon as possible after nonconformance is detected. Each nonconformance report will be assigned a unique file number and recorded on a nonconformance report log (Attachment A, Form A.8 [444]). The log will allow the status of the nonconformance to be easily tracked.

The sole exception to this policy will be verbal notices made by EPA to the RA Contractor for procedures that can be, and are, corrected immediately upon notice. Verbal notices will be recorded in the daily reports with an explanation of corrective measures taken and the time required to bring the work into conformance.

5.2.5 Resolution of Nonconformance

No payment will be issued for nonconforming work until the associated nonconformance is resolved. Each nonconformance report will remain in effect until corrective actions have been taken that meet the intent of the contract documents and the satisfaction of onsite QA representatives. When corrective actions are acceptable, EPA will document the corrective actions taken, and the retest results will complete the acceptance portion of the nonconformance report. Likewise, EPA will observe and document the corrective actions and acceptability of the results on field observation forms.

Full documentation is required for resolution of each nonconformance report. When a nonconformance is resolved, the following documentation procedures (Attachment A, Notification of Correction of Defective/Rejected Work Form A.9 [443]) will be followed:

- A copy of the observer's explanation of corrective action and acceptance will be attached to the nonconformance report for review and filing.
- Daily reports, data summaries, and other information will be updated to reflect the resolved status of the original deficiency (for example, notes of corrective action in observation reports, resubmittals, and retest results). At a minimum, the nonconformance report file number, date, or test number that identifies the initial deficiency will be included.

The corrected nonconformance will be checked off the record book, initialed, and dated by the CM or CQM.

6. Change Management

It is critical to successfully anticipate and track changes to keep on schedule and budget. If the changes will affect schedule or budget, the project team must be fully aware of what the ramifications will be. Changes or clarifications may be needed during preparation of the deliverables and during field operations. All requests for change or clarification will be documented and resolved. Changes to design sketches, final project plans, field changes, and modifications to operating facilities are subject to design verification measures commensurate with those applied to the original documents (for example, plans, design sketches).

EPA will approve design or scope changes that do not impact project costs. The PM will communicate design or scope changes to the EPA TOCOR that will impact project costs and obtain EPA approval before proceeding. RFIs will be used to communicate and document clarifications and modifications that will result in a cost or schedule change. Field orders will be used to document changes or field agreements that do not affect cost or schedule. RFIs can be requested by any member of the project team and will be tracked and logged by the CQM and PM to ensure each RFI is fully addressed and that resolutions are documented.

All changes will be communicated to the PM as soon as the issue arises. The PM must notify EPA of any changes to the proposed scope.

Complete documentation will be maintained regarding who initiated the change, who approved the change and when, who implemented (completed) the change, and when was the change completed in the Change Management Tracking Log (Attachment C) maintained in the project folder.

The following steps should be followed to manage change and potential change.

- As soon as a situation presents itself, either in the field or in the office, that may affect schedule or budget, the CM needs to be notified immediately. The CM will notify the PM immediately.
- The PM and CM will determine the potential severity of the change and whether the potential change merits a budget and/or schedule estimate to discuss with EPA. If an estimate is required, the PM will work with project staff to compile an idea of the likely effect(s) on both schedule and budget.
- The PM will discuss the potential change with EPA.

The RFI process involves either the RA Contractor or EPA identifying a situation in the field that requires change that will result in a change in cost or schedule. The RFI will contain the project number, RFI identification number, and title. The CQM enters this information for RFI tracking. The party identifying the change prepares the RFI and forwards it to the CQM who will distribute the RFI to the appropriate project team member(s) for review and response (that is, RA Contractor or EPA). The RFI response will be transmitted through the CQM for review and concurrence by the project team member(s) who initiated the RFI. Once all project groups have come to an agreement on the resolution, the RFI will be addressed as outlined in the document.

The response will include a narrative explanation of the resolution and will have any drawings or specifications required to complete the work attached. The response is returned to the PM and forwarded to the CM and CQM for field implementation. The RFIs will be numbered sequentially for individual projects and filed electronically and at the work site.

6.1 Construction Changes

Changes to materials, supplies, work approaches, and corrective action area design during the construction effort will be documented in an overall effort to support sound engineering judgment and cost-effective project delivery. Changes during construction will be documented using the RFI process.

The RFI process involves the RA Contractor or EPA identifying the situation in the field that requires change. When a change is identified, the identifying team member prepares an internal memorandum (that is, RFI) identifying the concern and forwards it to the CQM, who distributes the RFI to the appropriate project team member(s) for evaluation and response. The response should include a narrative explanation of the resolution with any drawings or specifications required to complete the work attached. Once all project groups concur with the resolution, the response is returned to the CQM and forwarded to the CM for field implementation. The RFIs are numbered sequentially for individual projects and filed at the work site with the CM. The RFI will contain the project number, RFI identification number, and title. This information is used for RFI tracking.

The RFI process is a field construction tool for documenting changed field conditions or other issues that may require a deviation from project requirements identified in the specifications of the project plans. The RFI is intended to obtain input and concurrence from the management personnel responsible for developing the project plans. The RFI should clearly convey any identified issues that require a change to the project scope, schedule, or budget. In such instances, the PM is responsible for seeking and obtaining proper approval from EPA (in accordance with established contract procedures) before implementing the change recommended in the RFI.

7. Testing Requirements

The quality of materials and workmanship will be controlled by the RA Contractor or supplier who furnishes the work or material involved; however, the RA Contractor has the ultimate responsibility for QC of its subcontractors and vendors.

The CM and/or CQM will observe QC testing of the construction materials, workmanship, and the RA Contractor's QC activities and will provide test results to EPA. Specific QA requirements for observation and verification testing are detailed in the specifications. Attachment A contains samples of forms that may be used or modified during the RA to document QA activities.

The RA Contractor, the RA Contractor's supplier, or subcontracted independent testing companies will conduct QC testing, sampling, and inspecting. The RA Contractor will provide copies of QC inspection and testing reports to EPA in a timely fashion or as specified in the RA Contract. The reports will include documentation of failed tests and corrective actions taken.

7.1 Observation and Verification Testing

The CM, CQM, or other designated personnel will document observations in the Daily Report Form (Attachment A, Form A.10) and will document verification tests in the appropriate testing and field forms. Documentation will be recorded in ink. To correct an error in a testing or field form, a single line will be drawn through the error with the correct information entered next to the error. All corrections will be initialed and dated.

The field personnel will obtain, review, and become familiar with the applicable procedures, codes, standards, specifications, drawings, observation, and verification testing requirements and accept or reject criteria.

Daily observation records and verification testing forms will contain at least the following:

- Item, condition, activity observed, or testing performed
- Location of observation or verification test
- Date of the observation or verification test
- CM's name and signature
- Type of observation or verification test
- Observation or verification test source criteria (for example, drawings and specifications)
- Results or acceptability
- Reference to corrective action taken in connection with nonconformance
- Relevant nonconformance report number

The Checklist for Michigan Permit-by-Rule for Construction Activities Requirements (Attachment A, Form A.11) will be reviewed when observing construction activities and when completing the daily inspector's report to verify compliance of soil erosion and sediment controls.

7.2 Quality Assurance Subcontracts

The QA contracts include independent laboratory testing. Items or services procured for QA purposes that may affect the measurement of the quality of the construction project will meet the requirements of the contract specifications and this CQAP, as applicable.

7.3 Testing

Sampling and testing will be performed to verify that control measures are adequate to provide a product that conforms to project plans, specifications, and drawings. The Sampling and Testing Log binder will include all testing and field forms to be used during construction to document the sampling and testing conducted. Offsite testing will be performed by laboratories and testing companies with accreditation and certifications through industry-recognized organizations and standards. Onsite testing will be performed by individuals with documented training and experience to perform the testing as determined by their supervisor and accepted by the Remedial Program Quality Manager.

Testing services required for execution of the project will be contracted either directly by the RA Contractor or by its subcontractor(s). The testing services will be procured according to a scope of work, which will be compliant with the project requirements and specifications. The scope of work will specify specific analytical and geotechnical testing methods (for example, ASTM International or similar standards), professional services, and other measurement protocols as specified in the project plans, designs, and specifications. The scope of work will also specify the nature of the report or deliverable required of the testing laboratory, including requirements for professional certification. The CM or CQM will be responsible for scheduling site services.

The following activities will be performed and documented during testing:

- Verify that testing procedures comply with RA Contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check test instrument calibration data against traceable certified standards.
- Verify that recording forms and the test identification system, including all test documentation requirements, have been prepared.
- Record results of all tests, both passing and failing tests, on the appropriate field form. All tests will be compiled daily by the CQM and documented in the site-specific tracking log and daily report for the date taken.
- Give the section reference, location where tests were taken, and sequential control number identifying the test. Actual test reports may be submitted later in accordance with project specifications with a reference to the test number and the date taken.

The test results must be signed by the testing laboratory's representative authorized to sign certified test results. The signed reports, certifications, and other documentation will be submitted to EPA as part of the construction completion reports, and as otherwise requested by EPA.

7.3.1 Turbidity Monitoring

The RA Contractor will develop a Turbidity and Resuspension Management Plan during the RA that will describe the water quality monitoring objectives, turbidity monitoring methods and equipment, BMPs,

and corrective action measures for the DGVBW construction activities. It is anticipated that upstream and downstream monitoring will be performed during construction; however, specific details regarding the turbidity monitoring and compliance requirements will be known once the Joint Permit (Equivalent) Application is submitted and the substantive requirements document is issued. The RA Contractor will coordinate with the Owner during the RA to determine the submittal frequency for the turbidity monitoring results.

7.3.2 Dust Monitoring

The RA Contractor will conduct real-time air monitoring for particulate matter throughout construction to verify that nuisance dust particles are not migrating offsite. Data will be recorded to a data logger once per minute. The air monitoring equipment will be placed in locations to verify effectiveness of engineering controls in minimizing dust generation that may potentially leave the FPS. Dust monitors will be placed upwind and downwind of earthwork activities to determine the impact of the construction activities on air quality.

Dust monitoring data will be evaluated against the EPA National Ambient Air Quality Standards for particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) of 150 micrograms per cubic meter. The standards are based on a 24-hour average, but work will only be performed for approximately 10 to 12 hours per day, so no dust generation is assumed during non-working hours. During work hours, an alarm will be set at 500 micrograms per cubic meter to observe activities, to determine the cause for elevated particulate concentrations, and to evaluate potential mitigation measures to maintain the 24-hour average at a concentration less than the standard. Exceedances of the dust monitoring criteria require dust abatement measures (typically application of water) or stop work and further evaluation. The RA Contractor is responsible for submitting dust monitoring data to the Owner a daily basis.

7.3.3 Borrow Source Sampling

The RA Contractor will identify suppliers of borrow materials as part of preconstruction activities that are necessary for backfill, construction of temporary roadways, and site restoration. Borrow sources may include general backfill (sand), gravel, and topsoil.

The RA Contractor will collect samples of the borrow materials at the source and submit them to an approved laboratory for analyses as outlined in the specifications. The CQM or designee will track analytical and gradation results electronically throughout construction. The results will be made available to EPA and RA Contractor for review to ensure that materials comply with project specifications and meet criteria.

Additional QA/QC borrow samples will be collected during construction activities to verify continued compliance with project specifications. Additionally, a sample will be retained by the RA Contractor for visual comparison during construction activities to confirm consistency in the materials. If inconsistencies in the materials are observed, the RA Contractor may collect additional samples to determine continued compliance or nonconformance with project requirements.

7.3.4 Waste Characterization Sampling

Soil and aqueous waste will be generated during the RA. The RA Contractor will conduct soil and liquid waste characterization sampling during the RA, as necessary, to support establishment of waste profiles with the approved offsite nonhazardous disposal facility. The sampling frequency and analyses will be determined by the approval requirements of the selected EPA Offsite Rule-approved disposal facility. If

supplemental characterization indicates that recovered liquid is hazardous, material will be transferred from storage and disposed of at an appropriate, EPA Offsite Rule-approved, commercial Resource Conservation and Recovery Act (RCRA) Subtitle C facility. Regardless of final classification, waste profiles will be reviewed by the EPA Environmental Manager or Waste Coordinator before generator (EPA) signature, which can then be forwarded by the RA Contractor to the landfill for final approval. Offsite disposal of liquid waste will be coordinated and arranged upon receipt waste profile approval. EPA will evaluate the liquid waste results to determine whether the RA Contractor and waste transporters need to comply with Michigan liquid industrial waste regulations. The RA Contractor will use the Waste Tracking Log (Attachment A, Form A.12), or similar approved version, to manage waste.

7.3.5 Soil Compaction Testing

Soil compaction testing will be performed on borrow source materials placed between the DGVBW and existing shoreline. Compaction testing will be performed in accordance with Section 31 23 23, Fill and Backfill.

The RA Contractor will perform in situ density testing using a nuclear density gauge or approved equivalent to demonstrate proper compaction.

7.3.6 Proof Roll Testing

The RA Contractor will conduct proof roll testing on the aggregate fill placed behind the DGVBW to identify areas that will not support future loading without excessive settlement. Proof rolls will be performed throughout the backfill area as outlined in the specifications or approved by the Owner. Soil will be removed from areas with excessive settlement or pumping (greater than 1-inch rebound) until firm material is encountered. Fill material that is approved by the Owner will be placed to bring the area back to grade.

7.3.7 Rebar Inspection and Concrete Testing

Rebar inspections will be performed to verify rebar sizing and spacing with the drawings and specifications. Delivered concrete materials will be confirmed with the concrete mix designs in the specifications. Slump testing and air entrainment testing will be completed in accordance with the specifications. Test cylinders will be collected and tested as described in the specifications.

7.4 Sampling and Testing Log

As tests are performed, the CQM or approved supervising field staff will record the following information on appropriate field forms, which will be available in the Sampling and Testing Log binder:

- Field personnel observing the test
- Date the test was conducted
- Time the test was conducted
- Date the test results were received
- Results of the tests
- Whether results comply with the specifications

- Other relevant information pertaining to the test being performed
- Any remarks and acknowledgment that an accredited testing laboratory was used

Applicable project requirements, tests, or analytical procedures used must be cited on the respective field form. The CQM will obtain and compile all daily test results and update the site-specific electronic tracking log and field documentation binder. Testing records will be maintained onsite in the project files.

Testing and inspections performed will be summarized in the daily report for the date on which the test or inspection was performed. The updated electronic tracking log will be available for review by the CM, PM, and EPA.

7.5 Testing Laboratories

Independent testing laboratories that are authorized or certified to operate in the State of Michigan will be employed on this project. Before the start of the work, the name(s), facility information, qualifications, and certifications of the laboratories will be acquired and maintained in the project files. Laboratories performing chemical analysis of samples hold current accreditation under the EPA National Environmental Laboratory Accreditation Program and hold current certification by the State of Michigan. Laboratories performing geotechnical testing will be participating in an accreditation program and will be certified to perform the specified analytical method.

8. Inspection

During construction activities, receiving, in-process, and completion inspections will be performed as necessary. An inspection is necessary for acceptance of all the items listed as DFOWs in Section 3. A completion inspection is required before final EPA acceptance.

The CQM will be responsible for verifying the in-process inspections are documented in the daily reports and verifying the site-specific electronic tracking log is completed. The CQM is also responsible for verifying that the receiving inspections are documented in the daily report. The CQM is responsible for maintaining the punch list during the progress of the work.

8.1 Material Inspections

The CM will verify that the material and equipment received at the site are inspected for compliance with the project requirements and are in good working order before being accepted for use on the site. The CQM will complete any field tests will be documented in the testing log and plan. Any material or equipment not meeting the project requirements will be rejected or a written variance given by the CQM or designee. The performance and results of material and/or equipment inspections will be documented in the daily report.

8.2 Completion Inspections

This section provides further information on the punch list inspection(s) and final inspection.

8.2.1 Initial Punch List Inspection(s)

During the progression of work, the RA Contractor/subcontractor should address “rework” items to help maintain the schedule. As work completion approaches, the CQM will schedule an “initial” punch list inspection to verify completeness of each DFOW. The CQM will inspect the work with the CM and develop punch list items that do not conform to the approved drawings and specifications. The punch list will include remaining items on the “rework” items list that were not corrected before the “initial” punch list inspection. The punch list will include the estimated date by which the deficiencies will be corrected. The CQM and CM will make follow-up inspections to ascertain whether deficiencies have been corrected. Once this is accomplished, the RA Contractor will notify EPA that the DFOW is ready for inspection.

8.2.2 Final Inspection

The CQM, CM, PM, and EPA will attend the final inspection; other stakeholders also may attend. The inspection will be considered closed when EPA accepts the work and acceptance has been documented and signed by all parties in a final inspection form.

9. Project Documentation

All project quality activities and submittals pertaining to the RA Contract and subcontract documents and the CQAP will be documented. Table 9-1 lists the required reporting and field documentation.

9.1 Calibration Documentation

The RA Contractor will ensure that measuring and test equipment used at the site are of the proper type, range, accuracy, and tolerance to determine conformance to specified requirements. Project records must identify the measuring and test equipment used for an activity.

Normally, manufacturer's instructions are followed for calibration, calibration checks, and maintenance. The method and interval of calibration for each item are based on the type of equipment, stability characteristics, required accuracy, intended use, and other conditions affecting measurement control.

When measuring and test equipment is found to be out of calibration, an evaluation of the validity of previous inspection or test results and of the acceptability of items previously inspected or tested will be conducted and documented. Out-of-calibration devices will be tagged or segregated and not used until they have been re-calibrated. If an item of measuring and test equipment is consistently found to be out of calibration, it will be repaired or replaced. Re-calibration will be performed whenever the accuracy of the equipment is suspect.

9.2 Photographic Record

A project photographic record will be made and kept as part of the quality records. In addition to recording construction progress and "as-constructed" installation details, the photographic record will document deviations from design and nonconformance items. Each photograph will be electronically stamped with the date the photograph was taken and will be transferred daily to the cloud-based website provided by EPA for storage and viewing. Photographs will be organized in a folder with subfolders identified by specific construction activities (for example, specific DFOWs, site preparation activities, or final restoration activities).

The project team will use digital cameras and log and file photographs electronically for record purposes. The CQM, CM, or designated field personnel will maintain the photograph records.

9.3 Field Documentation

The object of field documentation is to check that appropriate project information is documented in logbooks or on appropriate field forms during construction. Documentation is important for communicating with other staff members and other project representatives. The following regular QC observations, inspections, and records of general QC activities should be made:

- Record daily progress and associated QA and QC sampling (that is, reference appropriate testing or inspection field form).
- Record construction operations, sequence, staging, and other information.
- Maintain transportation and waste disposal records (Attachment A, Form A.12).
- Describe deviations from expected conditions or unexpected problems and their resolution.

The CQM will maintain a record of daily QC activities during construction in a field logbook or on appropriate field forms. The logbook and field forms will be available upon request for review. They will be used to record at least the following information:

- Date of entry
- Project name and location
- Time that work starts and ends every day
- Summary of weather conditions
- General description of work, size of work crew, and equipment and personnel onsite
- Duration and type of breaks
- Start time and duration of downtime resulting from equipment breakdown, weather, or emergencies
- Summaries of QC meetings and actions recommended to be performed
- Conversations with subcontractors
- QC testing equipment and personnel
- Identification of work locations
- Description of materials delivered to the site, including QC data
- Decisions made regarding defective work or corrective measures implemented, or both
- Field tests
- Sampling activities

The field forms and the bottom of the last page of the daily field logbook entry will be signed or initialed. Each entry will be dated to show that notes are being entered daily.

A line-out will be placed on any part of an unused page. One-line strikethroughs will be used to show corrections to entries. The strikethroughs will be initialed and dated. No correction fluid may be used.

The field documentation will also be documented in the daily report and on appropriate field forms.

9.4 Daily Report

The daily report is the daily record of operations on the work site and will be kept current (Attachment A, Form A.10). It is an essential tool for recording and reporting the daily production, safety, and quality activities of the project. The reports are the official record of work performance and compliance with project plans, drawings, and specifications. Therefore, it is important that the reports are correct and timely.

The CM is responsible for preparing the daily report and submitting the reports to the PM who will forward the reports to EPA. The PM and CM will provide operational information, and the HSM will provide information on the health and safety activities for the daily report. The report also includes reports from subcontractor to address, at a minimum, the following:

- Quality aspects of the project that is being performed by the RA Contractor
- Scheduling and resource issues

- Site safety inspections and concerns
- Environmental concerns
- Job progress
- Control inspections
- Tests performed and their results
- Personnel and equipment onsite
- Material received

The CQM will review the daily reports for accuracy and completeness because these reports are used to prepare the final reports for the project. The PM will review the reports and check that the quality process is working on the project. The project Quality Manager will review the reports to check that the quality processes and systems are working on the program.

Attachment A, Form A.10 provides the daily report template. At a minimum, the following information should be included to the daily report:

- Tailgate safety meeting minutes
- Summary of work performed that day
- Labor hours for RA Contractor and each subcontractor
- Equipment used onsite
- Changed conditions, delays, and conflicts encountered, including QC issues
- DFOWs
- Submittal status
- Inspection conducted and findings or results of inspection
- Test conducted
- Waste disposal summary

9.4.1 Project Records

Records that are generated by the QC system must be maintained in an orderly manner. The CQM will make sure the project quality records are readily available for reference. The records should be arranged based on input from the document manager and include the following items:

- Submittals, including Submittal Register
- Daily reports
- Meeting minutes
- Inspection reports—Preparatory, Initial, and Follow-up Phases
- Punch list inspection results
- Prefinal and final inspection results
- Rework items lists

- Test results, including appropriate field forms and the site-specific electronic tracking log
- Chain-of-custody forms
- Construction change order and log
- Red-lined drawings or as-built drawing
- Field order and log
- RFIs arranged in numerical order and RFI log
- Nonconformance notices and corrective actions
- Certificates and qualifications
- Calibration records
- Photographs
- Correspondence (for example, e-mails, conversation records)
- Dust or particulate readings (daily)
- Waste tracking

Table 9-1. Reporting and Field Documentation Required

Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Report or Documentation Requirement	Completed by	Delivered to	Frequency	Report Description
Daily Report	CM	CQM	Daily	Document daily construction and QC activity on the site.
Daily Field Logbook	CM/CQM	Electronic Storage	Daily	Upload a scanned copy of the filed logbook daily.
Daily Health and Safety Briefing Records	CM	HSM	Daily	Document daily health and safety “tailgate” meetings.
Safety Observation Report	CM	HSM	Weekly	Record observation of RA Contractor work and document whether or not work was performed in a safe manner.
Self-assessment Checklists	CM	HSM	Per HASP	Upload a scanned copy of the completed form at the frequency described in the HASP.
Project Status Meeting Minutes	PM	Project Team	Weekly	Provide minutes of any project status meeting held.
Submittal Register	CQM	PM	As Needed	Update the Submittal Register to document receipt and review of RA Contractor submittals.
Photographic Record	CM	PM	Daily	Show construction progress, special situations.
Daily QA/QC Verification Sheet	CQM	CM	Daily	Use checklist to ensure appropriate documentation and filing procedures are implemented.
Calibration Record	CQM	PM	Manufacturer’s Requirements	Document equipment calibration and functionality.
Change Management Log	PM	EPA	As Needed	Track of out-of-scope activities that have been completed to monitor potential budget impacts.
HASP	HSM	HSM	Once	Present health and safety procedures to be followed while onsite.
RA Contractor AHAs	HSM	HSM	Once	Present activity hazards and mitigation measures to be followed by the RA Contractor while onsite.
RA Contractor Statements of Work	EPA or Engineer	PM	As Needed	Present bid packages as well as executed contracts.

Table 9-1. Reporting and Field Documentation Required

Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall

Report or Documentation Requirement	Completed by	Delivered to	Frequency	Report Description
Permits	Various	PM	Once	Complete required permits before beginning construction activities.
CQAP	CQM	PM	Once—as needed for updates	Describe the quality management process activities that will be implemented at the site during the construction activities.
Risk Management Plan and Log	PM	Project Team	As Needed	Present project risks as well as mitigation measures for construction activities; update as various risks are identified or removed.
Soil Erosion and Sedimentation Control Plan	PM	Project Team, EPA	Once	Provide site-specific soil erosion and sedimentation control prevention measures.
Waste Management or Transportation and Disposal Documents	Field Team	PM, EPA	As Needed	Present the results of the waste characterization activities including waste profiles and waste manifests and waste tracking log.
Transportation and Disposal Plan	PM	Project Team, EPA	Once	Describe environmental and waste management requirements for construction.

10. Project Closeout

Project closure is to ensure all pertinent project records are identified, labeled, and properly maintained for easy retrieval later. Closeout activities will be conducted throughout the progress of the project. In this way, closeout at the end of the project can be completed in an efficient and timely manner as part of budgeted activities. Closure activities to be completed for this project will include the following:

- Conduct closeout meeting with project team, including client (when possible), and obtain feedback.
- Ensure all project documentation is filed electronically and as a hard copy.
- Consolidate, purge, and archive files.
- Submit regular invoices, and reconcile all cost and revenue data in the financial accounting system after final payment.
- Close all project tasks and subcontractor purchase orders in the financial accounting system.
- Collect final payment, including outstanding accounts receivables.
- Notify client that the project is complete and formally closed.

11. References

CH2M HILL, Inc. (CH2M). 2017. *Velsicol Chemical Corporation Superfund Site Former Plant Site Remedial Design Groundwater Characterization, St. Louis, Michigan*. Prepared for U.S. Environmental Protection Agency – Region 5. January.

CH2M HILL, Inc. (CH2M). 2023. *Basis of Design Report, Remedial Design of the Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall, St. Louis, Michigan.* Final. September.

Conestoga-Rovers and Associates Limited (CRA). 1984. *Securement of Plant Site, St. Louis, Michigan, As Built.* October.

Curran, Dennis L., Donald N. Leske, Linda J. Miller, and the Western Michigan University Department of Geology. 1981. *Hydrogeologic Atlas of Michigan.*

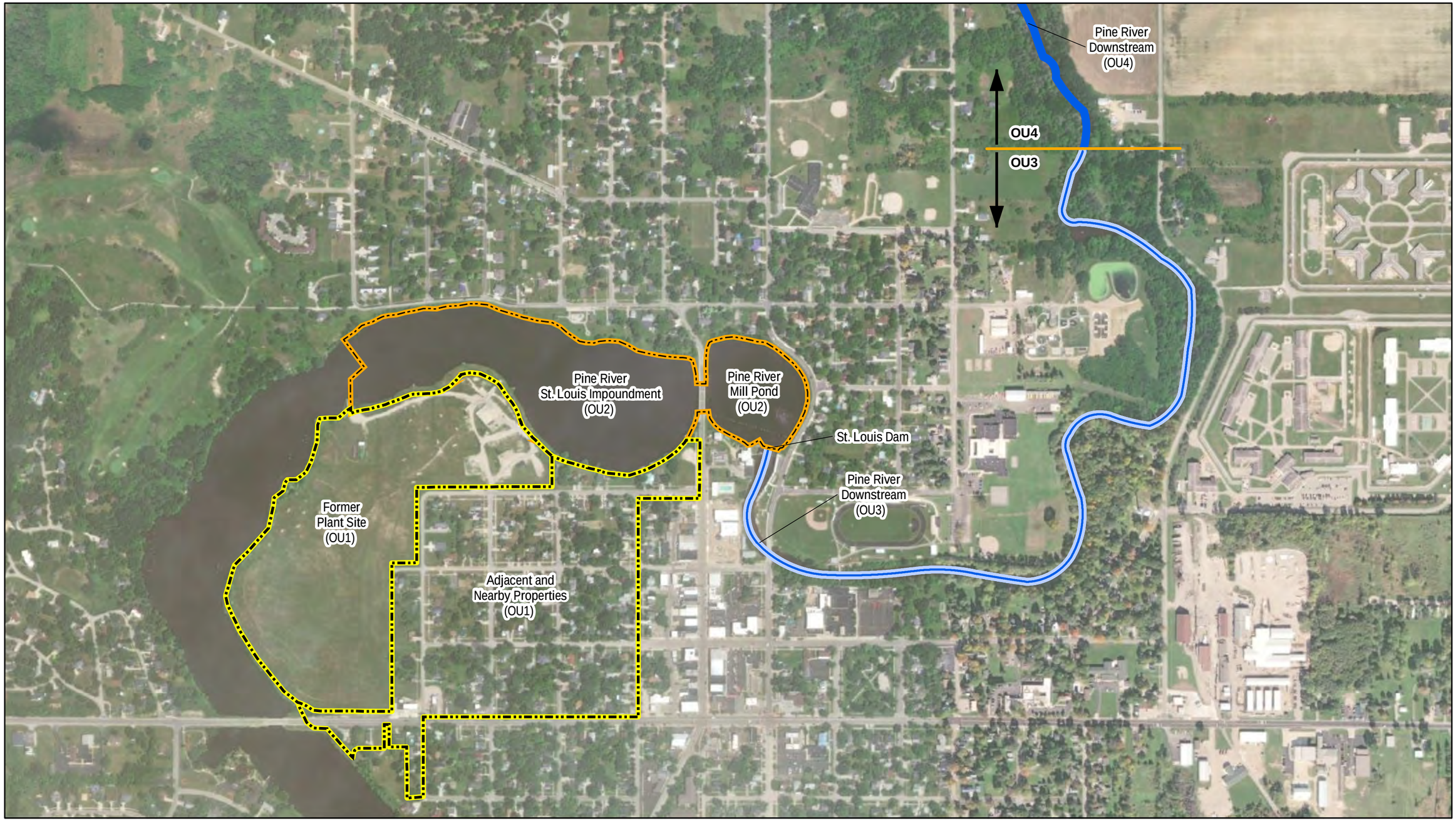
Memphis Environmental Center, Inc. (MEC). 1997. *Final Containment System Assessment Report – Former Michigan Chemical Plant Site, St. Louis, Michigan.* October.

U.S. Environmental Protection Agency (EPA). 1995. *Remedial Design/Remedial Action Handbook*. 9355.0-04B. EPA 540/R-95/059. June. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=100025CQ.TXT.

U.S. Environmental Protection Agency (EPA). 2012. *Record of Decision—Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan.* June 19.

Weston Solutions of Michigan, Inc. (Weston). 2006. *Remedial Investigation Report for Operable Unit One, Velsicol Chemical Corporation Superfund Site, St. Louis, Gratiot County, Michigan*. November.

Figure



Legend

- FORMER PLANT SITE AND ADJACENT AND NEARBY PROPERTIES (OU1)
- PINE RIVER - ST LOUIS IMPOUNDMENT (OU2)
- PINE RIVER (OU3)
- PINE RIVER (OU4)

N

0 600 1,200
Feet

FIGURE 1-1
Study Areas and Operable Units
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

Document Path - MKE - \\Hercules: \\dc1vs01\GISProj\E\EPA\Velsicol_SuperfundSite\Reports\2021\QAPP\MapFiles\Figure01_Study Areas and Operable Units.mxd User Name: mpetersh Date: 8/27/2021 Time: 3:47:13 PM

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Attachment A
Forms

Contract No:	PREPARATORY PHASE REPORT	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:	TASK ORDER NO:
PROJECT NO:	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:		

PERSONNEL PRESENT

CLIENT REP NOTIFIED _____ HOURS IN ADVANCE: YES ☐ NO ☐

NAME	POSITION	COMPANY

SUBMITTALS

REVIEW SUBMITTALS AND/OR SUBMITTAL REGISTER.

HAVE ALL SUBMITTALS BEEN APPROVED? YES ☐ NO ☐

IF NO, WHAT ITEMS HAVE NOT BEEN SUBMITTED?

ARE ALL MATERIALS ON HAND? YES ☐ NO ☐

IF NO, WHAT ITEMS ARE MISSING?

CHECK APPROVED SUBMITTALS AGAINST DELIVERED MATERIAL. (THIS SHOULD BE DONE AS MATERIAL ARRIVES).

COMMENTS:

MATERIAL STORAGE

ARE MATERIALS STORED PROPERLY? YES ☐ NO ☐

IF NO, WHAT ACTION IS TAKEN?

SPECIFICATIONS

REVIEW EACH PARAGRAPH OF SPECIFICATIONS.

DISCUSS PROCEDURE FOR ACCOMPLISHING THE WORK.

CLARIFY ANY DIFFERENCES.

PRELIMINARY WORK & PERMITS

ENSURE PRELIMINARY WORK IS CORRECT AND PERMITS ARE ON FILE.

IF NO, WHAT ACTION IS TAKEN?

CONTRACT NO:	**PREPARATORY PHASE REPORT**	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:	TASK ORDER NO:
PROJECT NO:	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:		

TESTING

IDENTIFY TEST TO BE PERFORMED, FREQUENCY, AND BY WHOM.

TEST	FREQUENCY	PERFORMER

WHEN REQUIRED?

WHERE REQUIRED?

REVIEW TESTING PLAN.

HAVE TEST FACILITIES BEEN

TEST FACILITY	APPROVED?
	YES ☐ NO ☐
	YES ☐ NO ☐

SAFETY

ACTIVITY HAZARD ANALYSIS APPROVED? YES ☐ NO ☐

REVIEW APPLICABLE PORTION OF EM 385-1-1.

MEETING COMMENTS

CLIENT/AGENCY/STAKEHOLDER COMMENTS DURING MEETING.

OTHER ITEMS OR REMARKS

OTHER ITEMS OR REMARKS:

PROJECT QC MANAGER NAME	PROJECT QC MANAGER'S SIGNATURE		DATE	

Contract No:	**INITIAL PHASE CHECKLIST** (ATTACH ADDITIONAL SHEETS IF NECESSARY)	REPORT DATE: REVISION NO: REVISION DATE:
CTO NO:	PROJECT NAME/LOCATION:	REPORT NO:
PROJECT NO:	PROJECT QC MANAGER:	SITE H&S SPECIALIST:

SPEC SECTION:	DEFINABLE FEATURE OF WORK:	SCHEDULE ACT NO.	INDEX #

PERSONNEL PRESENT

GOVERNMENT REP NOTIFIED | HOURS IN ADVANCE: | YES ☐ NO ☐

NAME	POSITION	COMPANY/GOVERNMENT

PROCEDURE COMPLIANCE

IDENTIFY FULL COMPLIANCE WITH PROCEDURES IDENTIFIED AT PREPARATORY. COORDINATE PLANS, SPECIFICATIONS, AND SUBMITTALS

COMMENTS:

PRELIMINARY WORK

ENSURE PRELIMINARY WORK IS COMPLETE AND CORRECT. IF NOT, WHAT ACTION IS TAKEN?

WORKMANSHIP

ESTABLISH LEVEL OF WORKMANSHIP.

WHERE IS WORK LOCATED?

IS SAMPLE PANEL REQUIRED? YES ☐ NO ☐

WILL THE INITIAL WORK BE CONSIDERED AS A SAMPLE? YES ☐ NO ☐

(IF YES, MAINTAIN IN PRESENT CONDITION AS LONG AS POSSIBLE AND DESCRIBE LOCATION OF SAMPLE)

RESOLUTION

RESOLVE ANY DIFFERENCES?

COMMENTS:

CHECK SAFETY

REVIEW JOB CONDITIONS USING EM 385-1-1 AND JOB HAZARD ANALYSIS

COMMENTS:

Contract No:	INITIAL PHASE CHECKLIST (ATTACH ADDITIONAL SHEETS IF NECESSARY)	REPORT DATE: REVISION NO: REVISION DATE:
CTO NO:	PROJECT NAME/LOCATION:	REPORT NO:
PROJECT NO:	PROJECT QC MANAGER:	SITE H&S SPECIALIST:

SPEC SECTION:	DEFINABLE FEATURE OF WORK:	SCHEDULE ACT NO.	INDEX #

OTHER	OTHER ITEMS OR REMARKS

	QC MANAGER	DATE	

Request for Information Form			
Contractor Name:		**RFI Number:**	
Contract Number:		**Date submitted:**	
Task Order Number:		**Project Officer:**	
RPM Name (TOCOR):		**EPA Contract Specialist:**	
Project Name:		**EPA Contracting Officer:**	
Section 1. Overview: *Addition of administrative and media support for community outreach.*			
Impact to scope and costs		**Response Requested by:**	
		Task Number:	
Scope?			
Cost?			
Schedule?			
Section 2. Specific Project Requirement			
Work Scope Description:		**Brief Summary:**	
Section 3: Technical Justification			
Section 4: Cost/Schedule Impacts:			
Section 5: EPA Approval and Guidance:			
1. Approved in full, apply existing funds to new effort			
2. Approved, TO will be modified to change ceiling/funding			
3. Conditional Approval, see Notes Below			
4. Disapproved (Do Not Proceed until otherwise notified)			
EPA Notes/Rational for Decision:			
EPA TOCOR SIGNATURE/DATE			
EPA CONTRACTING OFFICER SIGNATURE/DATE			
CONTRACTOR'S SIGNATURE/DATE			

FORM NO.	A.4 [275]
TITLE:	Field Order
PURPOSE:	Orders minor revisions to the subcontract documents that do not involve changes in the subcontract price or subcontract times.
PREPARED BY:	Contractor
DIRECTED TO:	Subcontractor
COPIES TO:	Owner, Resident Inspector, Document Manager, Project Field File
COMMENTS:	Use sparingly; if the revision involves changes in the subcontract price or times, either a Change Order or Written Amendment should be implemented.

FIELD ORDER

TO SUBCONTRACTOR: _____ FIELD ORDER NO: _____

PROJECT: _____ PROJECT NO: _____

OWNER: _____

CONTRACTOR: _____

The following minor changes in the work have been ordered and authorized:

Description of Changes:

Reason for Field Order:

Reference Drawing sheets and section(s) or detail(s):

Reference Specification section(s)/paragraph(s):

The intent of this Field Order is to authorize minor variations to the Subcontract Documents not involving a change in Subcontract Price or Subcontract Times and which are compatible with the design concept of the completed Project. This Field Order is binding upon OWNER and also on SUBCONTRACTOR who will perform the work promptly. If OWNER or SUBCONTRACTOR believes an adjustment to the Subcontract Price or Subcontract Times is necessary, the party may make a claim therefore in accordance with the General Conditions.

Issued by Contractor:

By: _____
Authorized Representative

Date: _____

Subcontractor Receipt Acknowledgement:

By: _____

Title: _____

Date: _____

Copy:
1. Owner
2. Resident Inspector
3. Document Manager
4. Project Field File

TRANSMITTAL OF SUB CONTRACTOR'S SUBMITTAL
(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____
_____
_____
_____
_____

Submittal No.: _____
☐ New Submittal ☐ Resubmittal
Project: _____
Project No.: _____
Specification Section No.: _____
(Cover only one section with each transmittal)

FROM: _____
Subcontractor
_____
_____
_____

Schedule Date of Submittal:
_____

SUBMITTAL TYPE: ☐ Shop Drawing ☐ Sample ☐ Informational

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Subcontract	
				No	Yes

SUBCONTRACTOR hereby certifies that (i) SUBCONTRACTOR has complied with the requirements of Subcontract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Subcontract Documents and requirements of laws and regulations and governing agencies.

By: _____
SUBCONTRACTOR (Authorized Signature)

Submittal Review Form A.6

Project Name	**Velsicol Chemical Superfund Site, Downgradient Vertical Barrier Wall RA**
Document/Product Name:	
Date Comments Submitted:	

Comment Number	Reference Page or Section Number	Reviewer	Review Comment	Response
1				
2				
3				
4				
5				
6				
7				
8				
9				
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11				
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14				
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FORM NO.	A.7 [442]
TITLE:	Defective/Rejected Work Notification
PURPOSE:	Written notice of deficiencies or rejection of work and a demand for corrective action.
PREPARED BY:	Contractor or resident project representative
DIRECTED TO:	Subcontractor
COPIES TO:	Owner, contractor, document manager, project field file
COMMENTS:	Description should contain accurate locations and specification references. The document may figure strongly in later contractor claims. EJCDC General Conditions require that “deficiencies” in the work be corrected; while “rejected” work must be removed and replaced.

DEFECTIVE/REJECTED WORK NOTIFICATION

TO SUBCONTRACTOR: _____ NOTIFICATION NO: _____

PROJECT: _____ PROJECT NO: _____

OWNER: _____ TIME: _____ AM/PM

CONTRACTOR: _____ OBSERVER: _____

Pursuant to the GENERAL CONDITIONS of the Contract, you are hereby notified of the following noncompliance violation:

Specification Section: _____ Paragraph: _____

Violation:

Subcontract Requirement:

Violation Detected by: ☐ Test ☐ Inspection ☐ Observation

Noncompliance Work is: ☐ Defective ☐ Rejected

Estimated Value of Noncomplying Work: $ _____

Defective work shall be corrected. Rejected work shall be removed and replaced. All costs shall be borne by the Subcontractor. Payment will not be made for defective or rejected work. Subcontractor shall notify Contractor when defective or rejected work is corrected.

Received by:

Contractor: _____
Authorized Representative

_____
Subcontractor

Date: _____

_____
Title

_____
Date

Distribution:
1. Owner
2. Contractor
3. Document Manager
4. Field File

DEFECTIVE/REJECTED WORK NOTIFICATION LOG

PAGE: 1

PROJECT: _____ PROJECT NO: _____

SUBCONTRACTOR: _____

Notification Number	Date	Spec Section	Defective/Rejected Work	Accepted	
				By	Date

NOTIFICATION OF CORRECTION OF DEFECTIVE/REJECTED WORK

TO SUBCONTRACTOR: _____ PREVIOUS NOTIFICATION NO: _____ DATE: _____

PROJECT: _____ PROJECT NO: _____

OWNER: _____

CONTRACTOR: _____

The below listed Defective/Rejected work has been reinspected and the results of the Subcontractor's corrective actions have placed the work in compliance with the Subcontract Documents.

Description of Violation:

Description of Correction:

Contractor: _____
Authorized Representative

Date: _____

Distribution:
1. Contractor
2. Owner
3. Document Manager
4. Project Field File

DAILY REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

SOP ES-P6-01, Final, Rev 1

(adapted from)

CONTRACT NAME:		REPORT NO:			
CONTRACT NUMBER:		REPORT DATE:			
TASK ORDER NUMBER:		REVISION DATE:		REV #	
PROJECT NAME:		SITE NAME:			
PROJECT NUMBER:		PROJECT DESCRIPTION:			
PROJECT MANAGER:		FIELD QUALITY MANAGER:			
CONSTRUCTION MANAGER:		H&S SAFETY Manager:			

AM WEATHER:		PM WEATHER:		MAX TEMP (F):		MIN TEMP (F):	

SUMMARY OF WORK PERFORMED

HEALTH AND SAFETY

JOB SAFETY

Was A Job Safety Meeting Held This Date?	☐ Yes	☐ No
Were there any lost-time accidents this date? (If yes, attach copy of completed OSHA report)	☐ Yes	☐ No
Was a Confined Space Entry Permit Administered This Date? (If yes, attach copy of each permit)	☐ Yes	☐ No
Was Crane/Manlift/Trenching/Scaffold/HV Elec/High Work/Hazmat Work Done?? (If yes, attach statement or checklist showing inspection performed)	☐ Yes	☐ No
Was Hazardous Material/Waste Released into the Environment? (If yes, attach description of incident and proposed action)	☐ Yes	☐ No

SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED (Include Observations, Safety Violations, Corrective Instructions Given, Corrective Actions Taken, and Results of Safety Inspections Conducted:

TAILGATE TOPICS:

SAFE BEHAVIOR OBSERVATIONS:

OPERATIONS / PRODUCTION REPORT

WORK FORCE – CONTRACTOR AND SUBCONTRACTOR

Company	Total Hours Today

DAILY REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

SOP ES-P6-01, Final, Rev 1

(adapted from)

TOTAL HOURS	

EQUIPMENT ON HAND (Intial Inspection conducted to check if the Equipment is clean and in good working order/operable)

Description of Equipment	Make/Model/Manufacture	Equipment ID Number	Inspection Performed By

EQUIPMENT COMMENTS (acceptance status, inspection findings, etc.):

PLANNED WORK

Planned Work / Test for Tomorrow:

Planned Work / Test for Next Week:

CHANGED CONDITIONS/DELAY/CONFLICTS ENCOUNTERED

(List any conflicts with the project [i.e., scope of work and/or drawings], delays to the project attributable to site and weather conditions, etc.)

VISITORS AND DISCUSSIONS:

DAILY REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

SOP ES-P6-01, Final, Rev 1

(adapted from)

REGULATORY COMPLIANCE REPORT

PERMIT INSPECTIONS PERFORMED:

WASTE ACCUMULATION/STOCKPILE AREA INSPECTION

Inspection Performed By:		Signature of Inspector:	
Accumulation / Stockpile Area Inspected:	See Waste Tracking Log		

No of Containers:	Na	No of Tanks	N/A	No of Roll-Off Boxes:	N/A	No. of Drums	N/A

Inspection Results:

GENERAL COMMENTS

General Comments~ (rework, directives, etc.):

DAILY CONTRACTOR QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DEFINABLE FEATURES OF WORK STATUS

DFOW No.	Definable Feature Of Work	Preparatory	Initial	Follow-Up
1	Mobilization and Setup	☐	☐	☐
2	Site Preparation Work	☐	☐	☐
3	Site Restoration	☐	☐	☐
4	Demobilization	☐	☐	☐

PREPARATORY

WAS PREPARATORY PHASE WORK PERFORMED TODAY? ☐ YES ☐ NO

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.

DFOW No.(from list above).	Description	PREPARATORY PHASE REPORT NO. 02

INITIAL AND FOLLOW-UP FEATURE OF WORK COMMENTS

DFOW No.(from list above)	Phase	Comment/Finding/Action
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	

REWORK ITEMS

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)			REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)	
TASK/ ACTIVITY	DATE ISSUED	DESCRIPTION	TASK/ACTIVITY	CORRECTIVE ACTION(S) TAKEN

DAILY CONTRACTOR
QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

SAMPLING/TESTING PERFORMED:

TASK/ACTIVITY TESTED	SAMPLING/TEST PERFORMED	TEST RESULTS (PASS/FAIL/CRITERIA)

MATERIALS/EQUIPMENT INSPECTION (Materials received and inspected against specifications)

DESCRIPTION/QUANTITY/VOLUME/WEIGHT	MAKE/MODEL/MANUFACTURER	MATERIAL LOT NUMBER	INSPECTION PERFORMED BY

SUBMITTALS INSPECTION / REVIEW:

SUBMITTAL NO	SUBMITTAL DESCRIPTION	SPEC/PLAN REFERENCE	SUBMITTAL APPROVED?	COMMENT/REASON/ACTION
			YES ☐ NO ☐	
			YES ☐ NO ☐	
			YES ☐ NO ☐	
			YES ☐ NO ☐	

LIST OF ATTACHMENTS (examples, as applicable: preparatory phase checklist, QC meeting minutes, safety meeting minutes, crane inspections, crane operation checklist, COCs, weight tickets, manifests, profiles, rework item list, testing plan and log, etc.):

On behalf of the contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report.

PREPARER'S SIGNATURE DATE

Form A.11: Checklist for Michigan Permit-by-Rule for Construction Activities Requirements
Downgradient Vertical Barrier Wall
Velsicol Chemical Superfund Site - St. Louis, Michigan
2023

Permit Requirements	Applicable?	Notification to Agency?	Calendar-Based Action item?	Requirement Location (if applicable)
(1) (a) File with the department, on a form approved by the department, notice of coverage pursuant to the provisions of this rule before the initiation of construction activity.	No; Administrative	Yes	No	N/A
(1) (a) (i) Notice of coverage shall include a copy of the individual soil erosion and sedimentation control permit for the site as issued to the construction permittee; or if the construction activity is to be carried out by an authorized public agency, certification by the authorized public agency that an approved control plan exists; or, for part 615 or part 631 permits, a copy of the permit, along with any forms or diagrams pertaining to soil erosion and sedimentation control that were part of the permit application.	No; Administrative	Yes	No	N/A
(1) (a) (ii) Notice of coverage shall include acknowledgement by the construction permittee that any discharge that is made pursuant to the provisions of this rule shall be in compliance with part 31 of the act and the rules promulgated there under.	No; Administrative	Yes	No	N/A
(1) (a) (iii) Notice of coverage shall include a location map and a description of the nature of the construction activity.	No; Administrative	Yes	No	N/A
(1) (a) (iv) Notice of coverage shall include the location of the proposed discharge and identification of the receiving water.	No; Administrative	Yes	No	N/A
(1) (a) (v) Notice of coverage shall include the total area of the site and the area of the site that is expected to undergo construction activity during the life of the project.	No; Administrative	Yes	No	N/A
(1) (a) (vi) Notice of coverage shall include name and certification number of a certified storm water operator responsible for inspection of the construction activity in accordance with subrule (2)(e) of this rule.	No; Administrative	Yes	No	N/A
(1) (b) Provide a valid signature of the construction permittee or authorized representative on the notice of coverage. If the construction permittee is a partnership, association, corporation, industry, municipality, state agency, or interstate body, the valid signatory for the notice of coverage shall be determined in accordance with R 323.2114.	No; Administrative	Yes	No	N/A
(2) (a) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall not directly or indirectly discharge wastes such as discarded building materials, concrete truck washout, chemicals, lubricants, fuels, litter, sanitary waste, or any other substance at the construction site into the waters of the state in violation of part 31 of the act or rules promulgated there under.	Yes	No	No	Prohibited in spec. section 01 50 00, 3.04 C 2.
(2) (b) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall be in compliance with a soil erosion and sedimentation control permit for the site or, if the construction activity is carried out by an authorized public agency, the approved control plan, including the selected control measures that are applicable to the site.	Yes	No	No	Compliance with SESC Plan required in spec. section 01 50 00, 3.04 C 1.
(2) (c) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall properly maintain and operate the soil erosion control measures.	Yes	No	No	SESC Plan - section 3.1
(2) (d) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall have the soil erosion control measures under the specific supervision and control of a storm water operator who has been certified by the department as properly qualified to operate the soil erosion control measures. The certification shall be done in accordance with the requirements of R 323.1251 et seq. [For the Velsicol OU1 ANP Phase 2A RA, the certified storm water operator will be employed by the earthwork subcontractor.]	Yes	No	No	SESC Plan - section 3.3

Form A.11: Checklist for Michigan Permit-by-Rule for Construction Activities Requirements
Downgradient Vertical Barrier Wall
Velsicol Chemical Superfund Site - St. Louis, Michigan
2023

Permit Requirements	Applicable?	Notification to Agency?	Calendar-Based Action item?	Requirement Location (if applicable)
(2) (e) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall cause the construction activity to be inspected by a certified storm water operator once per week, and within 24 hours after every precipitation event that results in a discharge from the site, and ensure that any needed corrective actions are carried out. A log of the inspections and corrective actions shall be maintained on file by the construction permittee for review and shall be retained by the construction permittee for a period of 3 years from the date of the inspection or corrective action.	Yes	No	Yes	SESC Plan - section 5.1
(2) (f) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall, in accordance with the requirements for on-land facilities as set forth in spillage of oil and polluting materials, being part 5 of these rules, provide facilities and comply with reporting procedures for containment of any accidental losses of oil or other polluting materials.	Yes	No	No	Required to be addressed in site-specific HASP as described in spec. section 01 11 00 1.07 D 2 i.
(2) (g) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall dispose of solids, sediment, filter backwash, or other waste that is removed from or results from the treatment or control of storm water in compliance with applicable state laws and regulations and in a manner that prevents any waste from entering waters of the state.	Yes	No	No	
(2) (h) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall allow the department to enter upon the site at any reasonable time before the expiration of the authorization to discharge as set forth in subrule (5) of this rule, upon presentation of credentials and other documents as may be required by law, for the purpose of inspecting conditions relating to the pollution of any waters or determining compliance with the provisions of this rule.	Yes	No	No	RA Contractor will maintain control of site and will permit agency access as requested.
(2) (i) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall, upon request, make available for public inspection or provide to the department all reports or logs prepared pursuant to the provisions of this rule.	Yes	No	No	RA Contractor will provide information from daily reports and earthwork subcontractor daily reports as requested.
(2) (j) A construction permittee that has authorization to discharge under a national permit pursuant to subrule (1) of this rule shall file a revised notice of coverage in compliance with the provisions of subrule (1) of this rule before any expansion of the construction activity or change in the soil erosion control measures that requires a change in the soil erosion and sedimentation control permit.	No; Administrative	No	No	N/A
(3) The department may require that discharges from a construction activity be authorized by an individual national permit if it has been determined by the department that unlawful pollution cannot be adequately guarded against, and there is or may be water quality degradation that will violate the commission act unless requirements in addition to those in the soil erosion and sedimentation control permit are imposed. A determination by the department for an individual national permit or other additional control constitutes grounds for revocation of the authorization to discharge pursuant to the provisions of this rule.	No; Administrative	No	No	N/A
(4) The department may require that discharges from a construction activity be authorized by an individual national permit if it has been determined by the department that the responsible part 91 permitting entity or authorized public agency is not carrying out a program that is adequate to ensure that the requirements of part 91 of the act are complied with.	No; Administrative	No	No	N/A

Form A.11: Checklist for Michigan Permit-by-Rule for Construction Activities Requirements
Downgradient Vertical Barrier Wall
Velsicol Chemical Superfund Site - St. Louis, Michigan
2023

Permit Requirements	Applicable?	Notification to Agency?	Calendar-Based Action item?	Requirement Location (if applicable)
(5) (a) The authorization to discharge pursuant to the provisions of this rule expires when the soil erosion and sedimentation control permit expires, or is revoked or terminated by the part 91 permitting entity in accordance with the provisions of part 91 of the act and 1969 PA 306, MCL 24.201 et seq., or when the authorized public agency determines that the project has been completed by the stabilization of earth change activity.	No; Administrative	No	No	N/A
(5) (b) The authorization to discharge pursuant to the provisions of this rule expires five years from the date of the notice that is filed pursuant to the provisions of subrule (1)(a) of this rule, if the authorization to discharge has not previously expired pursuant to subdivision (a) of this subrule. This authorization may be extended by filing a new notice in compliance with the provisions of subrule (1)(a) of this rule. The construction permittee shall file a notice of termination with the department, on a form approved by the department, when authorization to discharge expires as set forth in accordance with subdivision (a) of this subrule. The notice of termination shall include the name and address of the construction permittee, the location of the construction site, and the mailing address, if available, and certification that stabilization of earth change activity has been completed or, if the certification cannot be made, the reason why the authorization to discharge has expired.	No; Administrative	No	No	N/A
(6) The department may revoke authorization to discharge pursuant to the provisions of this rule if an individual national permit is required pursuant to the provisions of subrule (3) of this rule or in compliance with R 323.2159.	No; Administrative	No	No	N/A
(7) Nothing in this rule shall be construed to preclude the institution of any legal action or relieve the construction permittee from any responsibilities, liabilities, or penalties to which the construction permittee may be subject pursuant to part 31 of the act or rules promulgated there under.	No; Administrative	No	No	N/A
(8) The provisions of this rule are severable, and if any provision of this rule or the application of any provisions of this rule to any circumstances is held invalid, the application of the provisions of this rule to other circumstances and the remainder of this rule shall not be affected by the invalidity.	No; Administrative	No	No	N/A
(9) The construction permittee shall take all reasonable steps to minimize any adverse impact to the surface or groundwaters of the state that result from noncompliance with any of the conditions specified in this rule.	Yes	No	No	
(10) If, for any reason, the construction permittee does not comply with, or will be unable to comply with, any of the conditions that are specified in this rule, the construction permittee shall provide the department with the following information, in writing, within 5 days of becoming aware of the noncompliance or inability to comply: (a) A description of the noncompliance and its cause; (b) The period of noncompliance, including exact dates and times, or, if the noncompliance is not corrected, the anticipated time that the noncompliance is expected to continue and the steps taken to reduce, eliminate, and prevent recurrence of the noncompliance.	Yes	Yes	No	
(11) The provisions of this rule do not convey any property rights in either real or personal property, or any exclusive privileges, authorize any pollution, impairment, or destruction of the natural resources of the state, or the violation of any federal, state, or local laws or regulations, or obviate the necessity of obtaining permits or approvals from other units of government as may be required by law.	No; Administrative	No	No	N/A
(12) The provisions of this rule do not exempt the construction permittee from giving notice to public utilities and complying with each of the requirements of 1974 PA 53, MCL 460.701 et seq.	Yes	No	No	Required in spec. section 01 31 13 1.02
(13) This rule shall not provide authorization to discharge storm water from construction activity which is mixed with non-storm water, or which is subject to an existing national permit or general permit.	Yes	No	No	Water discharge requirements in spec. section 01 50 00 3.06

Form A.12 Waste Tracking Log

TO No	Project No	Project Name	Site Description	Container Type	Container Desig.	Waste Profile Sample No	Sub-contractor	Transporter	Date Transported	Transporter EPA ID	Load ID	Disposal Facility	Disp Fac EPA ID	Media	Waste Type (Haz, Nonhaz, TSCA)	Waste Code/ Haz Waste No	Disposal Date	Manifest Number	Disposal Treatment Method (Enter disposal quantity under appropriate method)					Certif of Disp/ Destruc Date	Comments/ Notes	File Status (see note)
																			Incineration	Recycle	Landfill	Other	Unit			

Attachment B
Submittal Register

Submittal Register

PROJECT NO:		PROJECT NAME:		TASK ORDER NO:		CONTRACT NO:			CONTRACT NAME:			
ITEM NO	TYPE OF SUBMITTAL	DESCRIPTION OF SUBMITTAL	REFERENCE: Spec / Drawing	APPROVING REQUIREMENT: Approval (A) or Information (I)	APPROVING AUTHORITY: (CH or Client)	SUBMITTAL FREQUENCY: (One time, weekly, etc.)	DATE SUBMITTED TO APPROVER	APPROVIING AUTHORITY NAME	TITLE / COMPANY OR AGENCY	STATUS: -Approved -Rejected	DATE APPROVED	REMARKS

Attachment C
Change Management Tracking Log

Change Management Tracking Workbook

Velsicol Former Plant Site

USEPA - Region 5

Task		Scope Change		Cost	Estimated Budget Impacts (Revenue)				Schedule Impacts	Communicated (date)	
Date	WBS #	Scope Change	Initiator	Description	Labor	Expense	Total	Resource(s) Required	Description	Team	Client
					$0.00	$0.00	$0.00				

Appendix K
Operable Unit 2 Sheet Pile Memorandums

As-Built Description of Sheetpile Wall USEPA Velsicol Chemical Site St. Louis, Michigan

PREPARED FOR: File

PREPARED BY: Rob Stryker/MKE
Don Anderson/SEA

REVIEWED BY: Ike Johnson/MKE

COPIES: Jeff Lamont/MKE
Gina Bayer/MKE
Matt Kluge/MKE

DATE: June 29, 2000

Introduction

The purposes of this technical memorandum and the related figure and tables are (1) to serve as an "as-built" description of the sheetpile wall installed at the Velsicol Chemical site between October 1999 and April 2000, and (2) to provide requirements for excavation in light of the embedment shortfalls that are identified in this memorandum. The "as-built" information is presented in this memorandum rather than on design drawings because of the number of "as-built" cases that are involved. The embedment requirement along the sheetpiling alignment was established on a sheet-by-sheet basis, and the total length of sheetpiling was in excess of 2,000 feet. For this combination no single drawing or set of drawings showing "typical" sections would have adequately documented what was constructed.

This technical memorandum was prepared as part of Remedial Action cleanup activities at the Velsicol Chemical Site in St. Louis, Michigan. CH2M HILL served as both the designer and the construction manager for this work. This memorandum describes only the sheetpiling sections installed at the site between October 15, 1999, and April 19, 2000. Any sheetpiling installed after April 19, 2000 will require separate documentation.

Summary of As-Built Sheetpile Installation Information

Figure 1 shows locations and numbering conventions for the sheetpiling that were installed as part of this and previous work at the site. Three separate cells are shown. The Removal Cell, including the settling basin, was installed by subcontractors of the USEPA Removal Group prior to CH2M HILL's presence onsite, and its final construction is not described in this document. Cell 123 was originally shown as three separate cells in the original design prior to bid, with the subcontractor's option to install the dividing walls. Our subcontractor, National Environmental Services Corporation (NES), elected to forgo the installation of these interior walls. Table 1 gives the designation for the six walls installed, listed from west to east.

Tables 2 through 7 indicate both the installed embedment depth (minus a 2-foot safety factor) and the required design embedment depth for each individual sheet installed at the site during the Removal

Action. Figures 2 through 7 show the installed and required embedment depth graphically along each wall. The installed embedment depth was determined from the average of 11 adjacent individual sheets, consisting of five sheets on either side of the designated sheet. This averaging procedure was used to take localized group effects into account. Design embedment depths were determined using standard earth pressure theory. The depth of required embedment typically ranged from 7 to 8 feet. Methods used to determine these depths are documented in a CH2M HILL technical memorandum dated January 20, 2000 (CH2M HILL, 2000), which is included as Attachment A.

Results given in Table 2 through 7 indicate that the required depth was not satisfied at 6 locations. The shortfall in embedment ranged from less than 1 foot to slightly more than 3 feet. By not meeting the required embedment depth at these locations, the factor of safety for sheetpile wall stability is less than normally accepted within engineering practice. Whereas assumptions made during the determination of embedment depth are thought to be conservative, the uncertainties associated with these determinations are such that the required factor of safety should be satisfied to be consistent with the current standards of geotechnical practice. For this reason excavation methods must recognize and compensate for these shortfalls, as discussed in the next section of this technical memorandum.

Addressing Embedment Shortfalls

As noted above, several minor embedment shortfall areas occur. In each of these areas a specific sequence of steps will be followed to maintain stability. These steps will involve the following:

- Prior to dewatering activities, each of these locations will be clearly marked on the sheetpiling so that locations are known by the personnel conducting the excavation activities.
- Excavation in these areas will proceed without corrective measures down to a certain "critical" depth. The maximum allowable freeboard, which includes the total distance from the river level on the outside of the sheetpiling down to the critical depth of excavation, will be written on the sheetpiling in each shortfall area.
- No more than 15 linear feet of sheetpiling (i.e., an exposed face along the sheetpile alignment of 15 feet) in the shortfall section will be excavated below the critical depth at any given time.
- When the excavation in one area is complete, it will be bermed with clean, imported material back up to the critical elevation. The backfill will extend back from the sheetpiling at least three times as far as the berm height.

A summary of the shortfall areas for each of the cells is provided in Table 8. This table identifies the sheetpiling that do not meet the required embedment depth, the number of individual sheets involved, the horizontal length, and the maximum allowable freeboard that can be exposed without implementing the provisions noted above. A brief discussion of these cases follows. Shortfall areas are listed from west to east along the alignment. It should be noted that confirmatory sampling may indicate that all contamination above the project action limit has been removed prior to reaching the critical depth. In this case excavation can be terminated and the soil berms will not need to be constructed in the shortfall area.

Cell 4—Northwest Wall

One shortfall area occurs between 4NW63 and 4NW76. The horizontal length of this shortfall is 21 feet, indicating that it will require 2 excavation sequences to remove and replace the material below the critical depth.

The minimum embedment into clay is 5.3 feet, corresponding to a maximum shortfall of 2.1 feet. A maximum of 11 feet of dewatering and excavation can occur in this area before corrective measures need to be implemented. This compares to a maximum potential freeboard of 15 feet.

Cell 4—North Wall

Between 4N6 and 4N14, a very minor shortfall with a horizontal length of 13.5 feet exists. The minimum embedment depth in this stretch is 7.2 feet, which yields a maximum shortfall of 0.5 feet. The maximum allowable freeboard in this area is 14.5 feet, compared to a maximum potential freeboard of 15.5 feet.

Another minor shortfall of 10.5 feet occurs between 4N59 and 4N65. Minimum embedment and maximum shortfall here are 7.1 feet and 0.6 feet, respectively. These correspond to a maximum allowable freeboard of 14.0 feet, whereas maximum potential freeboard is 15.5 feet.

Cell 1—North Wall

A shortfall having a total length of 12 feet occurs between 1N13 and 1N20, with a minimum embedment depth of 7.3 feet and a maximum shortfall of 0.6 feet. The maximum allowable freeboard in this area is 14.5 feet, compared to a maximum possible freeboard of 16.0 feet. Since the length of this shortfall is 12 feet, only one excavation sequence will be required.

Another shortfall with a length of 12 feet occurs between 1N152 and 1N159. Minimum embedment and maximum shortfall here are 6.0 feet and 1.4 feet, respectively. These correspond to a maximum allowable freeboard of 12.0 feet, whereas maximum potential freeboard is 15.0 feet.

Cell 3—North Wall

A shortfall occurs over a 12-sheet area at the eastern end of the wall, from 3N203 to 3N214. This was due to rubble and concrete in the river bottom, which could not be penetrated with a vibratory hammer. Thus, only the diesel impact hammer was used to drive these sheets, and they were poorly aligned following driving and were unable to be straightened. Additionally, an overhead utility line is present over this portion of the wall, which limited the sheet length that could be driven. The sheets were driven until the minimum amount of stickup was reached. Welding additional piling and driving the sheets further is not possible due to the misalignment. The minimum embedment depth is 2.6 feet, the maximum shortfall is 3.4 feet, and the maximum possible freeboard tapers down from 17.0 feet to 6.0 feet in this area. The maximum allowable freeboard here is 9.0 feet. Watertightness may also be a concern here due to one or two sheets not driven into the tight clay, and the subcontractor is aware of the necessity to address this potential problem.

Concluding Comments

The shortfalls identified in this technical memorandum, as well as the methods for addressing these shortfalls, are directly related to the safety of the crews working in the excavation. It is therefore critical that continuous, attentive oversight be provided as the contractor's excavation work approaches the sheetpiling. It is also critical that excavations not go beyond the depths identified in this technical memorandum.

Since failure of the sheetpiling could risk the safety of the workers, the behavior of the sheetpiling should be monitored on a continuous basis. If inward movement of the sheetpiling appears to be occurring, excavation should be stopped and corrective measures implemented.

In view of the potential consequences of sheetpiling failure, a contingency plan should be developed by the contractor before excavations are within 50 feet of the sheetpiling. This plan should identify how movement of the wall will be determined (e.g., surveying or visual only) and what will be done by the contractor in the event that movements exceed more than a predetermined amount. All field crew should be made aware of this contingency plan, and reminders of this plan should be given at weekly tailgate meetings.

Review Certification

This technical memorandum has been reviewed by a professional engineer registered in the state of Michigan

Name

July 19, 2000

Date

STATE OF MICHIGAN
ISAAC H. JOHNSON
ENGINEER NO. 34101
LICENSED PROFESSIONAL ENGINEER

Figures

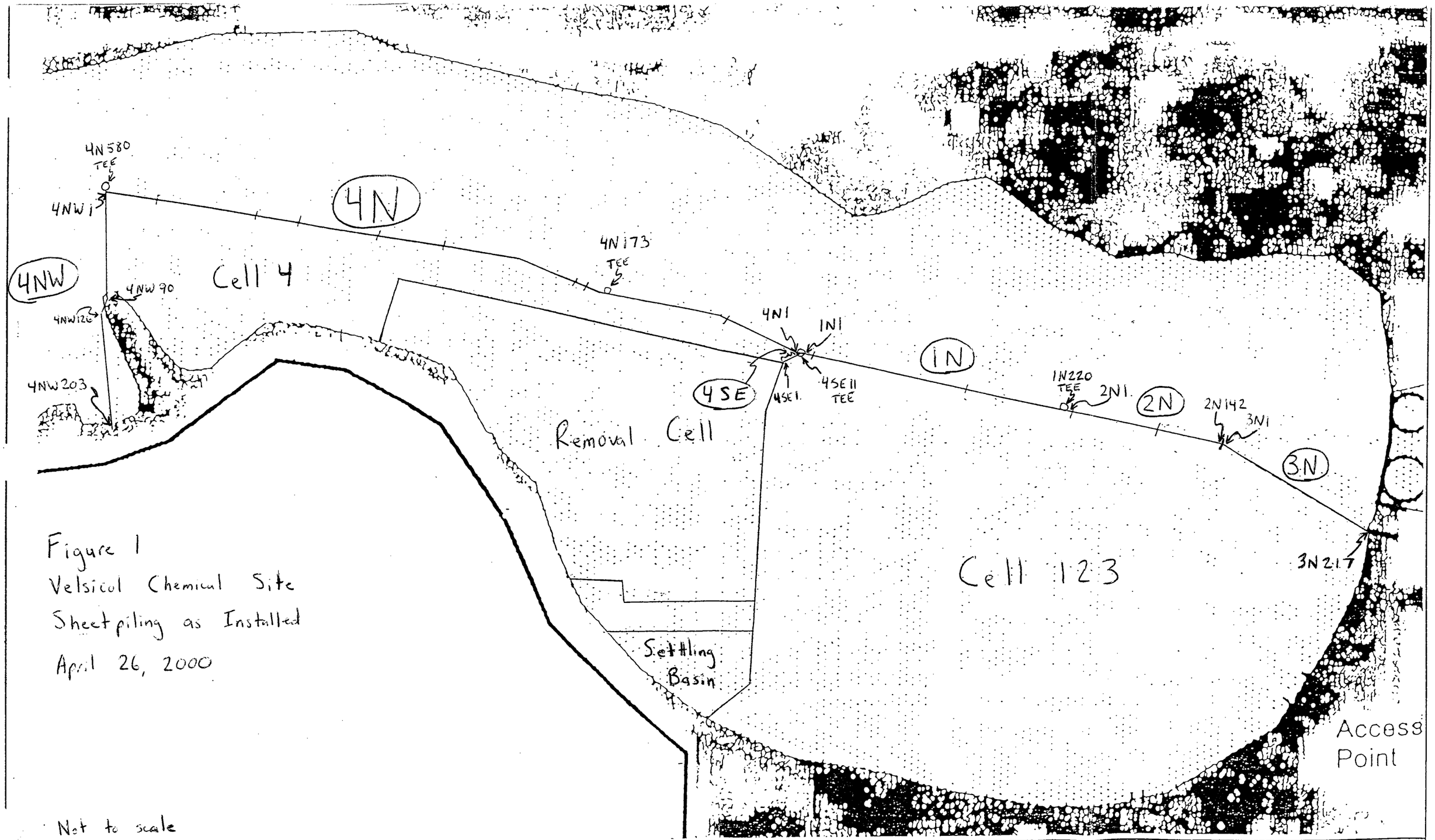

Figure 1
Velsicol Chemical Site
Sheetpiling as Installed
April 26, 2000

Not to scale

NATIONAL ENVIRONMENTAL SERVICES CORP.

CORPORATE OFFICE:
417 SOUTH WALNUT ST.
BLOOMINGTON, IN 47401
PHONE (812)-339-9000
FAX (812)-331-8235

FIELD OFFICE:
214 Saginaw Street
St Louis, Michigan 48880
PHONE: (517) 681-5065

Drawn DK	Date 2/7/00				
Designed JR	Date 1/31/00				
Checked DK	Date 2/8/00				
Reviewed	Date				
Approved	Date				
Approved	Date	No	Date	Revision	By

PHASE I SEDIMENT REMEDIAL ACTION
VESICOL/PINE RIVER SITE

SHEET PILE INSTALLATION (DRAFT)

Field Book
Atlas Sheet
File No.
Job No.
Scale
SHEET OF
Index No. 4

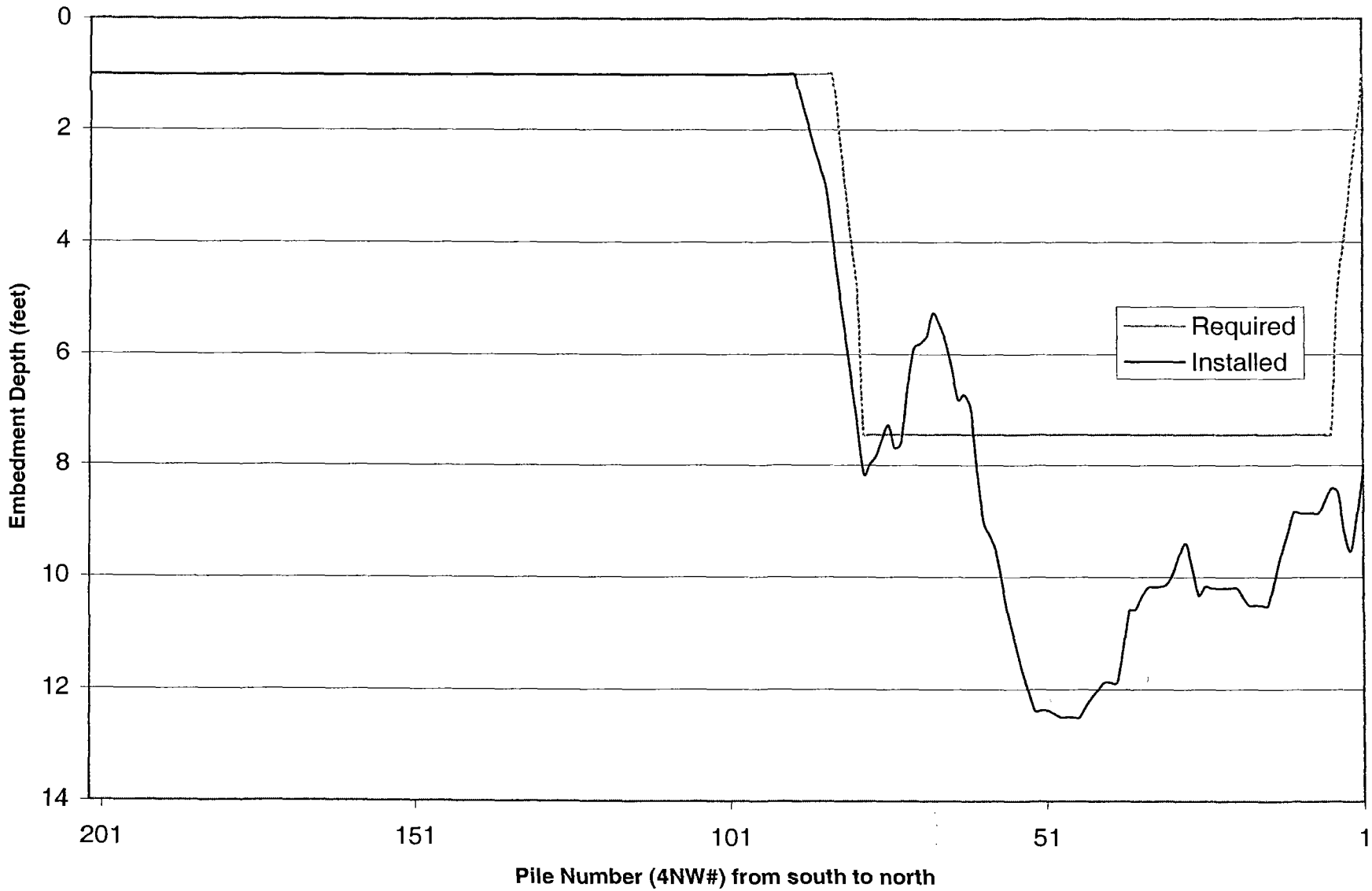

Figure 2. Installed and Required Embedment--Northwest Wall of Cell 4

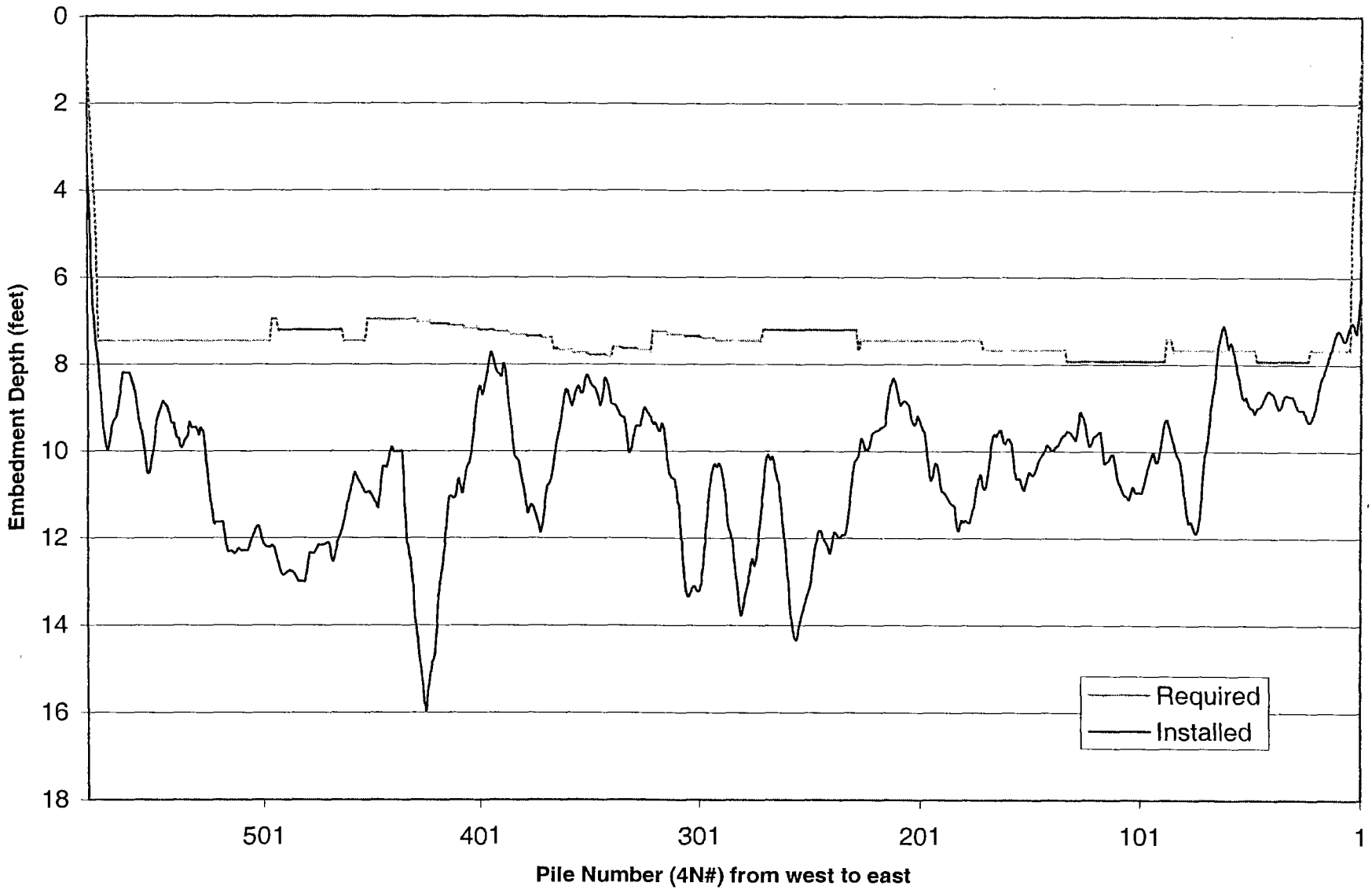

Figure 3. Installed and Required Embedment--North Wall of Cell 4

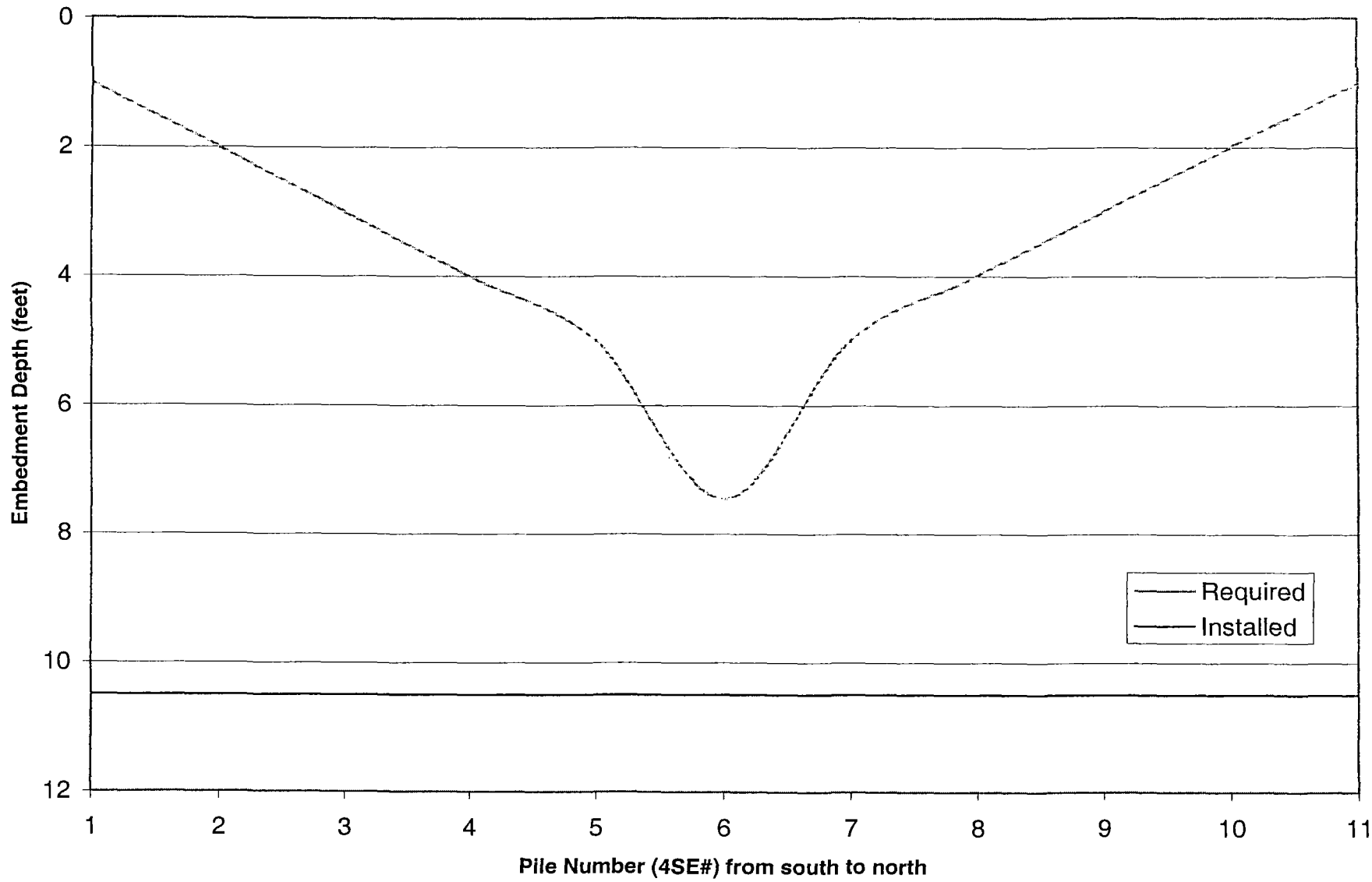

Figure 4. Installed and Required Embedment--Southeast Wall of Cell 4

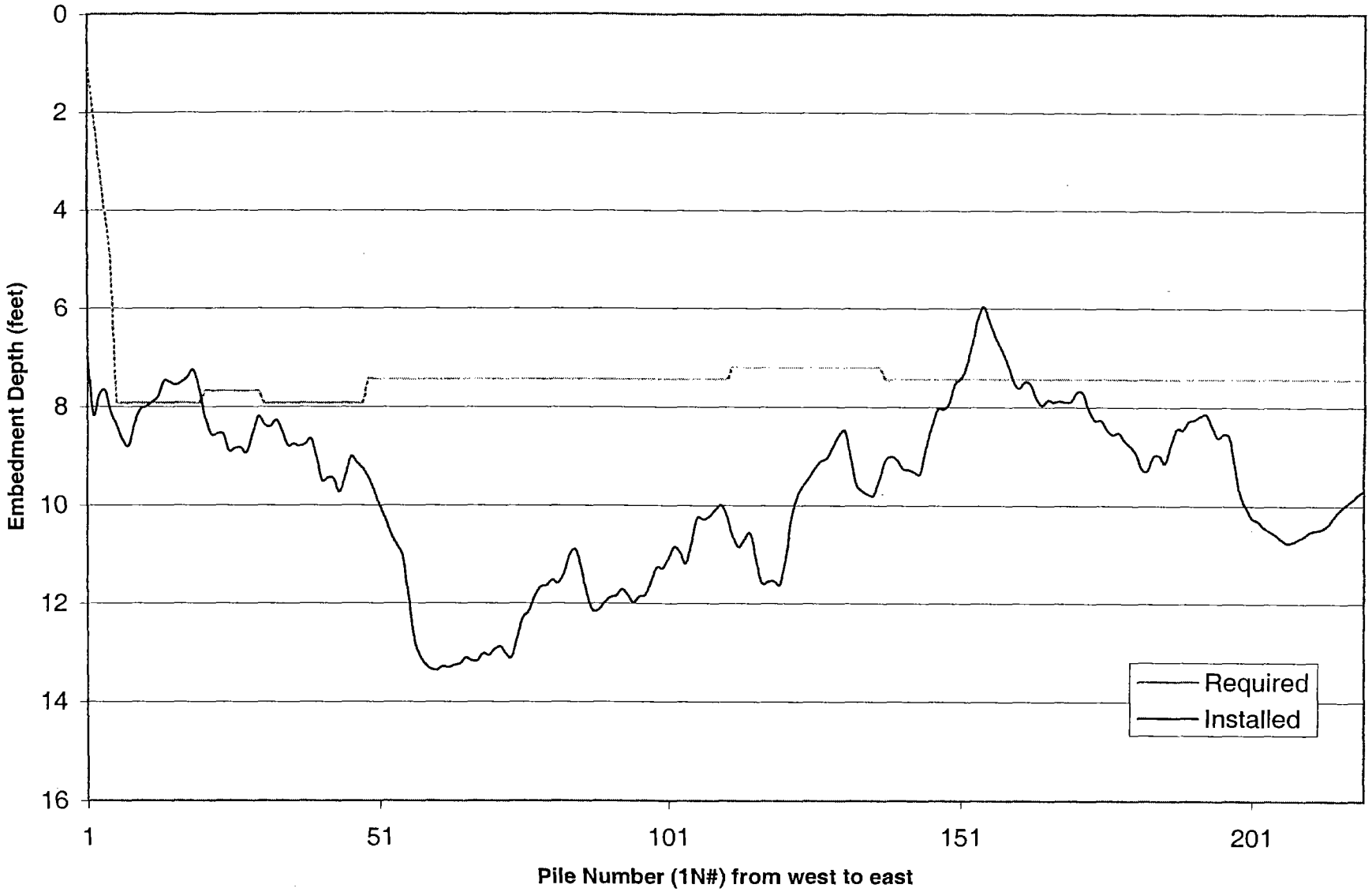

Figure 5. Installed and Required Embedment--North Wall of Cell 1

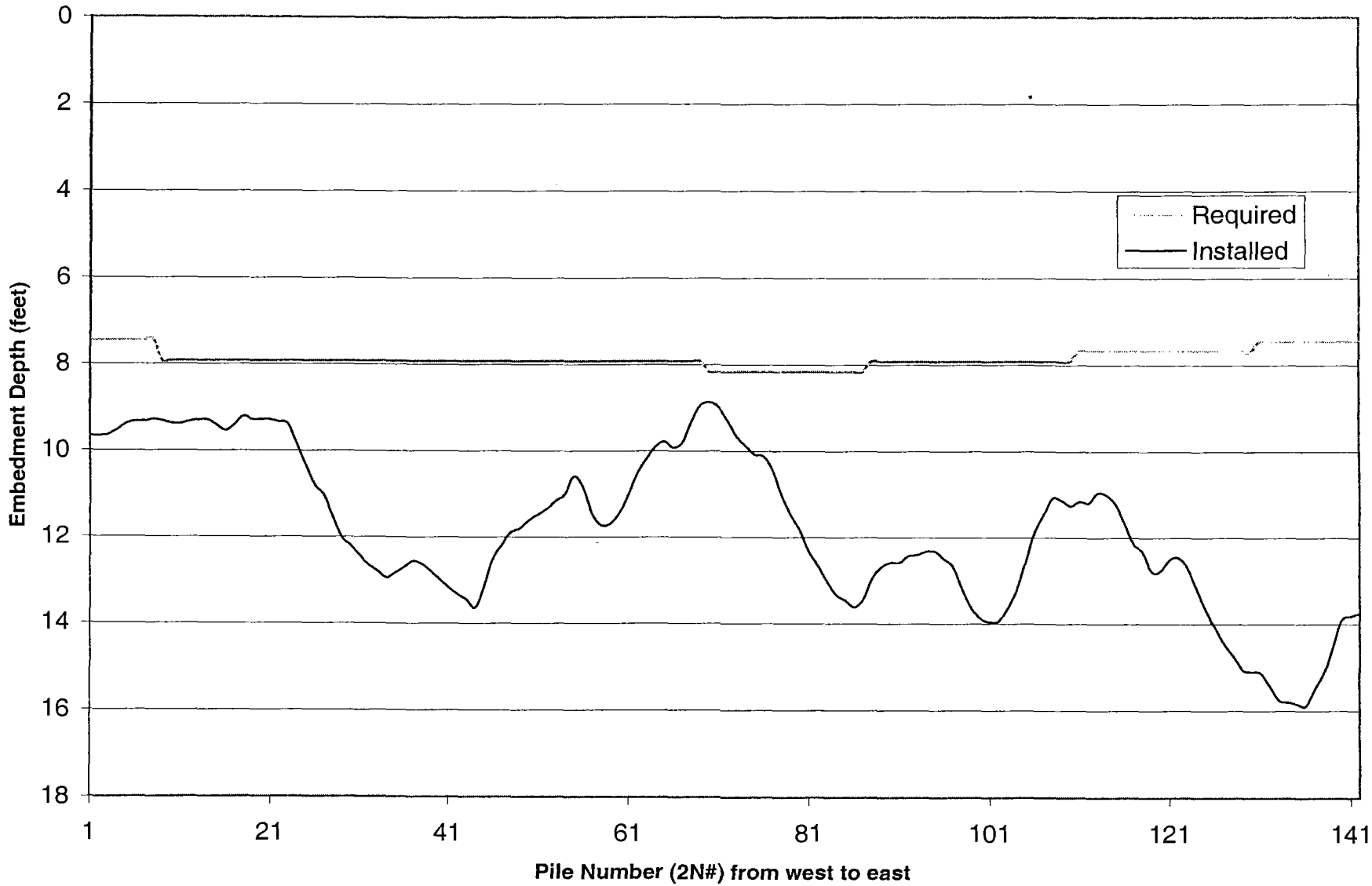

Figure 6. Installed and Required Embedment--North Wall of Cell 2

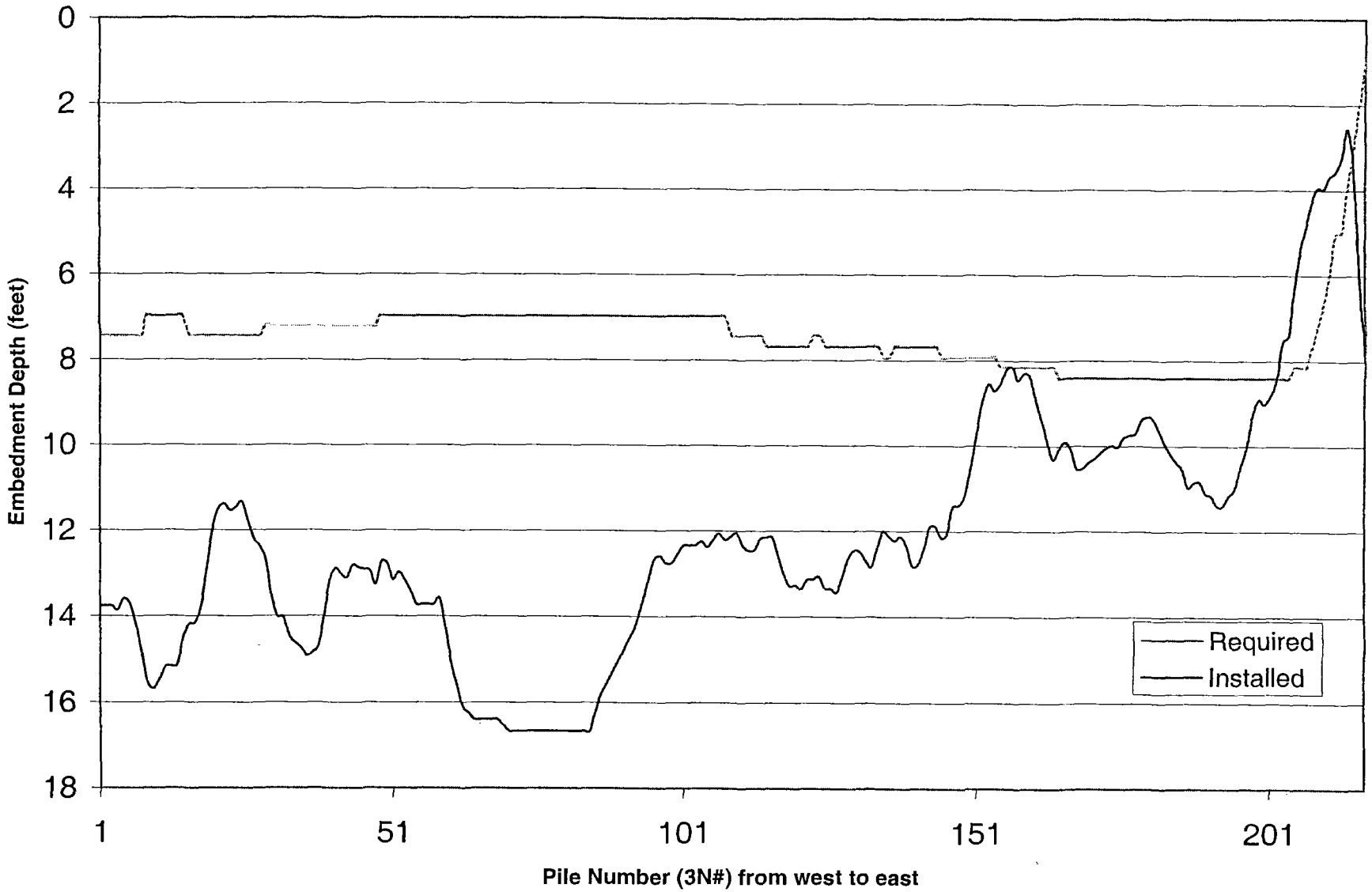

Figure 7. Installed and Required Embedment--North Wall of Cell 3

Tables

TABLE 1
Sheetpile Wall Designations
Velsicol Chemical Site

Cell	Location	Designation	Number of Sheets
4	West/Northwest	4NW	203
4	North	4N	580
4	East/Southeast	4SE	11
123	North (western portion)	1N	220
123	North (central portion)	2N	142
123	North (eastern portion)	3N	217

TABLE 2
Sheetpiling Embedment in Northwest Wall of Cell 4
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
4NW1	8.1	1.0	Yes	4NW44	12.2	7.4	Yes	4NW87	2.7	1.0[a]	Yes	4NW130	1.0	1.0[a]	Yes	4NW173	1.0	1.0[a]	Yes
4NW2	8.9	2.0	Yes	4NW45	12.3	7.4	Yes	4NW88	2.3	1.0[a]	Yes	4NW131	1.0	1.0[a]	Yes	4NW174	1.0	1.0[a]	Yes
4NW3	9.5	3.0	Yes	4NW46	12.5	7.4	Yes	4NW89	1.9	1.0[a]	Yes	4NW132	1.0	1.0[a]	Yes	4NW175	1.0	1.0[a]	Yes
4NW4	9.2	4.0	Yes	4NW47	12.5	7.4	Yes	4NW90	1.4	1.0[a]	Yes	4NW133	1.0	1.0[a]	Yes	4NW176	1.0	1.0[a]	Yes
4NW5	8.5	5.0	Yes	4NW48	12.5	7.4	Yes	4NW91	1.0	1.0[a]	Yes	4NW134	1.0	1.0[a]	Yes	4NW177	1.0	1.0[a]	Yes
4NW6	8.4	7.4	Yes	4NW49	12.5	7.4	Yes	4NW92	1.0	1.0[a]	Yes	4NW135	1.0	1.0[a]	Yes	4NW178	1.0	1.0[a]	Yes
4NW7	8.6	7.4	Yes	4NW50	12.4	7.4	Yes	4NW93	1.0	1.0[a]	Yes	4NW136	1.0	1.0[a]	Yes	4NW179	1.0	1.0[a]	Yes
4NW8	8.8	7.4	Yes	4NW51	12.4	7.4	Yes	4NW94	1.0	1.0[a]	Yes	4NW137	1.0	1.0[a]	Yes	4NW180	1.0	1.0[a]	Yes
4NW9	8.8	7.4	Yes	4NW52	12.4	7.4	Yes	4NW95	1.0	1.0[a]	Yes	4NW138	1.0	1.0[a]	Yes	4NW181	1.0	1.0[a]	Yes
4NW10	8.8	7.4	Yes	4NW53	12.4	7.4	Yes	4NW96	1.0	1.0[a]	Yes	4NW139	1.0	1.0[a]	Yes	4NW182	1.0	1.0[a]	Yes
4NW11	8.8	7.4	Yes	4NW54	12.0	7.4	Yes	4NW97	1.0	1.0[a]	Yes	4NW140	1.0	1.0[a]	Yes	4NW183	1.0	1.0[a]	Yes
4NW12	8.8	7.4	Yes	4NW55	11.7	7.4	Yes	4NW98	1.0	1.0[a]	Yes	4NW141	1.0	1.0[a]	Yes	4NW184	1.0	1.0[a]	Yes
4NW13	9.2	7.4	Yes	4NW56	11.2	7.4	Yes	4NW99	1.0	1.0[a]	Yes	4NW142	1.0	1.0[a]	Yes	4NW185	1.0	1.0[a]	Yes
4NW14	9.6	7.4	Yes	4NW57	10.8	7.4	Yes	4NW100	1.0	1.0[a]	Yes	4NW143	1.0	1.0[a]	Yes	4NW186	1.0	1.0[a]	Yes
4NW15	10.1	7.4	Yes	4NW58	10.2	7.4	Yes	4NW101	1.0	1.0[a]	Yes	4NW144	1.0	1.0[a]	Yes	4NW187	1.0	1.0[a]	Yes
4NW16	10.5	7.4	Yes	4NW59	9.6	7.4	Yes	4NW102	1.0	1.0[a]	Yes	4NW145	1.0	1.0[a]	Yes	4NW188	1.0	1.0[a]	Yes
4NW17	10.5	7.4	Yes	4NW60	9.3	7.4	Yes	4NW103	1.0	1.0[a]	Yes	4NW146	1.0	1.0[a]	Yes	4NW189	1.0	1.0[a]	Yes
4NW18	10.5	7.4	Yes	4NW61	9.0	7.4	Yes	4NW104	1.0	1.0[a]	Yes	4NW147	1.0	1.0[a]	Yes	4NW190	1.0	1.0[a]	Yes
4NW19	10.5	7.4	Yes	4NW62	8.1	7.4	Yes	4NW105	1.0	1.0[a]	Yes	4NW148	1.0	1.0[a]	Yes	4NW191	1.0	1.0[a]	Yes
4NW20	10.3	7.4	Yes	4NW63	7.0	7.4	No	4NW106	1.0	1.0[a]	Yes	4NW149	1.0	1.0[a]	Yes	4NW192	1.0	1.0[a]	Yes
4NW21	10.2	7.4	Yes	4NW64	6.7	7.4	No	4NW107	1.0	1.0[a]	Yes	4NW150	1.0	1.0[a]	Yes	4NW193	1.0	1.0[a]	Yes
4NW22	10.2	7.4	Yes	4NW65	6.8	7.4	No	4NW108	1.0	1.0[a]	Yes	4NW151	1.0	1.0[a]	Yes	4NW194	1.0	1.0[a]	Yes
4NW23	10.2	7.4	Yes	4NW66	6.2	7.4	No	4NW109	1.0	1.0[a]	Yes	4NW152	1.0	1.0[a]	Yes	4NW195	1.0	1.0[a]	Yes
4NW24	10.2	7.4	Yes	4NW67	5.8	7.4	No	4NW110	1.0	1.0[a]	Yes	4NW153	1.0	1.0[a]	Yes	4NW196	1.0	1.0[a]	Yes
4NW25	10.2	7.4	Yes	4NW68	5.5	7.4	No	4NW111	1.0	1.0[a]	Yes	4NW154	1.0	1.0[a]	Yes	4NW197	1.0	1.0[a]	Yes
4NW26	10.2	7.4	Yes	4NW69	5.3	7.4	No	4NW112	1.0	1.0[a]	Yes	4NW155	1.0	1.0[a]	Yes	4NW198	1.0	1.0[a]	Yes
4NW27	10.3	7.4	Yes	4NW70	5.7	7.4	No	4NW113	1.0	1.0[a]	Yes	4NW156	1.0	1.0[a]	Yes	4NW199	1.0	1.0[a]	Yes
4NW28	9.9	7.4	Yes	4NW71	5.8	7.4	No	4NW114	1.0	1.0[a]	Yes	4NW157	1.0	1.0[a]	Yes	4NW200	1.0	1.0[a]	Yes
4NW29	9.4	7.4	Yes	4NW72	5.9	7.4	No	4NW115	1.0	1.0[a]	Yes	4NW158	1.0	1.0[a]	Yes	4NW201	1.0	1.0[a]	Yes
4NW30	9.6	7.4	Yes	4NW73	6.7	7.4	No	4NW116	1.0	1.0[a]	Yes	4NW159	1.0	1.0[a]	Yes	4NW202	1.0	1.0[a]	Yes
4NW31	9.9	7.4	Yes	4NW74	7.6	7.4	Yes	4NW117	1.0	1.0[a]	Yes	4NW160	1.0	1.0[a]	Yes	4NW203	1.0	1.0[a]	Yes
4NW32	10.1	7.4	Yes	4NW75	7.7	7.4	Yes	4NW118	1.0	1.0[a]	Yes	4NW161	1.0	1.0[a]	Yes				
4NW33	10.2	7.4	Yes	4NW76	7.3	7.4	No	4NW119	1.0	1.0[a]	Yes	4NW162	1.0	1.0[a]	Yes				
4NW34	10.2	7.4	Yes	4NW77	7.5	7.4	Yes	4NW120	1.0	1.0[a]	Yes	4NW163	1.0	1.0[a]	Yes				
4NW35	10.2	7.4	Yes	4NW78	7.8	7.4	Yes	4NW121	1.0	1.0[a]	Yes	4NW164	1.0	1.0[a]	Yes				
4NW36	10.4	7.4	Yes	4NW79	8.0	7.4	Yes	4NW122	1.0	1.0[a]	Yes	4NW165	1.0	1.0[a]	Yes				
4NW37	10.6	7.4	Yes	4NW80	8.2	7.4	Yes	4NW123	1.0	1.0[a]	Yes	4NW166	1.0	1.0[a]	Yes				
4NW38	10.6	7.4	Yes	4NW81	7.3	5.0	Yes	4NW124	1.0	1.0[a]	Yes	4NW167	1.0	1.0[a]	Yes				
4NW39	11.2	7.4	Yes	4NW82	6.4	4.0	Yes	4NW125	1.0	1.0[a]	Yes	4NW168	1.0	1.0[a]	Yes				
4NW40	11.9	7.4	Yes	4NW83	5.6	3.0	Yes	4NW126	1.0	1.0[a]	Yes	4NW169	1.0	1.0[a]	Yes				
4NW41	11.9	7.4	Yes	4NW84	4.8	2.0	Yes	4NW127	1.0	1.0[a]	Yes	4NW170	1.0	1.0[a]	Yes				
4NW42	11.9	7.4	Yes	4NW85	3.9	1.0	Yes	4NW128	1.0	1.0[a]	Yes	4NW171	1.0	1.0[a]	Yes				
4NW43	12.0	7.4	Yes	4NW86	3.0	1.0[a]	Yes	4NW129	1.0	1.0[a]	Yes	4NW172	1.0	1.0[a]	Yes				

[a]Only one foot of embedment is required since no excavation will occur adjacent to the sheetpiling, and watertightness is the only concern.

TABLE 3
Sheetpiling Embedment in North Wall of Cell 4
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
4N1	6.3	1.0	Yes	4N45	8.8	7.9	Yes	4N89	9.3	7.4	Yes	4N133	9.6	7.9	Yes	4N177	11.4	7.4	Yes
4N2	6.9	2.0	Yes	4N46	8.9	7.9	Yes	4N90	9.3	7.9	Yes	4N134	9.5	7.9	Yes	4N178	11.6	7.4	Yes
4N3	7.3	3.0	Yes	4N47	9.0	7.9	Yes	4N91	9.6	7.9	Yes	4N135	9.6	7.7	Yes	4N179	11.6	7.4	Yes
4N4	7.1	4.0	Yes	4N48	9.0	7.9	Yes	4N92	10.0	7.9	Yes	4N136	9.7	7.7	Yes	4N180	11.6	7.4	Yes
4N5	7.0	5.0	Yes	4N49	9.1	7.7	Yes	4N93	10.2	7.9	Yes	4N137	9.7	7.7	Yes	4N181	11.6	7.4	Yes
4N6	7.2	7.7	No	4N50	9.0	7.7	Yes	4N94	10.2	7.9	Yes	4N138	9.9	7.7	Yes	4N182	11.6	7.4	Yes
4N7	7.3	7.7	No	4N51	9.0	7.7	Yes	4N95	10.0	7.9	Yes	4N139	9.9	7.7	Yes	4N183	11.8	7.4	Yes
4N8	7.4	7.7	No	4N52	8.9	7.7	Yes	4N96	10.1	7.9	Yes	4N140	10.0	7.7	Yes	4N184	11.7	7.4	Yes
4N9	7.4	7.7	No	4N53	8.8	7.7	Yes	4N97	10.3	7.9	Yes	4N141	10.0	7.7	Yes	4N185	11.3	7.4	Yes
4N10	7.3	7.7	No	4N54	8.8	7.7	Yes	4N98	10.5	7.9	Yes	4N142	9.9	7.7	Yes	4N186	11.2	7.4	Yes
4N11	7.2	7.7	No	4N55	8.7	7.7	Yes	4N99	10.7	7.9	Yes	4N143	9.9	7.7	Yes	4N187	11.2	7.4	Yes
4N12	7.3	7.7	No	4N56	8.4	7.7	Yes	4N100	10.9	7.9	Yes	4N144	10.0	7.7	Yes	4N188	11.1	7.4	Yes
4N13	7.4	7.7	No	4N57	8.1	7.7	Yes	4N101	10.9	7.9	Yes	4N145	10.1	7.7	Yes	4N189	11.0	7.4	Yes
4N14	7.6	7.7	No	4N58	7.9	7.7	Yes	4N102	10.9	7.9	Yes	4N146	10.1	7.7	Yes	4N190	10.9	7.4	Yes
4N15	7.7	7.7	Yes	4N59	7.6	7.7	No	4N103	10.9	7.9	Yes	4N147	10.3	7.7	Yes	4N191	10.9	7.4	Yes
4N16	7.9	7.7	Yes	4N60	7.5	7.7	No	4N104	10.8	7.9	Yes	4N148	10.4	7.7	Yes	4N192	10.6	7.4	Yes
4N17	8.1	7.7	Yes	4N61	7.6	7.7	No	4N105	11.0	7.9	Yes	4N149	10.5	7.7	Yes	4N193	10.3	7.4	Yes
4N18	8.2	7.7	Yes	4N62	7.3	7.7	No	4N106	11.1	7.9	Yes	4N150	10.5	7.7	Yes	4N194	10.3	7.4	Yes
4N19	8.3	7.7	Yes	4N63	7.1	7.7	No	4N107	11.0	7.9	Yes	4N151	10.5	7.7	Yes	4N195	10.6	7.4	Yes
4N20	8.5	7.7	Yes	4N64	7.3	7.7	No	4N108	11.0	7.9	Yes	4N152	10.6	7.7	Yes	4N196	10.7	7.4	Yes
4N21	8.8	7.7	Yes	4N65	7.4	7.7	No	4N109	10.9	7.9	Yes	4N153	10.9	7.7	Yes	4N197	10.3	7.4	Yes
4N22	9.1	7.7	Yes	4N66	7.8	7.7	Yes	4N110	10.8	7.9	Yes	4N154	10.9	7.7	Yes	4N198	9.9	7.4	Yes
4N23	9.2	7.7	Yes	4N67	8.3	7.7	Yes	4N111	10.6	7.9	Yes	4N155	10.7	7.7	Yes	4N199	9.6	7.4	Yes
4N24	9.3	7.7	Yes	4N68	8.7	7.7	Yes	4N112	10.4	7.9	Yes	4N156	10.6	7.7	Yes	4N200	9.5	7.4	Yes
4N25	9.3	7.9	Yes	4N69	9.0	7.7	Yes	4N113	10.1	7.9	Yes	4N157	10.6	7.7	Yes	4N201	9.3	7.4	Yes
4N26	9.2	7.9	Yes	4N70	9.5	7.7	Yes	4N114	10.1	7.9	Yes	4N158	10.3	7.7	Yes	4N202	9.2	7.4	Yes
4N27	9.1	7.9	Yes	4N71	9.9	7.7	Yes	4N115	10.2	7.9	Yes	4N159	9.9	7.7	Yes	4N203	9.3	7.4	Yes
4N28	9.0	7.9	Yes	4N72	10.2	7.7	Yes	4N116	10.2	7.9	Yes	4N160	9.7	7.7	Yes	4N204	9.4	7.4	Yes
4N29	9.0	7.9	Yes	4N73	10.9	7.7	Yes	4N117	10.3	7.9	Yes	4N161	9.7	7.7	Yes	4N205	9.2	7.4	Yes
4N30	9.0	7.9	Yes	4N74	11.6	7.7	Yes	4N118	9.9	7.9	Yes	4N162	9.8	7.7	Yes	4N206	9.0	7.4	Yes
4N31	8.9	7.9	Yes	4N75	11.8	7.7	Yes	4N119	9.6	7.9	Yes	4N163	9.8	7.7	Yes	4N207	8.9	7.4	Yes
4N32	8.8	7.9	Yes	4N76	11.9	7.7	Yes	4N120	9.6	7.9	Yes	4N164	9.5	7.7	Yes	4N208	8.8	7.4	Yes
4N33	8.7	7.9	Yes	4N77	11.7	7.7	Yes	4N121	9.6	7.9	Yes	4N165	9.5	7.7	Yes	4N209	8.9	7.4	Yes
4N34	8.7	7.9	Yes	4N78	11.6	7.7	Yes	4N122	9.7	7.9	Yes	4N166	9.7	7.7	Yes	4N210	8.9	7.4	Yes
4N35	8.7	7.9	Yes	4N79	11.7	7.7	Yes	4N123	9.8	7.9	Yes	4N167	9.6	7.7	Yes	4N211	8.7	7.4	Yes
4N36	8.8	7.9	Yes	4N80	11.4	7.7	Yes	4N124	9.9	7.9	Yes	4N168	9.8	7.7	Yes	4N212	8.5	7.4	Yes
4N37	9.0	7.9	Yes	4N81	10.9	7.7	Yes	4N125	9.7	7.9	Yes	4N169	10.3	7.7	Yes	4N213	8.3	7.4	Yes
4N38	9.0	7.9	Yes	4N82	10.5	7.7	Yes	4N126	9.4	7.9	Yes	4N170	10.7	7.7	Yes	4N214	8.4	7.4	Yes
4N39	8.9	7.9	Yes	4N83	10.2	7.7	Yes	4N127	9.2	7.9	Yes	4N171	10.9	7.7	Yes	4N215	8.6	7.4	Yes
4N40	8.8	7.9	Yes	4N84	10.1	7.7	Yes	4N128	9.1	7.9	Yes	4N172	10.8	7.7	Yes	4N216	8.9	7.4	Yes
4N41	8.7	7.9	Yes	4N85	10.0	7.7	Yes	4N129	9.4	7.9	Yes	4N173	10.5	7.4	Yes	4N217	9.4	7.4	Yes
4N42	8.6	7.9	Yes	4N86	9.8	7.7	Yes	4N130	9.7	7.9	Yes	4N174	10.7	7.4	Yes	4N218	9.4	7.4	Yes
4N43	8.6	7.9	Yes	4N87	9.6	7.4	Yes	4N131	9.7	7.9	Yes	4N175	11.0	7.4	Yes	4N219	9.5	7.4	Yes
4N44	8.7	7.9	Yes	4N88	9.5	7.4	Yes	4N132	9.6	7.9	Yes	4N176	11.2	7.4	Yes	4N220	9.5	7.4	Yes

TABLE 3
Sheetpiling Embedment in North Wall of Cell 4
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
4N221	9.5	7.4	Yes	4N265	10.8	7.2	Yes	4N309	12.0	7.3	Yes	4N353	8.4	7.7	Yes	4N397	8.0	7.2	Yes
4N222	9.6	7.4	Yes	4N266	10.6	7.2	Yes	4N310	11.4	7.3	Yes	4N354	8.6	7.7	Yes	4N398	8.3	7.2	Yes
4N223	9.6	7.4	Yes	4N267	10.4	7.2	Yes	4N311	10.9	7.3	Yes	4N355	8.7	7.7	Yes	4N399	8.5	7.2	Yes
4N224	9.9	7.4	Yes	4N268	10.1	7.2	Yes	4N312	10.7	7.3	Yes	4N356	8.5	7.7	Yes	4N400	8.7	7.2	Yes
4N225	10.0	7.4	Yes	4N269	10.2	7.2	Yes	4N313	10.6	7.3	Yes	4N357	8.6	7.7	Yes	4N401	8.5	7.2	Yes
4N226	10.0	7.4	Yes	4N270	10.1	7.2	Yes	4N314	10.6	7.3	Yes	4N358	8.8	7.7	Yes	4N402	8.6	7.2	Yes
4N227	9.8	7.4	Yes	4N271	10.2	7.2	Yes	4N315	10.4	7.3	Yes	4N359	9.0	7.7	Yes	4N403	9.1	7.2	Yes
4N228	9.7	7.4	Yes	4N272	10.8	7.2	Yes	4N316	9.9	7.3	Yes	4N360	8.8	7.7	Yes	4N404	9.5	7.2	Yes
4N229	10.1	7.7	Yes	4N273	11.4	7.4	Yes	4N317	9.6	7.3	Yes	4N361	8.6	7.7	Yes	4N405	10.0	7.2	Yes
4N230	10.2	7.2	Yes	4N274	11.9	7.4	Yes	4N318	9.4	7.3	Yes	4N362	8.6	7.7	Yes	4N406	10.3	7.2	Yes
4N231	10.3	7.2	Yes	4N275	12.4	7.4	Yes	4N319	9.5	7.3	Yes	4N363	8.9	7.7	Yes	4N407	10.4	7.2	Yes
4N232	10.8	7.2	Yes	4N276	12.6	7.4	Yes	4N320	9.5	7.3	Yes	4N364	9.3	7.7	Yes	4N408	10.7	7.2	Yes
4N233	11.2	7.2	Yes	4N277	12.5	7.4	Yes	4N321	9.3	7.3	Yes	4N365	9.6	7.7	Yes	4N409	11.0	7.1	Yes
4N234	11.7	7.2	Yes	4N278	12.8	7.4	Yes	4N322	9.4	7.3	Yes	4N366	9.8	7.6	Yes	4N410	10.8	7.1	Yes
4N235	11.9	7.2	Yes	4N279	13.1	7.4	Yes	4N323	9.2	7.7	Yes	4N367	10.2	7.6	Yes	4N411	10.7	7.1	Yes
4N236	11.9	7.2	Yes	4N280	13.3	7.4	Yes	4N324	9.1	7.7	Yes	4N368	10.6	7.4	Yes	4N412	11.0	7.1	Yes
4N237	12.0	7.2	Yes	4N281	13.6	7.4	Yes	4N325	9.1	7.7	Yes	4N369	10.8	7.4	Yes	4N413	11.1	7.1	Yes
4N238	12.0	7.2	Yes	4N282	13.8	7.4	Yes	4N326	9.0	7.7	Yes	4N370	10.8	7.4	Yes	4N414	11.1	7.1	Yes
4N239	11.9	7.2	Yes	4N283	13.4	7.4	Yes	4N327	9.2	7.7	Yes	4N371	11.2	7.4	Yes	4N415	11.0	7.1	Yes
4N240	11.9	7.2	Yes	4N284	12.9	7.4	Yes	4N328	9.4	7.7	Yes	4N372	11.6	7.4	Yes	4N416	11.4	7.1	Yes
4N241	12.1	7.2	Yes	4N285	12.5	7.4	Yes	4N329	9.4	7.7	Yes	4N373	11.9	7.4	Yes	4N417	12.0	7.1	Yes
4N242	12.3	7.2	Yes	4N286	12.0	7.4	Yes	4N330	9.4	7.6	Yes	4N374	11.7	7.4	Yes	4N418	12.5	7.1	Yes
4N243	12.2	7.2	Yes	4N287	11.8	7.4	Yes	4N331	9.7	7.6	Yes	4N375	11.5	7.4	Yes	4N419	12.9	7.1	Yes
4N244	12.1	7.2	Yes	4N288	11.7	7.4	Yes	4N332	9.9	7.6	Yes	4N376	11.4	7.4	Yes	4N420	13.3	7.1	Yes
4N245	12.0	7.2	Yes	4N289	11.0	7.4	Yes	4N333	10.0	7.6	Yes	4N377	11.2	7.4	Yes	4N421	14.1	7.1	Yes
4N246	11.8	7.2	Yes	4N290	10.7	7.4	Yes	4N334	9.7	7.6	Yes	4N378	11.3	7.4	Yes	4N422	14.7	7.1	Yes
4N247	11.8	7.2	Yes	4N291	10.4	7.4	Yes	4N335	9.2	7.6	Yes	4N379	11.4	7.4	Yes	4N423	14.8	7.1	Yes
4N248	12.0	7.2	Yes	4N292	10.3	7.4	Yes	4N336	9.2	7.6	Yes	4N380	11.0	7.3	Yes	4N424	15.2	7.0	Yes
4N249	12.3	7.2	Yes	4N293	10.4	7.4	Yes	4N337	9.2	7.6	Yes	4N381	10.8	7.3	Yes	4N425	15.6	7.0	Yes
4N250	12.7	7.2	Yes	4N294	10.3	7.4	Yes	4N338	9.1	7.6	Yes	4N382	10.5	7.3	Yes	4N426	16.0	7.0	Yes
4N251	13.1	7.2	Yes	4N295	10.4	7.4	Yes	4N339	9.0	7.6	Yes	4N383	10.2	7.3	Yes	4N427	15.5	7.0	Yes
4N252	13.3	7.2	Yes	4N296	10.8	7.4	Yes	4N340	8.9	7.6	Yes	4N384	10.2	7.3	Yes	4N428	15.1	7.0	Yes
4N253	13.5	7.2	Yes	4N297	11.2	7.4	Yes	4N341	8.9	7.8	Yes	4N385	10.1	7.3	Yes	4N429	14.7	7.0	Yes
4N254	13.7	7.2	Yes	4N298	11.9	7.4	Yes	4N342	8.6	7.8	Yes	4N386	9.7	7.3	Yes	4N430	14.2	7.0	Yes
4N255	13.8	7.2	Yes	4N299	12.5	7.4	Yes	4N343	8.4	7.8	Yes	4N387	9.2	7.3	Yes	4N431	13.8	7.0	Yes
4N256	14.0	7.2	Yes	4N300	13.0	7.4	Yes	4N344	8.3	7.8	Yes	4N388	8.8	7.3	Yes	4N432	13.1	7.0	Yes
4N257	14.3	7.2	Yes	4N301	13.2	7.4	Yes	4N345	8.7	7.8	Yes	4N389	8.2	7.3	Yes	4N433	12.5	7.0	Yes
4N258	14.3	7.2	Yes	4N302	13.2	7.4	Yes	4N346	8.9	7.8	Yes	4N390	8.0	7.3	Yes	4N434	12.3	7.0	Yes
4N259	14.1	7.2	Yes	4N303	13.1	7.4	Yes	4N347	8.8	7.8	Yes	4N391	8.3	7.3	Yes	4N435	11.9	7.0	Yes
4N260	13.6	7.2	Yes	4N304	13.1	7.4	Yes	4N348	8.6	7.8	Yes	4N392	8.2	7.3	Yes	4N436	10.9	7.0	Yes
4N261	12.9	7.2	Yes	4N305	13.3	7.4	Yes	4N349	8.5	7.8	Yes	4N393	8.2	7.3	Yes	4N437	10.0	7.0	Yes
4N262	12.3	7.2	Yes	4N306	13.4	7.4	Yes	4N350	8.5	7.8	Yes	4N394	8.1	7.3	Yes	4N438	10.0	7.0	Yes
4N263	11.9	7.2	Yes	4N307	13.2	7.4	Yes	4N351	8.3	7.8	Yes	4N395	7.8	7.2	Yes	4N439	10.0	7.0	Yes
4N264	11.3	7.2	Yes	4N308	12.7	7.3	Yes	4N352	8.2	7.7	Yes	4N396	7.7	7.2	Yes	4N440	10.0	7.0	Yes

TABLE 3
Sheetpiling Embedment in North Wall of Cell 4
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
4N441	10.0	7.0	Yes	4N485	13.0	7.2	Yes	4N529	9.5	7.4	Yes	4N573	9.4	7.4	Yes				
4N442	9.9	7.0	Yes	4N486	12.9	7.2	Yes	4N530	9.6	7.4	Yes	4N574	8.8	7.4	Yes				
4N443	10.1	7.0	Yes	4N487	12.8	7.2	Yes	4N531	9.5	7.4	Yes	4N575	8.1	7.4	Yes				
4N444	10.4	7.0	Yes	4N488	12.8	7.2	Yes	4N532	9.5	7.4	Yes	4N576	7.6	5.0	Yes				
4N445	10.4	7.0	Yes	4N489	12.7	7.2	Yes	4N533	9.5	7.4	Yes	4N577	7.0	4.0	Yes				
4N446	10.4	7.0	Yes	4N490	12.8	7.2	Yes	4N534	9.3	7.4	Yes	4N578	6.1	3.0	Yes				
4N447	10.8	7.0	Yes	4N491	12.8	7.2	Yes	4N535	9.7	7.4	Yes	4N579	4.5	2.0	Yes				
4N448	11.3	7.0	Yes	4N492	12.9	7.2	Yes	4N536	9.7	7.4	Yes	4N580	3.5	1.0	Yes				
4N449	11.2	7.0	Yes	4N493	12.8	7.2	Yes	4N537	9.9	7.4	Yes								
4N450	11.1	7.0	Yes	4N494	12.6	7.2	Yes	4N538	9.9	7.4	Yes								
4N451	11.0	7.0	Yes	4N495	12.4	7.0	Yes	4N539	9.7	7.4	Yes								
4N452	10.9	7.0	Yes	4N496	12.3	7.0	Yes	4N540	9.7	7.4	Yes								
4N453	10.9	7.0	Yes	4N497	12.2	7.0	Yes	4N541	9.4	7.4	Yes								
4N454	11.0	7.4	Yes	4N498	12.2	7.4	Yes	4N542	9.3	7.4	Yes								
4N455	10.9	7.4	Yes	4N499	12.2	7.4	Yes	4N543	9.2	7.4	Yes								
4N456	10.8	7.4	Yes	4N500	12.2	7.4	Yes	4N544	9.0	7.4	Yes								
4N457	10.7	7.4	Yes	4N501	12.1	7.4	Yes	4N545	8.9	7.4	Yes								
4N458	10.6	7.4	Yes	4N502	11.9	7.4	Yes	4N546	8.8	7.4	Yes								
4N459	10.5	7.4	Yes	4N503	11.7	7.4	Yes	4N547	9.0	7.4	Yes								
4N460	10.7	7.4	Yes	4N504	11.8	7.4	Yes	4N548	9.2	7.4	Yes								
4N461	11.0	7.4	Yes	4N505	11.9	7.4	Yes	4N549	9.4	7.4	Yes								
4N462	11.2	7.4	Yes	4N506	12.0	7.4	Yes	4N550	9.9	7.4	Yes								
4N463	11.4	7.4	Yes	4N507	12.2	7.4	Yes	4N551	10.2	7.4	Yes								
4N464	11.6	7.4	Yes	4N508	12.3	7.4	Yes	4N552	10.5	7.4	Yes								
4N465	11.8	7.2	Yes	4N509	12.3	7.4	Yes	4N553	10.5	7.4	Yes								
4N466	12.0	7.2	Yes	4N510	12.3	7.4	Yes	4N554	10.1	7.4	Yes								
4N467	12.1	7.2	Yes	4N511	12.3	7.4	Yes	4N555	9.7	7.4	Yes								
4N468	12.3	7.2	Yes	4N512	12.2	7.4	Yes	4N556	9.5	7.4	Yes								
4N469	12.5	7.2	Yes	4N513	12.3	7.4	Yes	4N557	9.2	7.4	Yes								
4N470	12.4	7.2	Yes	4N514	12.4	7.4	Yes	4N558	8.9	7.4	Yes								
4N471	12.1	7.2	Yes	4N515	12.3	7.4	Yes	4N559	8.5	7.4	Yes								
4N472	12.1	7.2	Yes	4N516	12.3	7.4	Yes	4N560	8.4	7.4	Yes								
4N473	12.1	7.2	Yes	4N517	12.3	7.4	Yes	4N561	8.2	7.4	Yes								
4N474	12.2	7.2	Yes	4N518	12.0	7.4	Yes	4N562	8.2	7.4	Yes								
4N475	12.2	7.2	Yes	4N519	11.6	7.4	Yes	4N563	8.2	7.4	Yes								
4N476	12.2	7.2	Yes	4N520	11.6	7.4	Yes	4N564	8.2	7.4	Yes								
4N477	12.3	7.2	Yes	4N521	11.6	7.4	Yes	4N565	8.6	7.4	Yes								
4N478	12.3	7.2	Yes	4N522	11.6	7.4	Yes	4N566	9.0	7.4	Yes								
4N479	12.3	7.2	Yes	4N523	11.7	7.4	Yes	4N567	9.2	7.4	Yes								
4N480	12.3	7.2	Yes	4N524	11.3	7.4	Yes	4N568	9.3	7.4	Yes								
4N481	12.7	7.2	Yes	4N525	10.9	7.4	Yes	4N569	9.5	7.4	Yes								
4N482	13.0	7.2	Yes	4N526	10.5	7.4	Yes	4N570	9.8	7.4	Yes								
4N483	13.0	7.2	Yes	4N527	10.0	7.4	Yes	4N571	10.0	7.4	Yes								
4N484	13.0	7.2	Yes	4N528	9.6	7.4	Yes	4N572	9.8	7.4	Yes								

TABLE 4
Sheetpiling Embedment in Southeast Wall of Cell 4
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
4SE1	10.5	1.0	Yes
4SE2	10.5	2.0	Yes
4SE3	10.5	3.0	Yes
4SE4	10.5	4.0	Yes
4SE5	10.5	5.0	Yes
4SE6	10.5	7.4	Yes
4SE7	10.5	5.0	Yes
4SE8	10.5	4.0	Yes
4SE9	10.5	3.0	Yes
4SE10	10.5	2.0	Yes
4SE11	10.5	1.0	Yes

TABLE 5
Sheetpiling Embedment in North Wall of Cell 1
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
1N1	7.0	1.0	Yes	1N45	9.4	7.9	Yes	1N89	12.1	7.4	Yes	1N133	9.6	7.2	Yes	1N177	8.6	7.4	Yes
1N2	8.2	2.0	Yes	1N46	9.0	7.9	Yes	1N90	12.0	7.4	Yes	1N134	9.7	7.2	Yes	1N178	8.5	7.4	Yes
1N3	7.8	3.0	Yes	1N47	9.1	7.9	Yes	1N91	11.9	7.4	Yes	1N135	9.8	7.2	Yes	1N179	8.7	7.4	Yes
1N4	7.7	4.0	Yes	1N48	9.3	7.9	Yes	1N92	11.8	7.4	Yes	1N136	9.8	7.2	Yes	1N180	8.8	7.4	Yes
1N5	8.1	5.0	Yes	1N49	9.4	7.4	Yes	1N93	11.7	7.4	Yes	1N137	9.5	7.2	Yes	1N181	8.9	7.4	Yes
1N6	8.4	7.9	Yes	1N50	9.7	7.4	Yes	1N94	11.8	7.4	Yes	1N138	9.1	7.4	Yes	1N182	9.3	7.4	Yes
1N7	8.7	7.9	Yes	1N51	10.0	7.4	Yes	1N95	12.0	7.4	Yes	1N139	9.0	7.4	Yes	1N183	9.3	7.4	Yes
1N8	8.8	7.9	Yes	1N52	10.3	7.4	Yes	1N96	11.9	7.4	Yes	1N140	9.1	7.4	Yes	1N184	9.0	7.4	Yes
1N9	8.4	7.9	Yes	1N53	10.6	7.4	Yes	1N97	11.8	7.4	Yes	1N141	9.3	7.4	Yes	1N185	9.0	7.4	Yes
1N10	8.1	7.9	Yes	1N54	10.8	7.4	Yes	1N98	11.6	7.4	Yes	1N142	9.3	7.4	Yes	1N186	9.1	7.4	Yes
1N11	8.0	7.9	Yes	1N55	11.1	7.4	Yes	1N99	11.3	7.4	Yes	1N143	9.3	7.4	Yes	1N187	8.8	7.4	Yes
1N12	7.9	7.9	Yes	1N56	11.9	7.4	Yes	1N100	11.3	7.4	Yes	1N144	9.4	7.4	Yes	1N188	8.4	7.4	Yes
1N13	7.8	7.9	No	1N57	12.7	7.4	Yes	1N101	11.1	7.4	Yes	1N145	8.8	7.4	Yes	1N189	8.5	7.4	Yes
1N14	7.5	7.9	No	1N58	13.1	7.4	Yes	1N102	10.8	7.4	Yes	1N146	8.4	7.4	Yes	1N190	8.3	7.4	Yes
1N15	7.5	7.9	No	1N59	13.3	7.4	Yes	1N103	11.0	7.4	Yes	1N147	8.0	7.4	Yes	1N191	8.3	7.4	Yes
1N16	7.6	7.9	No	1N60	13.3	7.4	Yes	1N104	11.2	7.4	Yes	1N148	8.0	7.4	Yes	1N192	8.2	7.4	Yes
1N17	7.5	7.9	No	1N61	13.4	7.4	Yes	1N105	10.7	7.4	Yes	1N149	7.9	7.4	Yes	1N193	8.2	7.4	Yes
1N18	7.4	7.9	No	1N62	13.3	7.4	Yes	1N106	10.3	7.4	Yes	1N150	7.5	7.4	Yes	1N194	8.4	7.4	Yes
1N19	7.3	7.9	No	1N63	13.3	7.4	Yes	1N107	10.3	7.4	Yes	1N151	7.4	7.4	Yes	1N195	8.6	7.4	Yes
1N20	7.7	7.9	No	1N64	13.3	7.4	Yes	1N108	10.2	7.4	Yes	1N152	7.2	7.4	No	1N196	8.6	7.4	Yes
1N21	8.2	7.7	Yes	1N65	13.2	7.4	Yes	1N109	10.1	7.4	Yes	1N153	6.7	7.4	No	1N197	8.6	7.4	Yes
1N22	8.6	7.7	Yes	1N66	13.1	7.4	Yes	1N110	10.0	7.4	Yes	1N154	6.2	7.4	No	1N198	9.2	7.4	Yes
1N23	8.6	7.7	Yes	1N67	13.2	7.4	Yes	1N111	10.2	7.4	Yes	1N155	6.0	7.4	No	1N199	9.8	7.4	Yes
1N24	8.6	7.7	Yes	1N68	13.2	7.4	Yes	1N112	10.6	7.2	Yes	1N156	6.3	7.4	No	1N200	10.0	7.4	Yes
1N25	8.9	7.7	Yes	1N69	13.0	7.4	Yes	1N113	10.8	7.2	Yes	1N157	6.6	7.4	No	1N201	10.2	7.4	Yes
1N26	8.8	7.7	Yes	1N70	13.1	7.4	Yes	1N114	10.7	7.2	Yes	1N158	6.8	7.4	No	1N202	10.3	7.4	Yes
1N27	8.8	7.7	Yes	1N71	12.9	7.4	Yes	1N115	10.6	7.2	Yes	1N159	7.1	7.4	No	1N203	10.4	7.4	Yes
1N28	8.9	7.7	Yes	1N72	12.9	7.4	Yes	1N116	11.1	7.2	Yes	1N160	7.5	7.4	Yes	1N204	10.5	7.4	Yes
1N29	8.5	7.7	Yes	1N73	13.0	7.4	Yes	1N117	11.6	7.2	Yes	1N161	7.6	7.4	Yes	1N205	10.6	7.4	Yes
1N30	8.2	7.7	Yes	1N74	13.1	7.4	Yes	1N118	11.6	7.2	Yes	1N162	7.5	7.4	Yes	1N206	10.7	7.4	Yes
1N31	8.4	7.9	Yes	1N75	12.7	7.4	Yes	1N119	11.5	7.2	Yes	1N163	7.6	7.4	Yes	1N207	10.8	7.4	Yes
1N32	8.4	7.9	Yes	1N76	12.3	7.4	Yes	1N120	11.6	7.2	Yes	1N164	7.8	7.4	Yes	1N208	10.7	7.4	Yes
1N33	8.3	7.9	Yes	1N77	12.2	7.4	Yes	1N121	11.1	7.2	Yes	1N165	8.0	7.4	Yes	1N209	10.7	7.4	Yes
1N34	8.5	7.9	Yes	1N78	11.8	7.4	Yes	1N122	10.2	7.2	Yes	1N166	7.9	7.4	Yes	1N210	10.6	7.4	Yes
1N35	8.8	7.9	Yes	1N79	11.7	7.4	Yes	1N123	9.8	7.2	Yes	1N167	7.9	7.4	Yes	1N211	10.5	7.4	Yes
1N36	8.8	7.9	Yes	1N80	11.6	7.4	Yes	1N124	9.6	7.2	Yes	1N168	7.9	7.4	Yes	1N212	10.5	7.4	Yes
1N37	8.8	7.9	Yes	1N81	11.5	7.4	Yes	1N125	9.4	7.2	Yes	1N169	7.9	7.4	Yes	1N213	10.5	7.4	Yes
1N38	8.8	7.9	Yes	1N82	11.6	7.4	Yes	1N126	9.2	7.2	Yes	1N170	7.9	7.4	Yes	1N214	10.4	7.4	Yes
1N39	8.7	7.9	Yes	1N83	11.4	7.4	Yes	1N127	9.1	7.2	Yes	1N171	7.7	7.4	Yes	1N215	10.2	7.4	Yes
1N40	9.0	7.9	Yes	1N84	11.0	7.4	Yes	1N128	9.0	7.2	Yes	1N172	7.7	7.4	Yes	1N216	10.1	7.4	Yes
1N41	9.5	7.9	Yes	1N85	10.9	7.4	Yes	1N129	8.8	7.2	Yes	1N173	8.1	7.4	Yes	1N217	10.0	7.4	Yes
1N42	9.4	7.9	Yes	1N86	11.3	7.4	Yes	1N130	8.6	7.2	Yes	1N174	8.3	7.4	Yes	1N218	9.9	7.4	Yes
1N43	9.5	7.9	Yes	1N87	11.8	7.4	Yes	1N131	8.5	7.2	Yes	1N175	8.3	7.4	Yes	1N219	9.8	7.4	Yes
1N44	9.7	7.9	Yes	1N88	12.1	7.4	Yes	1N132	9.0	7.2	Yes	1N176	8.5	7.4	Yes	1N220	9.7	7.4	Yes

TABLE 6
Sheetpiling Embedment in North Wall of Cell 2
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
2N1	9.7	7.4	Yes	2N45	13.2	7.9	Yes	2N89	12.7	7.9	Yes	2N133	15.8	7.4	Yes
2N2	9.7	7.4	Yes	2N46	12.5	7.9	Yes	2N90	12.6	7.9	Yes	2N134	15.8	7.4	Yes
2N3	9.6	7.4	Yes	2N47	12.2	7.9	Yes	2N91	12.6	7.9	Yes	2N135	15.8	7.4	Yes
2N4	9.5	7.4	Yes	2N48	11.9	7.9	Yes	2N92	12.4	7.9	Yes	2N136	15.9	7.4	Yes
2N5	9.4	7.4	Yes	2N49	11.8	7.9	Yes	2N93	12.4	7.9	Yes	2N137	15.5	7.4	Yes
2N6	9.3	7.4	Yes	2N50	11.6	7.9	Yes	2N94	12.3	7.9	Yes	2N138	15.1	7.4	Yes
2N7	9.3	7.4	Yes	2N51	11.5	7.9	Yes	2N95	12.3	7.9	Yes	2N139	14.5	7.4	Yes
2N8	9.3	7.4	Yes	2N52	11.4	7.9	Yes	2N96	12.5	7.9	Yes	2N140	13.9	7.4	Yes
2N9	9.3	7.9	Yes	2N53	11.2	7.9	Yes	2N97	12.7	7.9	Yes	2N141	13.8	7.4	Yes
2N10	9.4	7.9	Yes	2N54	11.0	7.9	Yes	2N98	13.2	7.9	Yes	2N142	13.8	7.4	Yes
2N11	9.4	7.9	Yes	2N55	10.6	7.9	Yes	2N99	13.7	7.9	Yes				
2N12	9.3	7.9	Yes	2N56	10.8	7.9	Yes	2N100	13.9	7.9	Yes				
2N13	9.3	7.9	Yes	2N57	11.4	7.9	Yes	2N101	14.0	7.9	Yes				
2N14	9.3	7.9	Yes	2N58	11.7	7.9	Yes	2N102	13.9	7.9	Yes				
2N15	9.4	7.9	Yes	2N59	11.7	7.9	Yes	2N103	13.6	7.9	Yes				
2N16	9.5	7.9	Yes	2N60	11.5	7.9	Yes	2N104	13.2	7.9	Yes				
2N17	9.4	7.9	Yes	2N61	11.0	7.9	Yes	2N105	12.6	7.9	Yes				
2N18	9.2	7.9	Yes	2N62	10.5	7.9	Yes	2N106	11.9	7.9	Yes				
2N19	9.3	7.9	Yes	2N63	10.2	7.9	Yes	2N107	11.5	7.9	Yes				
2N20	9.3	7.9	Yes	2N64	9.9	7.9	Yes	2N108	11.1	7.9	Yes				
2N21	9.3	7.9	Yes	2N65	9.8	7.9	Yes	2N109	11.1	7.9	Yes				
2N22	9.3	7.9	Yes	2N66	9.9	7.9	Yes	2N110	11.3	7.9	Yes				
2N23	9.4	7.9	Yes	2N67	9.8	7.9	Yes	2N111	11.2	7.7	Yes				
2N24	9.9	7.9	Yes	2N68	9.3	7.9	Yes	2N112	11.2	7.7	Yes				
2N25	10.3	7.9	Yes	2N69	9.0	7.9	Yes	2N113	11.0	7.7	Yes				
2N26	10.8	7.9	Yes	2N70	8.9	8.2	Yes	2N114	11.0	7.7	Yes				
2N27	11.0	7.9	Yes	2N71	9.0	8.2	Yes	2N115	11.2	7.7	Yes				
2N28	11.5	7.9	Yes	2N72	9.3	8.2	Yes	2N116	11.7	7.7	Yes				
2N29	12.0	7.9	Yes	2N73	9.7	8.2	Yes	2N117	12.1	7.7	Yes				
2N30	12.2	7.9	Yes	2N74	9.9	8.2	Yes	2N118	12.3	7.7	Yes				
2N31	12.4	7.9	Yes	2N75	10.1	8.2	Yes	2N119	12.8	7.7	Yes				
2N32	12.7	7.9	Yes	2N76	10.1	8.2	Yes	2N120	12.8	7.7	Yes				
2N33	12.8	7.9	Yes	2N77	10.5	8.2	Yes	2N121	12.5	7.7	Yes				
2N34	12.9	7.9	Yes	2N78	11.1	8.2	Yes	2N122	12.5	7.7	Yes				
2N35	12.8	7.9	Yes	2N79	11.5	8.2	Yes	2N123	12.7	7.7	Yes				
2N36	12.7	7.9	Yes	2N80	11.8	8.2	Yes	2N124	13.2	7.7	Yes				
2N37	12.6	7.9	Yes	2N81	12.3	8.2	Yes	2N125	13.7	7.7	Yes				
2N38	12.6	7.9	Yes	2N82	12.7	8.2	Yes	2N126	14.1	7.7	Yes				
2N39	12.8	7.9	Yes	2N83	13.0	8.2	Yes	2N127	14.5	7.7	Yes				
2N40	13.0	7.9	Yes	2N84	13.3	8.2	Yes	2N128	14.8	7.7	Yes				
2N41	13.2	7.9	Yes	2N85	13.5	8.2	Yes	2N129	15.1	7.7	Yes				
2N42	13.3	7.9	Yes	2N86	13.6	8.2	Yes	2N130	15.1	7.7	Yes				
2N43	13.4	7.9	Yes	2N87	13.4	8.2	Yes	2N131	15.1	7.4	Yes				
2N44	13.6	7.9	Yes	2N88	13.0	7.9	Yes	2N132	15.4	7.4	Yes				

TABLE 7
Sheetpiling Embedment in North Wall of Cell 3
Velsicol Chemical Site

Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?	Sheet Designation	Installed Embedment Depth	Required Embedment Depth	Embedment Criteria Met?
3N1	13.8	7.4	Yes	3N45	12.9	7.2	Yes	3N89	15.3	7.0	Yes	3N133	12.8	7.7	Yes	3N177	9.8	8.4	Yes
3N2	13.8	7.4	Yes	3N46	12.9	7.2	Yes	3N90	15.0	7.0	Yes	3N134	12.4	7.7	Yes	3N178	9.7	8.4	Yes
3N3	13.8	7.4	Yes	3N47	13.0	7.2	Yes	3N91	14.7	7.0	Yes	3N135	12.0	7.9	Yes	3N179	9.4	8.4	Yes
3N4	13.9	7.4	Yes	3N48	13.3	7.2	Yes	3N92	14.5	7.0	Yes	3N136	12.1	7.9	Yes	3N180	9.3	8.4	Yes
3N5	13.6	7.4	Yes	3N49	12.7	7.0	Yes	3N93	14.2	7.0	Yes	3N137	12.2	7.7	Yes	3N181	9.4	8.4	Yes
3N6	13.7	7.4	Yes	3N50	12.8	7.0	Yes	3N94	13.7	7.0	Yes	3N138	12.1	7.7	Yes	3N182	9.6	8.4	Yes
3N7	14.2	7.4	Yes	3N51	13.2	7.0	Yes	3N95	13.2	7.0	Yes	3N139	12.4	7.7	Yes	3N183	9.9	8.4	Yes
3N8	14.8	7.4	Yes	3N52	13.0	7.0	Yes	3N96	12.7	7.0	Yes	3N140	12.8	7.7	Yes	3N184	10.2	8.4	Yes
3N9	15.5	7.0	Yes	3N53	13.2	7.0	Yes	3N97	12.6	7.0	Yes	3N141	12.8	7.7	Yes	3N185	10.4	8.4	Yes
3N10	15.7	7.0	Yes	3N54	13.4	7.0	Yes	3N98	12.8	7.0	Yes	3N142	12.4	7.7	Yes	3N186	10.5	8.4	Yes
3N11	15.5	7.0	Yes	3N55	13.7	7.0	Yes	3N99	12.8	7.0	Yes	3N143	11.9	7.7	Yes	3N187	11.0	8.4	Yes
3N12	15.2	7.0	Yes	3N56	13.7	7.0	Yes	3N100	12.6	7.0	Yes	3N144	11.9	7.7	Yes	3N188	10.9	8.4	Yes
3N13	15.2	7.0	Yes	3N57	13.7	7.0	Yes	3N101	12.3	7.0	Yes	3N145	12.2	7.9	Yes	3N189	10.8	8.4	Yes
3N14	15.1	7.0	Yes	3N58	13.7	7.0	Yes	3N102	12.3	7.0	Yes	3N146	12.0	7.9	Yes	3N190	11.1	8.4	Yes
3N15	14.5	7.0	Yes	3N59	13.6	7.0	Yes	3N103	12.3	7.0	Yes	3N147	11.4	7.9	Yes	3N191	11.2	8.4	Yes
3N16	14.2	7.4	Yes	3N60	14.3	7.0	Yes	3N104	12.3	7.0	Yes	3N148	11.4	7.9	Yes	3N192	11.4	8.4	Yes
3N17	14.2	7.4	Yes	3N61	15.1	7.0	Yes	3N105	12.4	7.0	Yes	3N149	11.2	7.9	Yes	3N193	11.4	8.4	Yes
3N18	13.8	7.4	Yes	3N62	15.6	7.0	Yes	3N106	12.2	7.0	Yes	3N150	10.5	7.9	Yes	3N194	11.2	8.4	Yes
3N19	12.9	7.4	Yes	3N63	16.1	7.0	Yes	3N107	12.1	7.0	Yes	3N151	9.7	7.9	Yes	3N195	11.0	8.4	Yes
3N20	12.0	7.4	Yes	3N64	16.2	7.0	Yes	3N108	12.2	7.0	Yes	3N152	8.9	7.9	Yes	3N196	10.5	8.4	Yes
3N21	11.5	7.4	Yes	3N65	16.4	7.0	Yes	3N109	12.1	7.4	Yes	3N153	8.6	7.9	Yes	3N197	10.0	8.4	Yes
3N22	11.4	7.4	Yes	3N66	16.4	7.0	Yes	3N110	12.1	7.4	Yes	3N154	8.7	7.9	Yes	3N198	9.3	8.4	Yes
3N23	11.5	7.4	Yes	3N67	16.4	7.0	Yes	3N111	12.4	7.4	Yes	3N155	8.6	8.2	Yes	3N199	8.9	8.4	Yes
3N24	11.5	7.4	Yes	3N68	16.4	7.0	Yes	3N112	12.5	7.4	Yes	3N156	8.2	8.2	Yes	3N200	9.0	8.4	Yes
3N25	11.3	7.4	Yes	3N69	16.4	7.0	Yes	3N113	12.4	7.4	Yes	3N157	8.2	8.2	Yes	3N201	8.8	8.4	Yes
3N26	11.7	7.4	Yes	3N70	16.5	7.0	Yes	3N114	12.2	7.4	Yes	3N158	8.5	8.2	Yes	3N202	8.5	8.4	Yes
3N27	12.2	7.4	Yes	3N71	16.7	7.0	Yes	3N115	12.2	7.7	Yes	3N159	8.3	8.2	Yes	3N203	7.6	8.4	No
3N28	12.4	7.4	Yes	3N72	16.7	7.0	Yes	3N116	12.2	7.7	Yes	3N160	8.4	8.2	Yes	3N204	7.4	8.4	No
3N29	12.7	7.2	Yes	3N73	16.7	7.0	Yes	3N117	12.6	7.7	Yes	3N161	8.9	8.2	Yes	3N205	6.4	8.2	No
3N30	13.6	7.2	Yes	3N74	16.7	7.0	Yes	3N118	13.0	7.7	Yes	3N162	9.4	8.2	Yes	3N206	5.5	8.2	No
3N31	14.0	7.2	Yes	3N75	16.7	7.0	Yes	3N119	13.3	7.7	Yes	3N163	9.9	8.2	Yes	3N207	4.9	8.2	No
3N32	14.0	7.2	Yes	3N76	16.7	7.0	Yes	3N120	13.3	7.7	Yes	3N164	10.3	8.2	Yes	3N208	4.3	7.7	No
3N33	14.5	7.2	Yes	3N77	16.7	7.0	Yes	3N121	13.4	7.7	Yes	3N165	10.1	8.4	Yes	3N209	4.0	7.2	No
3N34	14.6	7.2	Yes	3N78	16.7	7.0	Yes	3N122	13.1	7.7	Yes	3N166	9.9	8.4	Yes	3N210	4.0	6.7	No
3N35	14.7	7.2	Yes	3N79	16.7	7.0	Yes	3N123	13.1	7.4	Yes	3N167	10.1	8.4	Yes	3N211	3.7	6.0	No
3N36	14.9	7.2	Yes	3N80	16.7	7.0	Yes	3N124	13.1	7.4	Yes	3N168	10.5	8.4	Yes	3N212	3.6	5.1	No
3N37	14.8	7.2	Yes	3N81	16.7	7.0	Yes	3N125	13.3	7.7	Yes	3N169	10.5	8.4	Yes	3N213	3.2	5.0	No
3N38	14.7	7.2	Yes	3N82	16.7	7.0	Yes	3N126	13.3	7.7	Yes	3N170	10.4	8.4	Yes	3N214	2.6	4.0	No
3N39	14.0	7.2	Yes	3N83	16.7	7.0	Yes	3N127	13.4	7.7	Yes	3N171	10.3	8.4	Yes	3N215	3.6	3.0	Yes
3N40	13.2	7.2	Yes	3N84	16.7	7.0	Yes	3N128	13.1	7.7	Yes	3N172	10.2	8.4	Yes	3N216	6.0	2.0	Yes
3N41	12.9	7.2	Yes	3N85	16.7	7.0	Yes	3N129	12.6	7.7	Yes	3N173	10.1	8.4	Yes	3N217	8.0	1.0	Yes
3N42	13.0	7.2	Yes	3N86	16.2	7.0	Yes	3N130	12.5	7.7	Yes	3N174	10.0	8.4	Yes				
3N43	13.1	7.2	Yes	3N87	15.8	7.0	Yes	3N131	12.5	7.7	Yes	3N175	10.0	8.4	Yes				
3N44	12.8	7.2	Yes	3N88	15.5	7.0	Yes	3N132	12.7	7.7	Yes	3N176	9.8	8.4	Yes				

TABLE 8
Sheetpiling Embedment Depth Shortfall Areas
Velsicol Chemical Site

Sheetpile Range	Number of Sheets	Horizontal Length (feet)	Maximum Allowable Freeboard (feet)
4NW63 to 4NW76	14	21	11
4N6 to 4N14	9	13.5	14.5
4N59 to 4N65	7	10.5	14
1N13 to 1N20	8	12	14.5
1N152 to 1N159	8	12	12
3N203 to 3N214	12	18	9

Attachment A
Technical Memorandum dated January 20, 2000
Velsicol—Sheet Pile Options

Velsicol – Sheet Pile Options

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DATE: January 20, 2000

Introduction

River bottom sediments at the bottom of the Pine River adjacent to the Velsicol Superfund Site are currently being remediated. The remedial action selected entails dividing the river into separate cells with a cantilever sheetpile wall, dewatering the cells, and excavating contaminated sediments from the base of those cells. Approximately 1,700 of 1,900 lineal feet of sheet piling have been installed.

During installation of the sheetpile wall, the subcontractor encountered difficult driving conditions and stated that he was unable to install the sheetpile to the design elevations. The original specification required driving the sheetpile to 20 feet below the proposed dredge line.

The subcontractor was able to achieve up to 14 feet of total penetration (through the sediment and an average of 4.3 feet into the underlying glacial till) using an International Construction Equipment (ICE) Model 44-30 vibratory hammer. Approximately one-half of the sheetpiles were driven an additional 55 inches (4.6 feet) into the glacial till using an ICE Model 42-S diesel impact hammer. Weather conditions forced operations to cease for the winter before the remaining sheetpiles could driven either with the vibratory or impact hammer. The 55-inch driving target was a value identified by the subcontractor as what he would be able to achieve. The contractor's current plan is to return to the site in the spring and complete sheetpile driving.

Because embedment depths are less than required, a stability analysis was conducted by CH2M HILL's geotechnical engineers to determine the minimum acceptable embedment depth that was required to meet sheetpile stability requirements. Results of these analyses determined that sheetpile penetration was inadequate from the standpoint of stability for a significant portion of the wall. Three options to address the embedment shortfall were developed:

- Additional driving to attain the required depth
- Construction of a soil berm adjacent to the toe of the wall as excavation progresses
- Installation of soldier pile reinforcement

Each of these options is discussed in this technical memorandum. Preliminary cost estimates are also given for each option. This technical memorandum concludes with a summary of the recommended approach for addressing the shortfall in sheetpile embedment.

Background

Subsurface Conditions

Ten soil borings were drilled into the river bottom near the middle of the channel to characterize the stratigraphy of the river bottom sediments. These borings identified 7 to 12 feet of sediment (loose, poorly graded sand, N = 0 to 3 blows per foot) underlain by glacial till (hard sandy silt or silty clay, N>50 blows per foot). Based on blow counts recorded during Standard Penetration Tests (SPT), the river bottom soil units were assigned the following values for use during redesign/evaluation of the sheetpile system:

Sediment

- Unit weight = 120 pcf
- Undrained shear strength (cohesion)= 0 psf
- Friction angle = 25 degrees

Till

- Unit weight = 135 pcf
- Undrained shear strength (cohesion) = 10,000 to 20,000 psf
- Friction angle = 0 degrees

The glacial till is heavily overconsolidated with estimated undrained shear strengths from 10,000 to 20,000 psf (10 to 20 ksf). This estimate is based on judgment and experience with other soils. Laboratory strength tests have not been conducted on soil samples obtained at the site because of the inability to obtain undisturbed soil samples for laboratory testing. The strengths are also such that empirical relationships between SPT N-values and soil strength have questionable validity (i.e., they exceed the range of most published correlations).

Field vane shear tests were attempted at the site in an effort to measure the shear strength of the soil in place. These tests were generally unsuccessful. In all but one attempt the vane could not be pushed into the till. In the one case where the vane was pushed into the till, the torque to twist the vane exceeded the range for acceptable measurements. The acceptable range is normally limited to soil strengths less than 2,000 to 3,000 psf.

The following additional information was obtained before or during the boring program:

- The water depth was generally about 5 feet
- Sediment thickness ranged from 7 to 12 feet
- PID readings indicated that, in some areas, all sediment may require removal (to the top of till).

Sheet Pile Stability Analyses

Using the subsurface information, required sheetpile penetration depths (below dredge line) were developed for the range of excavation depths. The maximum required freeboard of the sheetpile wall was 16feet (5 feet of water plus 11 feet of sediment). The minimum anticipated freeboard along the wall was about 14 feet (5 feet of water plus 9 feet of sediment). "Freeboard," as used in this memorandum, refers to the exposed wall above the dredge line required to hold back the river water and sediment.

On the basis of these loading conditions, required penetration depths below dredge line were re-evaluated. During the re-evaluation, it was assumed that the top 2 feet of till, in front of the sheetpile,

would lose its cohesive properties due to excavation/equipment disturbance. This 2-foot unit was reassigned the following design parameters:

- Unit weight = 135 pcf
- Undrained shear strength (cohesion)= 0 psf
- Friction angle = 30 degrees

The sheetpile stability analysis determined that the following penetration depths would be required to meet stability requirements with an adequate factor of safety:

Freeboard	Penetration below Dredge Line
14 feet	85 inches
15 feet	90 inches
16 feet	96 inches

On the basis of these values, it was determined that the existing toe depths are inadequate for about 70 percent of the total length of wall. Embedment shortfall are summarized below:

- Adequate Penetration (no shortfall) 30 percent
- Embedment Shortfall Less than 24 inches 40 percent
- Embedment Shortfall Greater than 24 inches 30 percent

Driving Analysis

A drivability analysis was undertaken to examine the potential of driving the sheetpiles deeper with the same pile hammer or with a different (larger) hammer. The drivability studies were conducted using the computer program GRLWEAP, Version 1998-2 (PDI, 1998). A brief background discussion and summary of the results are provided in this section. A detailed discussion of the drivability analysis, including input parameters and detailed results, is provided in Appendix A.

Background

The sheetpiles installed at the Velsicol site are Bethlehem Steel model PZ-27 sheet piles as manufactured by Nucor-Yamato. The contractor installed the sheetpiles in pairs using both a vibratory hammer and a diesel impact hammer. During the initial pass, an ICE 44-30 vibratory hammer was used to install the sheetpiles through the loose sediment and into the till as far as possible. A structural steel template was used to position the sheetpiles during driving. After the sheetpiles were driven to refusal with the vibratory hammer, an ICE 42-S diesel impact hammer was used to drive the sheetpiles deeper. The impact driving program employed a hanging-lead system and included no template at the top of the sheetpiles.

Methodology

As an initial step in the drivability analyses, a back analysis was performed using data collected during the sheetpile driving program for the PZ-27 sheet piles. The back analysis provided an estimate of the resistance of the glacial till during sheetpile driving. This resistance was used to estimate the undrained shear strength of the till, which was then used in subsequent drivability studies to evaluate the drivability of the sheetpiles using different hammers. The fundamental question to be answered by the drivability analyses was whether the sheetpiles could be driven deeper - either with the ICE 42-S hammer or with a larger hammer. This question was addressed by estimating the blow counts (per inch, bpi) at the required embedment depth and the maximum stresses imposed in the sheetpile during each hammer blow. Generally, the maximum blow count during sheetpile installation should be less than 10 bpi, based on recommendations given by FHWA (1996) and other

similar organizations. The maximum compressive stress during a blow should be limited to 90 percent of the yield stress of the steel, which is 45 ksi for a Grade 50 steel section.

Results

The sheetpile drivability results indicate that the contractor's ICE 42-S hammer should be capable of driving the sheetpiles to a depth of 11 to 13 feet below the top of the till before exceeding a blow count of 10 bpi. Results of the analyses also indicate that for driving at 10 bpi, compressive stresses for the existing hammer are less than 90 percent of yield and therefore are satisfactory. A drivability analysis was also completed for the same sheetpile and soil conditions, but using an ICE 80-S hammer. This hammer delivers approximately twice the energy per hammer blow. The blow count at the required embedment depth was approximately 4 bpi, which is well within the normal range for driving. However, compressive stresses in the pile exceeded the 45 ksi allowable stress level, suggesting that the pile could be damaged during driving.

The drivability analyses were then repeated using a Delmag 30-02 hammer. The energy from this hammer, 66 ft-kip, is approximately midway between the energy delivered by the ICE 42-S and the ICE 80-S hammers. Results of these analyses suggest that the sheetpiles can be installed to depths of 11 to 14 feet into the till, for upper bound estimates of undrained shear strength. Compressive stresses per blow range from 40 to 47 ksi. The high-end of the range is slightly greater than the allowable value of 45 ksi, but may be acceptable given the temporary nature of the installation and the upper-bound undrained soil shear used in the analyses.

Drivability Conclusions

The following preliminary conclusions for sheetpile driving are made.

1. The maximum embedment depth that can be reached using the ICE 42-S hammer should be greater than those obtained by the contractor. The termination criterion used by the contractor during driving appears to be less than the commonly applied limit of 10 bpi.

2. The damage and limited penetration depth achieved by the contractor may have been related to the fixity of the sheetpiles and driving system. The combination of the hanging-lead setup and unsupported length of the sheetpile could be allowing for lateral movement during each blow, which reduces the efficiency of driving and increases the likelihood of damage to the sheetpile. Also, helmet fit and hammer cushion can contribute to driving system problems.

3. It appears that a Delmag 30-02 hammer, having a rated energy of 66 ft-kip, can drive the sheetpiles to a greater depth than already achieved. This hammer delivers approximately 50 percent more energy that the ICE 42-S hammer used by the contractor. For sheetpile driving, a fixed-lead system should be used with the impact hammer to minimize the possibility of energy loss and pile damage during the installation.

Several pile failures were observed while using the ICE 42-S impact hammer to drive the sheetpiles to their current depths. As discussed above the GRLWEAP analysis predicts that pile yield strengths should not have been exceeded. This suggests that these failures are more likely associated with the installation methods (i.e., use of hanging leads, loose templates, inappropriate cushions, inappropriate helmets, etc.) than the hammer energy.

The conclusions given above involve a considerable degree of uncertainty, not uncommon with any drivability analyses. Actual drivability is determined by the resistance provided by the soils and the details and function of the contractor's driving system. Small changes in any of these factors could significantly affect the ability of the contractor to drive the sheetpiles. This uncertainty is particularly the case at sites comprised of glacial till. These soils can be almost concrete like in consistency at

some locations. However, depending on the consistency of the soil and the amount of natural weathering, significantly lower resistance can occur locally. For these reasons, the results of the driving analyses should be considered as indicators of expected behavior rather than unequivocal behavior.

Berm Analysis

An analysis of the use of an incremental soil berm to resist toe and overturning failure of the sheetpile wall was performed. Assumptions and results are provided in this section. Detailed calculations are provided in Appendix B.

Methodology

Field implementation of this alternative would generally be as follows:

- A cell would be dewatered
- Sediment within 15 feet of the sheetpile wall would be excavated incrementally such that no more than 10 feet of the wall was exposed at a given time
- The area incrementally excavated would be backfilled with a well-graded granular soil
- Excavation could then progress to the next 10-foot segment of wall

This alternative, if considered, would be implemented on the opposite side of the wall during Phase 2 of the Remedial Action.

Iterative analyses were performed to determine berm heights required to stabilize the cantilever wall for the range of embedment depths achieved in the field. To demonstrate equilibrium, sums of both forces and moments about the wall were confirmed to equal zero (0).

Results

The required height of the berm above the dredge line is a function of the embedment shortfall. For example, if the embedment shortfall for a wall section was 2 feet, a 5-foot high berm would be required. The width of the berm would be a minimum of 15 feet at the crest, or wider as required to facilitate equipment movement. Figure 1 shows the berm height which would be required to make up an embedment shortfall for a given length of wall.

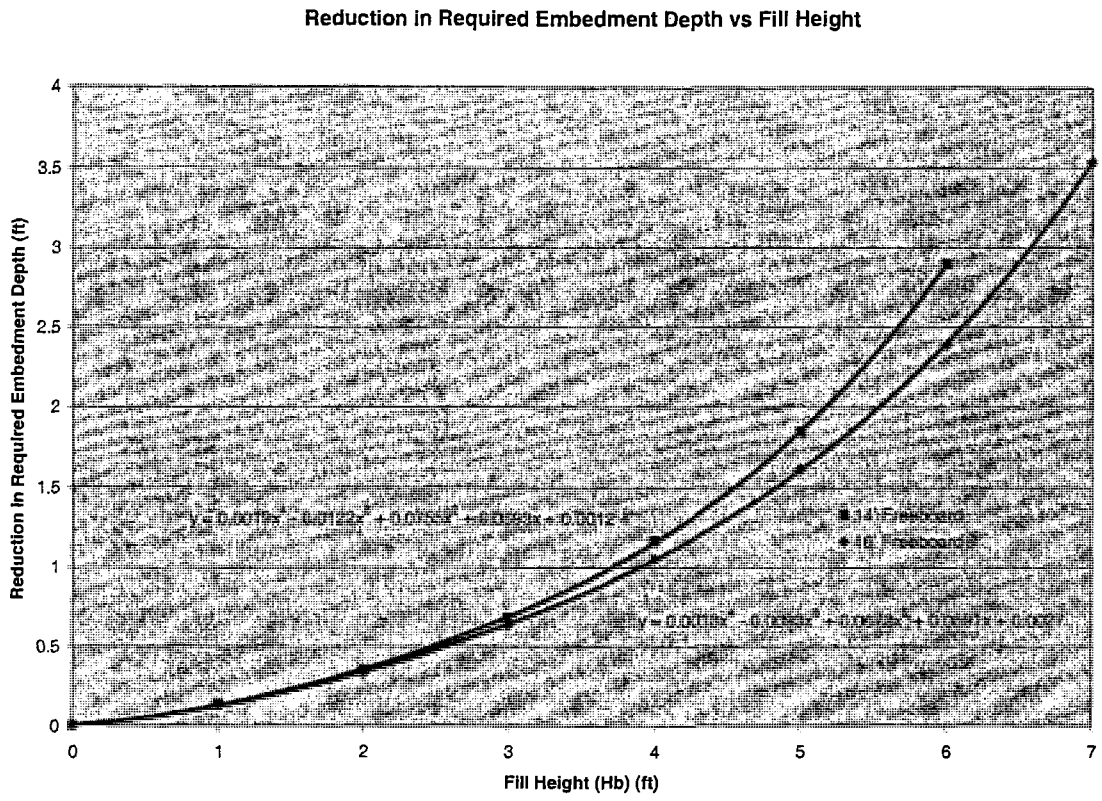

FIGURE 1 – Reduction in Required Embedment vs. Fill Height

Soldier Pile Analysis

A soldier pile reinforcement system to brace the sheetpile wall and allow for a reduced sheet pile embedment depth was also evaluated. The soldier pile system was assumed to be fixed to the sheetpile near the top of the wall using a waler. The combination of waler and soldier pile bracing provided sufficient reaction to provide global stability. Since the soldier pile and associated waler would be welded or bolted to the sheetpile, the soldier piles would function during dewatering/excavation activities on either side of the wall (i.e., installation would only be required on one side of the wall). Assumptions and results are provided in this section. Detailed calculations are provided in Appendix C.

Methodology

1. Iterative analyses were performed to determine bracing forces necessary to stabilize the cantilever wall for the minimum embedment depth of 55 inches (the minimum depth which the contractor believes can be achieved at all locations). To demonstrate equilibrium, sums of both forces and moments about the wall were confirmed to equal zero (0).

2. Bracing forces determined in Step 1 were used to determine the embedment depth and structural properties of the soldier piles.

3. Soldier pile spacing was iteratively analyzed to determine the bracing forces per pile.

4. The soldier piles were treated as free cantilever elements. The unsupported length of the cantilever pile was conservatively lengthened to that below the dredge line to avoid double-counting forces acting on the sheetpile wall.
5. Embedment depths and loading conditions (i.e., maximum moment) were determined, and the pile was sized.

A drivability analysis was subsequently conducted for the H-piles using GRLWEAP. The purpose of this analysis was to determine if the H-pile could be installed with the same hammer as used for the sheetpile installation.

Results

Results for the structural analysis are summarized in Table 1. A typical section is shown in Figure 2.

TABLE 1: SOLDIER PILE SYSTEM SUMMARY

Freeboard	Soldier Pile Size	Total Length of Pile (below water surface)	Spacing (c-c)	Waler Size
< or = 14 feet	HP 14x117 Grade 50	30 feet	12 feet	W14x26
>14 feet	HP 14x117 Grade 50	30 feet	8 feet	W14x26

The soldier pile drivability analysis indicated that the required H-pile section (HP14x117 or larger) can most likely be driven to the required embedment depth using the ICE 42-S hammer. A Delmag hammer can also drive the HP14x117, although the compressive stresses may be close to the recommended limit of 32 ksi (for a Grade 36 steel section). However, as Table 1 shows, the cantilever analysis indicates that Grade 50 steel would be required for the HP14x117 soldier piles. Provided this grade of steel is used, driving stresses should not exceed the allowable yield capacity for the piles. Appendix A contains a more detailed discussion of the drivability analyses and results.

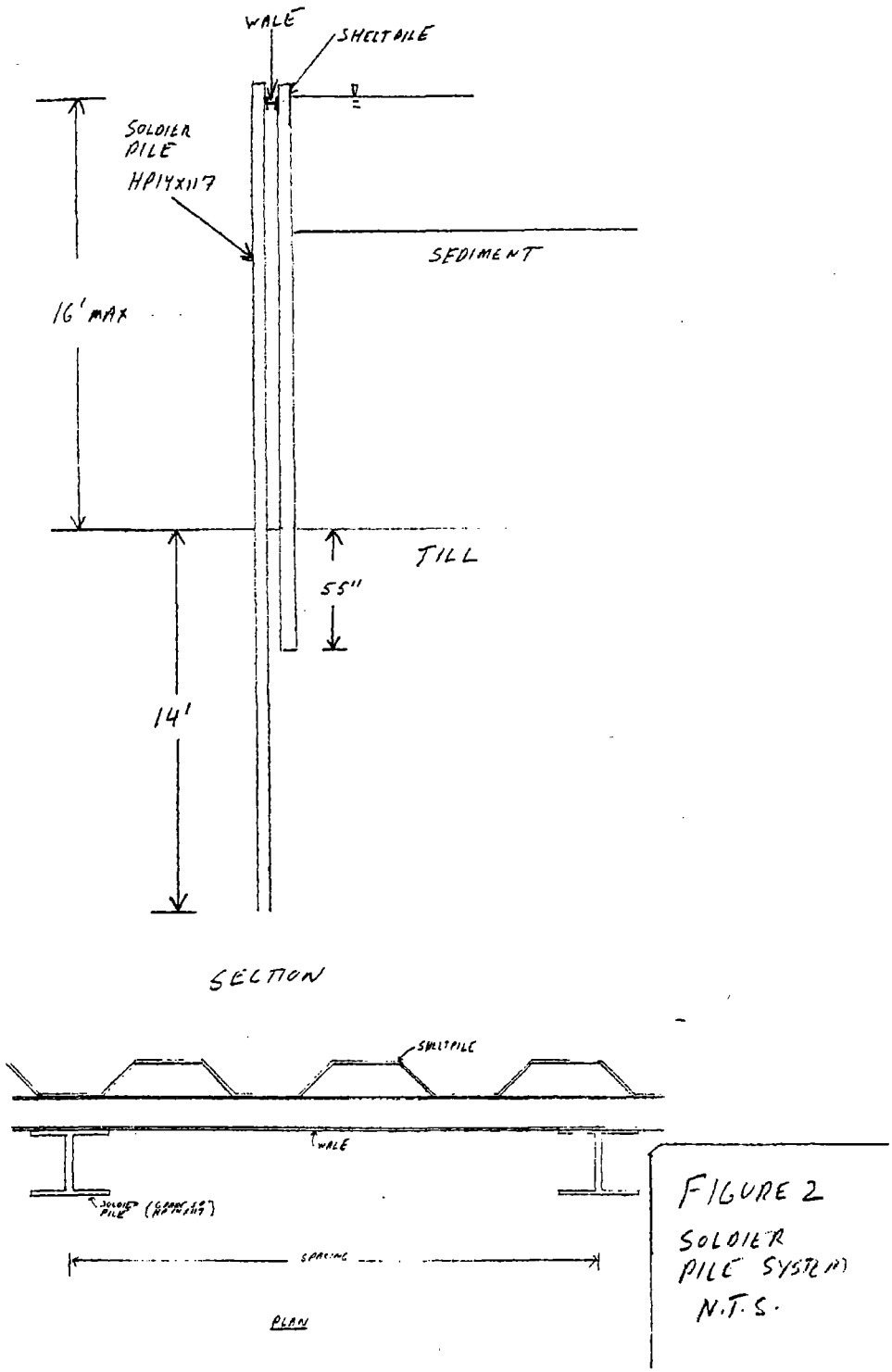

FIGURE 2: SOLIDER PILE SYSTEM (NOT TO SCALE)

Relative Cost

Additional Driving

To be added by Jeff per actual site costs???

Berm Construction

Material costs of berm construction are estimated at about $120,000 for each side of the sheeting, or about $60/linear foot of wall stabilized ($120/linear foot if both sides are considered). This estimate is based on the cost for sand and gravel delivered to the site (net $30/cubic yard). Placement costs will be dependent on the construction staging and methods used to construct the berm. Depending on the method selected, placement costs could be incidental to sediment excavation costs.

Soldier Piles

Estimated costs for soldier piling is $110/vertical linear foot of pile, or about $3,000 per pile. Assuming an average spacing of 10 feet center-to-center, this is equivalent to about $300 per linear foot of wall stabilized. This is inclusive of mobilization, bracing, and marine construction. The presence of the barge and hammer on site could reduce this cost, however, handling and installation will still be hampered by the need to work off of a barge.

Recommendations

The following recommendations for addressing the sheetpile shortfall are made. These recommendations are presented sequentially in order of implementation.

1. Additional Driving

   - It is recommended that the contractor be contacted and asked how he plans to achieve the penetration depth required by the specifications. During this contact, the contractor should be asked if consideration has been given to use of a larger hammer and a fixed-lead system, as well as if a driveability analysis would help in the selection of the appropriate hammer size.
   - Results of the drivability studies discussed in this memorandum should not be provided to the contractor as the embedment shortfall is the contractor's responsibility and must be solved by the contractor.
   - It is clear that some segments were not driven to practical refusal with the ICE 42-S impact hammer, and it is possible that some of the overstressing issues which have occurred may be attributable to the driving set-up which was used. Use of a fixed template, fixed leads, and removal of excess stick-up prior to driving may improve results and also allow the use of a larger hammer.
   - When the contractor starts re-driving, CH2M HILL should monitor installation of the sheetpiles. Blow counts should be recorded for each foot of penetration. If the sheetpiles cannot be installed with a larger hammer and if there are questions about the efficiency of the contractor's hammer or driving system, consideration should be given to performing Pile Driving Analyses (PDA) to evaluate the performance of the contractor's driving system.

2. Placement of Berm and H-Pile Bracing

- If additional driving is not an option or cannot be accomplished, then it is recommended that the contractor be requested to provide a staging plan and cost for berm construction, and that a dialogue be opened with EPA on this method.
- If either cost or logistics are not acceptable, the soldier pile option should be considered.

It is possible that some combination of the options presented here may also be appropriate. Details of the selected options are related to both the depth of the excavation required and the depth of the sheetpile penetration achieved; therefore, it is imperative that each pile segment be considered individually as options are selected and details are developed.

Under no circumstances should freeboard of greater than 16.5 feet be authorized without further analyses or reconsideration of these options.

References

FHWA (1997). *Design and Construction of Driven Pile Foundations.* US Dept. of Transportation, Federal Highway Administration, and National Highway Institute. FHWA-HI-97-014, Volume II.

PDI (1998). *GRLWEAP, Wave Equation Analysis of Pile Driving.* Pile Dynamics, Inc. Version 1998-2. Cleveland, OH.

Appendix A

Technical Memorandum dated January 27, 2000
Velsicol Sheet Pile and H-Pile Driveability Study

Velsicol Sheet Pile and H-Pile Driveability Study

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DATE: January 27, 2000

Introduction

As part of the remediation of the Velsicol Superfund Site, a sheet pile wall was installed to facilitate dredging and remediation of the Pine River. During installation, the sheet pile contractor encountered difficulty installing the sheet piles to the required embedment depth. Several options for remedying the shortfalls in sheet pile embedment have been identified. The most viable options appear to involve driving the sheet piles deeper, providing support along the wall using either a reaction berm comprised of granular fill or a structural (e.g., H-pile) support system, or using a combination of additional driving and a reaction system.

As part of the embedment shortfall study, a driveability analysis was undertaken to examine the following two issues:

1. The potential of driving the sheet piles deeper with the same pile hammer or with a different (larger) hammer, and
2. The driveability of H-piles at the site.

The driveabilty studies were conducted using the computer program GRLWEAP, Version 1998-2 (PDI, 1998). The remainder of this memorandum discusses the driveability analyses and results. A separate memorandum titled "Velsicol – Sheet Pile Embedment Shortfall Options" (CH2M HILL, February 2000), includes a summary of the work described in this memorandum, as well as related studies such as cantilever requirements.

Background and Relevant Parameters

Subsurface Conditions

Based on a soil boring program conducted along the wall alignment, the general subsurface profile consists of the two primary soil units shown in Table 1.

TABLE 1: SUBSURFACE PROFILE

Layer	Thickness[1]	Soil Description	Average N value[2]	Comments
1	9-11 feet	Very loose fine sands	0 to 3 for most of layer, slightly denser with depth	Contaminated sediment
2	Below Layer 1	Very dense sandy clay	Refusal – greater than 50/6"	Glacial Till bearing layer

[1]Approximately 5 feet of water overlies the sediment; average depths

[2]N value = Standard Penetration Test (SPT) N-value

The glacial till is heavily overconsolidated with estimated undrained shear strengths range from 10,000 to 20,000 pounds per square foot (psf, or 10 to 20 kips per square foot, ksf). This estimate is based on judgment and experience with other soils. Laboratory strength tests have not been conducted on soil samples obtained at the site because of the inability to obtain undisturbed soil samples for laboratory testing. The strengths are also such that empirical relationships between SPT N-values and soil strength have questionable validity (i.e., they exceed the range of most published correlations).

Sheet Piles and H-Piles

The sheet piles installed at the Velsicol site are Bethlehem Steel model PZ-27 sheet piles as manufactured by Nucor-Yamato. The sheets piles were installed in pairs. Properties for the sheet piles are shown in Table 2. The listed properties were obtained from the contractor's submittal.

TABLE 2: SHEET PILE PROPERTIES

Property	Single Sheet	Pair of Sheets
Cross Sectional Area, [in^2]	11.91	23.82
Section Modulus, [in^3]	45.3	90.6
Nominal Surface Area, [ft^2 per ft of pile][1]	4.48	8.96
Yield Strength, [ksi]	50	50

[1]The nominal surface area is the coating area – it does not include the interlock's internal surface area

Three H-pile sections and two wide-flange sections were considered during the evaluation of structural bracing systems: HP 12x84, HP 13x100, HP 14x117, W14x159, and W21x111. Properties for these sections are given in Table 3. Properties shown were obtained from AISC (1980).

TABLE 3: H-PILE AND WIDE FLANGE PROPERTIES

Property	HP 12x84	HP 13x100	HP 14x117	W14x159	W21x111

TABLE 3: H-PILE AND WIDE FLANGE PROPERTIES

Property	HP 12x84	HP 13x100	HP 14x117	W14x159	W21x111
Cross Sectional Area, [in^2]	24.6	29.4	34.4	46.7	32.7
Section Modulus in X-X direction, [in^3]	106	135	172	254	249
Full Perimeter, [in][1]	69.6	74.4	84	88.5	71.2
Yield Strength, [ksi][2]	36 or 50	36 or 50	36 or 50	36 or 50	36 or 50

[1]Perimeter calculated from shape dimensions

[2]Sections available in either grade

Pile Hammer Driving System

The contractor installed the sheet piles in pairs using both a vibratory hammer and a diesel impact hammer. During the initial pass, the vibratory hammer, an International Construction Equipment (ICE) 44-30, was used to install the sheet piles through the loose sediment and into the till as far as possible. A structural steel template was used to position the sheet piles during vibratory driving. After the sheet piles were driven to refusal with the vibratory hammer, an ICE 42-S diesel impact hammer was used to advance the sheet piles deeper. The impact driving program employed a hanging-lead system and included no template at the top of the sheet piles. The hanging-lead system also did not use a spotter at the base of the leads.

Key properties of the ICE 42-S are listed in Table 4. The information included in the table was provided by the contractor. Also listed in Table 4 are properties for two other hammers examined during the driveabilty analyses. The parameters for these two systems were obtained from information published in the GRLWEAP manual (PDI, 1998).

TABLE 4: HAMMER SYSTEM INFORMATION

Property	ICE 42-S[1]	DELMAG D30-02[2]	ICE 80-S[2]
Rated Energy, [ft-kips]	42	66	80
Helmet Weight, [kips]	1.65	2.7	2.3
Helmet Cushion (cap block) Material	Nylon	Aluminum + Conbest	Nylon
Helmet Cushion Parameters:			
Thickness, [in]	2	2	2
Area, [in^2]	283	415	398
Modulus of Elasticity, E, [ksi]	175	530	175
Coefficient of Restitution (COR)	0.9	0.8	0.92

TABLE 4: HAMMER SYSTEM INFORMATION

Property	ICE 42-S[1]	DELMAG D30-02[2]	ICE 80-S[2]

[1]Hammer used on site, information provided by contractor

[2]Hammers examined during driveability studies, information obtained from GRLWEAP manual (PDI, 1998)

Methodology and Results of Analyses

Back Analysis of Observed Installation

As an initial step in the driveability analyses, a back analysis was performed using data collected during the initial sheet pile driving program for the PZ-27 sheet piles. The back analysis provided an estimate of the resistance of the glacial till during sheet pile driving. This resistance was used to estimate the undrained shear strength of the till, which was then used in subsequent driveabilty studies to evaluate the driveability of the sheet piles using different hammers, as well as in the driveability of the H-piles.

Methodology

The back analysis was performed using an ultimate capacity analysis in GRLWEAP. This analysis allows the user to input a range of ultimate capacities along with the sheet pile, driving system, and soil information. Based on this information the program calculates the blow counts per unit depth (feet or inches) required to achieve the input ultimate capacities. By knowing the blow counts per unit depth measured in the field, the ultimate resistance of the soil, and therefore the soil strength, can be estimated. Key parameters and assumptions used in the back analyses are discussed below.

Subsurface Profile and Soil Properties

- The loose sandy sediment was ignored for all of the driveability analyses. A vibratory hammer was used to install the sheet piles through this material. This installation process cannot be adequately modeled with GRLWEAP. Also, a static capacity analysis performed for the sand showed that the sand contributes a very small portion of the overall sheet pile capacity. . Consequently, neglecting the contributions of the sand would have little bearing on the driveability evaluation.
- The glacial till was assumed as the bearing layer. Undrained shear strengths (S_u) in the range of 10 to 20 ksf are estimated for this material.
- Smith damping was used for all analyses. Soil properties for the till were determined from recommendations in GRLWEAP (PDI, 1998) as follows:
  - Quake for Shaft = 0.1 inches (for all soils)
  - Quake for Tip = 0.1 inches (for non-displacement piles)
  - Damping for Shaft = 0.2 sec/feet (cohesive soil)
  - Damping for Tip = 0.15 sec/feet
- The driving distance was assumed as the total embedment into the till, regardless of whether the embedment was achieved with the vibratory or the impact hammer. In most cases, the impact hammer provided most of the embedment.

Soil Resistance

- Basic static capacity analyses were performed to estimate the relative distribution of shaft resistance to tip resistance.
  - The shaft resistance was determined based on the "α-method" where the unit shaft friction, q_s, is equal to αS_u (AASHTO, 1996). In this analysis the parameter α is a reduction factor that is a function of the pile geometry (depth and diameter), subsurface stratigraphy, and undrained shear strength.
  - The tip resistance was determined based on bearing capacity theory for cohesive soils where the tip resistance, q_p, is equal to $9S_u$.
  - A median value of 90 percent shaft resistance and 10 percent tip resistance was used. Static capacity results for the range of embedment depths achieved in the field program suggest that the distribution of shaft resistance ranges between 87 percent and 93 percent for an α of 0.2 to 0.25.
- Soil capacities between 100 and 550 kips were input to provide a range of results to examine.

Pile Parameters

- Parameters for the PZ-27 as listed in Table 2 were used in the analysis.
- A pile damping of 1 percent was used.
- A total pile length of 30 feet was used.

Hammer Parameters

- Hammer parameters shown in Table 4 for the ICE 42-S were used in the analysis.
- The maximum fuel setting was modeled in GRLWEAP to be consistent with the contractor's reported field procedure.

Other information used in the back analysis included the blow counts recorded during driving of the sheet piles. In most locations the accumulated blow counts over the total impact driving distance were recorded, rather than the 1-foot or 6-inch intervals needed for the back analyses. At seven locations resistance information had been obtained for each 6 inches of driving. This information which is summarized in Table 5 was used during the back analysis.

TABLE 5: 6-INCH BLOW COUNT DATA FROM FIELD RECORDS

Sheet Number[1]	Blows per 6-inch Increment for Impact Hammer Embedment									
	0-6"	6-12"	12-18"	18-24"	24-30"	30-36"	36-42"	42-48"	48-54"	54-60"
near 4N200	2	3	3	4	5	6	7	--	--	--
4N275, 4N276	1	1	2	2	3	3	4	4	5	5

TABLE 5: 6-INCH BLOW COUNT DATA FROM FIELD RECORDS

Sheet Number[1]	Blows per 6-inch Increment for Impact Hammer Embedment									
	0-6"	6-12"	12-18"	18-24"	24-30"	30-36"	36-42"	42-48"	48-54"	54-60"
4N401, 4N402	1	2	3	3	4	5	7	10	30	--
4N337, 4N338	2	2	2	2	2	2	2	3	3	--
4N459, 4N460	1	2	2	2	3	3	3	3	--	--
4N499, 4N500	1	2	4	4	4	4	5	5	--	--
4NW11, 4NW12	1	2	2	2	2	3	3	4	5	--

[1]The reported pair numbers are estimated. The actual locations of the sheet piles are expected to be close to these locations.

Results

The GRLWEAP program was used to calculate the blow counts per unit depth required to obtain the input ultimate total capacities. For the assumed 90 percent shaft resistance and 8 feet of embedment, the range of possible shaft resistance and S_u values was determined. The results for the back analyses are presented in Table 6 and shown graphically in Figure 1 (included at the end of this memorandum).

The information presented in Table 5 indicates that the average blow counts recorded in the field varied from 3 to 6 bpi. For these values, the unit shaft resistance, in terms of undrained shear strength, varies between 13 and 22 ksf for an assumed α of 0.2 and between 3 and 4 ksf for an assumed α of 1.0. Because the glacial till is so heavily overconsolidated, values of α greater than 0.5 are considered unlikely. For the range of 3 to 6 bpi and for the more likely range of α between 0.2 and 0.5, the resulting S_u values vary between 5 and 22 ksf - a range generally consistent with the expected strength for the till. As a starting point for the driveability analyses, an S_u of 10 ksf and an α of 0.4 was used to determine the soil resistance during driving. This equates to a driving resistance of approximately 300 kips and an estimated blow count from 5 to 6 bpi.

Figure 2 shows the bearing graph and stresses from the back analysis. Generally, the maximum blow count during sheet pile installation should be less than 10 bpi, based on recommendations given by the FHWA (1996) and other similar organizations. The manufacturer's information for the ICE 42-S also recommends a refusal blow count of 10 bpi. The maximum compressive stress during a blow should be limited to 90 percent of the yield stress (f_y) of the steel. As shown in Figure 2, even for refusal blow counts (over 10 bpi), the compressive stresses are predicted to be below the allowable limit of $0.90f_y$, which is equal to 45 ksi. This indicates that the pile apparently was not being overstressed during driving based on the conditions modeled in GRLWEAP.

TABLE 6: BACK ANALYSIS RESULTS

Q_{total} [kips][1]	bpi[2]	Q_s [kips][3]	αS_u [ksf][4]	S_u [ksf] for various values of α					
				0.2	0.25	0.3	0.5	0.75	1.0
100	1	90	1.3	6	5	4	3	2	1
150	2	135	1.9	9	8	6	4	3	2

TABLE 6: BACK ANALYSIS RESULTS

Q_{total} [kips][1]	bpi[2]	Q_s [kips][3]	αS_u [ksf][4]	S_u [ksf] for various values of α					
				0.2	0.25	0.3	0.5	0.75	1.0
200	3	180	2.5	13	10	8	5	3	3
250	4	225	3.1	16	13	11	6	4	3
300	5	270	3.8	19	15	13	8	5	4
350	6	315	4.4	22	18	15	9	6	4
400	9	360	5.0	25	20	17	10	7	5
450	12	405	5.7	28	23	19	11	8	6
500	17	450	6.3	31	25	21	13	8	6
550	24	495	6.9	35	28	23	14	9	7

[1] Q_{total} = Total ultimate resistance input

[2] bpi = Blows per inch

[3] Qs = Ultimate shaft resistance = $0.9Q_{total}$

[4] $\alpha Su = q_s$ = Unit shaft resistance = Q_s/A_s where A_s = surface for 8 feet embedment = 71.7 ft^2

Sheet Pile Driveability

The fundamental question to be answered by a driveability study of the sheet piles was whether the sheet piles could be driven deeper - either with the ICE 42-S hammer or with a larger hammer. This question was addressed by determining the blow counts (per inch) at the required embedment depth and the maximum stresses imposed in the sheet pile during each hammer blow. The driveability option in GRLWEAP allows the user to determine both the blow count (per inch) and the stress developed in the pile during driving for incremental depths.

Methodology

For the purposes of analysis, the study assumed that the impact driving started from the top of the glacial till layer and proceeded to 15 feet of embedment. In reality, the piles have been driven to a particular depth and will have been stationary for a period of several months before being redriven. In this time period it is likely that the soil will regain some of the strength lost during driving. The α factor only takes into account the adhesion between the pile and the soil - not the reduction in strength due to driving. It is probable that at least the first few blows during a redriving operation will experience resistance in excess of that seen during the end of driving in the last program. With continued driving this "set-up" will lessen or disappear due to continued disturbance from the driving operation. Certain portions of set-up can be modeled in GRLWEAP. However, due to the large range of values of S_u and α that were determined plausible for the soil (as discussed in the previous section), the driveability analyses were not modified to account for this potential set-up.

While parameters for the sheet pile driveability analyses were generally similar to those described in the previous section, some changes were made, as discussed below.

Soil Properties and Soil Resistance

- Strengths for the glacial till were varied based on the results of the back analysis. Driveability analyses require determination of the unit shaft resistance (αS_u) and the ultimate tip resistance. Methodologies to determine these values were discussed previously and the values used in the analyses are presented with the results.
- Quake and damping values for the till were the same as discussed previously.

Pile Parameters

- Parameters for the PZ-27 as listed in Table 2 were used in the analysis.
- Pile damping values of 1 and 3 percent were examined. One percent is the value typically used for steel. Three percent was tried in an attempt to model the potential effects of the interlock friction on the driving.
- The total pile length was 30 feet. The analysis was carried out for up to 15 feet of embedment.

Hammer Parameters

- Hammer parameters for the three hammers shown in Table 4 were used in the analyses.
- In general, the hammer parameters were not varied from their GRLWEAP default database values during the analyses. The fuel setting and analysis convergence method were varied to see their effect on the results.

Results

The results of the analyses are presented in Table 7. This table shows the variation in blow count (per inch) and the maximum compressive stresses for different combinations of undrained shear strength of the soil and hammer size. A maximum blow count of 10 bpi was used to establish limiting conditions; the maximum allowable compressive stress is 45 ksi, based on 90 percent of the yield stress, which is 50 ksi.

The results in Table 7 correspond to those obtained in the back analysis – for the presumed existing conditions (soil strength and hammer properties); the compressive stresses do not exceed the allowable limit of 45 ksi (runs 1 through 5). The results also indicate that the contractor's ICE 42-S hammer should be capable of driving the sheet piles to a depth of 11 to 13 feet below the top of the till before exceeding a blow count of 10 bpi. Compressive stresses for the existing hammer are less than 90 percent of yield and therefore are satisfactory.

TABLE 7: RESULTS OF SHEET PILE DRIVEABILITY ANALYSIS

Run No.	S_u [ksf]	q_s[1] [ksf]	Q_p[2] [kips]	Hammer[3]	Depth for 10 bpi[4] [feet]	Max. Compressive Stress[5] [ksi]	Max. Tensile Stress[5] [ksi]	Comments
1	10	3.8	14.4	ICE42-S	12.5	38	4.5	Redriving with on-site equipment
2	15	3.8	21.6	ICE42-S	12	38	4.6	Higher strength with on-site equipment

TABLE 7: RESULTS OF SHEET PILE DRIVEABILITY ANALYSIS

Run No.	S_u [ksf]	q_s[1] [ksf]	Q_p[2] [kips]	Hammer[3]	Depth for 10 bpi[4] [feet]	Max. Compressive Stress[5] [ksi]	Max. Tensile Stress[5] [ksi]	Comments
3	19	3.8	27	ICE42-S	12	38	4.7	Higher strength with on-site equipment
4	18	4.5	26	ICE42-S	11	39	5.3	Higher strength with on-site equipment
5	10	3.8	14.4	ICE42-S	10.5	32	3.5	Hammer efficiency reduced to 0.60 (from default of 0.80)
6	10	3.8	14.4	ICE80-S	Highest recorded bpi = 4	50	2.7	Hammer 2x the size of on -site equipment
7	10	3.8	14.4	Delmag 30-02	Highest recorded bpi = 7	40.6	3	Mid-size hammer
8	25	5	36	Delmag 30-02	14	46.6	3.1	Mid-size hammer with upper end strength
9	25	5	36	Delmag 30-02	10.5	40	2.5	Reduced fuel setting
10	25	5	36	Delmag 30-02	14	46.6	3.1	Pile damping = 3%

[1] $q_s = \alpha S_u$

[2] $Q_p = 9 S_u A_p$

[3] See Table 4

[4] Depth where the bpi are 10 bpi; otherwise maximum number of bpi reported

[5] Maximum compressive and tensile stresses recorded. Compressive stresses generally are the greatest at the largest depth (15 feet in these analyses).

A driveability analysis was also completed for the same sheet pile and soil conditions, but using an ICE 80-S hammer. This hammer delivers approximately twice the energy per hammer blow. The blow count at the required embedment depth was approximately 4 bpi, which is well within the normal range for driving. However, compressive stresses in the pile were 50 ksi, and therefore exceeded the 45 ksi allowable stress level, suggesting that the pile might be damaged during driving.

The driveability analyses were then repeated using a Delmag 30-02 hammer. The energy from this hammer, 66 ft-kip, is approximately midway between the ICE 42-S and the ICE 80-S. Results of these analyses suggest that the sheet piles can be installed to depths of 11 to 14 feet into the till, for upper bound estimates of the undrained shear strength of the soil. Compressive stresses per blow range from 40 to 47 ksi. The high-end of the range is slightly greater than the allowable value of 45

ksi, but may be acceptable given the temporary nature of the installation and the upper-bound undrained shear strengths used in the analyses.

H-Pile and Wide-Flange Driveability

The second phase of the driveability analysis evaluated installation requirements for the H-piles and wide-flange sections. These piles could be used to provide additional lateral support at locations where either the sheet piles could not be driven deep enough or where excessive amounts of fill would be required to provide adequate reaction for sheet pile stability. The fundamental question to be answered for this phase of the driveability study was whether H-piles or wide-flange sections could be driven to the required embedment depth using either an ICE 42-S hammer or a larger hammer. Similar to the sheet pile analysis described above, this question was addressed by determining the blow counts (per inch) at the required embedment depth and the maximum stresses imposed in the sheet pile during each hammer blow. Generally, the maximum blow count during H-pile or wide flange installation should be less than 10 bpi. The maximum compressive stress during a blow should again be limited to 90 percent of the yield stress of the steel.

Methodology

The methodology used for these analyses was similar to that described above in the *Sheet Pile Driveability* section, except that that properties of the H-pile and wide-flange sections were used rather than the sheet pile properties. The piles were driven to 15 feet below the top of the till in the analyses, although the expected embedment depth for the piles is 12 feet. This depth was determined by performing an analysis of the lateral load response of the three H-pile sections and two wide-flange sections. The H-piles and the wide flange sections are available in either Grade 36 or Grade 50 steel (yield strengths of 36 ksi or 50 ksi, respectively). These grades give allowable compressive stress limits of 32 ksi and 45 ksi, respectively. The total length of the H-pile and wide-flange sections was 30 feet for the analyses. Soil strengths and α values were similar to those used during the sheet pile analyses. It was also assumed that the piles would not develop a plug during driving.

Two hammer sizes were considered in these analyses: the ICE 42-S and the Delmag 30-02. The goal was to identify a single hammer to use during the next phase of the program, rather than two, to minimize the contractor's cost. The single hammer must maximize the installation depth of the sheet piles and still be capable of driving the H-pile or wide-flange sections to the required depth without exceeding allowable compressive stresses.

Results

Table 8 presents the results of the H-pile and wide-flange driveability study; a discussion follows.

TABLE 8: RESULTS OF H-PILE DRIVEABILITY ANALYSIS

Pile Section	S_u [ksf]	q_s[1] [ksf]	Q_p[2] [kips]	Hammer[3]	Depth for 10 bpi[4] [feet]	Max. Compressive Stress[5] [ksi]	Max. Tensile Stress[5] [ksi]	Comments
12x84	10	3.8	15.4	ICE42-S	highest recorded bpi = 6	34	1.6	On-site hammer
13x100	10	3.8	18.4	ICE42-S	highest recorded bpi = 7	31	1.7	On-site hammer
14x117	10	3.8	21.5	ICE42-S	highest	29	2	On-site hammer

TABLE 8: RESULTS OF H-PILE DRIVEABILITY ANALYSIS

Pile Section	S_u [ksf]	q_s[1] [ksf]	Q_p[2] [kips]	Hammer[3]	Depth for 10 bpi[4] [feet]	Max. Compressive Stress[5] [ksi]	Max. Tensile Stress[5] [ksi]	Comments
					recorded bpi = 8			
14x117	20	8	36.8	ICE42-S	8	33	6	Upper bound soil strength with on-site hammer
14x117	23	4.5	49.4	ICE42-S	13.5	30	2.8	Upper bound soil strength with on-site hammer
14x117	5	2.5	10.8	ICE42-S	highest recorded bpi = 4	27	3.1	Lower bound soil strength with on-site hammer
14x117	10	3.8	21.5	Delmag 30-02	highest recorded bpi = 5	30	1.8	Larger hammer
W14x 159	10	3.8	29.2	ICE42-S	highest recorded bpi = 8	24	4.5	Larger section with on-site hammer
W14x 159	10	3.8	29.2	Delmag 30-02	highest recorded bpi = 6	27.3	4.5	Larger section with larger hammer
W21x 111	10	3.8	20.4	ICE42-S	highest recorded bpi = 6	29	2.9	Larger section with on-site hammer
W21x 111	10	3.8	20.4	Delmag 30-02	highest recorded bpi = 4	31	1	Larger section with larger hammer

[1] $q_s = \alpha S_u$

[2] $Q_p = 9 S_u A_p$

[3] See Table 4

[4] Depth where the bpi are 10 bpi; otherwise maximum number of bpi reported

[5] Maximum compressive and tensile stresses recorded. Compressive stresses generally are the greatest at the highest depth (15 feet in these analyses).

The results in Table 8 indicate the ICE 42-S hammer should be able to drive the two smaller H-piles, 12X84 and 13X100, to the required depth. Compressive stresses during driving will be close to or slightly above the allowable stress of 32 ksi for a Grade 36 Steel, depending on the actual soil resistance and the driving system efficiency. Driving stress are within allowable levels for Grade 50 steel.

The larger H-pile section, 14X117, can be driven to the required embedment depth for the best estimate of soil conditions (S_u = 10 ksf and q_s = 3.8 ksf) with either the ICE 42-S or the Delmag 30-02 diesel hammer. The Delmag hammer requires a lower blow count to install the pile but also gives a slightly higher compressive stress. For the hammer and driving system modeled, the ICE 42-S appears to be capable of installing the H-pile to the required depth for the best estimate of the upper

bound soil conditions (S_u = 23 ksf, q_s = 4.5 ksf). Although not modeled, it is expected that the Delmag would also be capable of installing this H-pile for an upper bound soil resistance.

The two larger sections, the W14x159 and W21x111, can be driven to the required depth with either the ICE 42-S or the Delmag hammer for the best estimate of soil conditions. However, the predicted driving stresses in the W21x111 are close to the allowable stress limits, particularly with the Delmag hammer.

Based on the results for the sheet piles and the H-pile or wide-flange studies (Tables 7 and 8), it appears that the Delmag hammer would provide the greatest project efficiency: it would meet the goal of maximizing the installation depth of the sheet piles and still meet the requirements for H-pile or wide-flange installation.

Preliminary Conclusions and Recommendations

The following preliminary conclusions and recommendations are made.

1. The maximum embedment depth that can be reached using the ICE 42-S hammer should be greater than that obtained by the contractor. The termination criteria used by the contractor during driving appears to be less than the limit given in the specification sheet for an ICE 42-S hammer (10 bpi) and what is commonly used in industry.

2. The damage and limited penetration depth achieved by the contractor may have been related to the fixity of the sheet piles and driving system. The contractor used a hanging-lead system, rather than a fixed-lead system. The combination of hanging-lead setup and unsupported length of the sheet pile could have resulted in lateral movement during each blow, which would reduce the efficiency of driving and increases the likelihood of damage to the sheet pile. However, in the absence of specific observations or measurements, this possibility is speculative.

3. It appears that a Delmag 30-02 hammer, having a rated energy of 66 ft-kip, can drive the sheet piles to a greater depth than already achieved. This hammer delivers approximately 50 percent more energy that the ICE 42-S hammer used by the contractor. For sheet pile driving, a fixed-lead system should be used with the impact hammer to minimize the possibility of energy loss and pile damage during the installation. A different hammer cushion may also help reduce driving stresses.

4. The Delmag 30-02 hammer is capable of driving a 14X117 H-pile to the required termination depth; however, the compressive stresses during driving exceed the allowable stress for Grade 36 steel. To meet compressive stresses requirements, one of the following options might be implemented:

   - use Grade 50 steel
   - change from a H-pile to a wide-flange section
   - reduced fuel settings for the hammer
   - use a different hammer cushion.

The conclusions given above involve a level of uncertainty common with any driveability analyses. Actual driveability is determined by the resistance provided by the soils and the details and function

of the contractor's driving system (i.e., hammer, leads, cushions, etc.). Small changes in any of these factors could significantly affect the ability of the contractor to drive the sheet piles, the H-piles, or the wide-flange sections. This is particularly the case at sites comprised of glacial till. These soils can be almost concrete like in consistency at some locations. However, depending on the consistency of the soil and the amount of natural weathering, significantly lower resistance can occur locally.

In view of these preliminary conclusions, it seems reasonable to request that the contractor address the shortfall in sheet pile embedment lengths and provide a plan for achieving the required penetration. This request should also ask if the contractor has considered:

- using a larger hammer and a fixed-lead system
- performing driveability analyses using a computer program such as GRLWEAP to determine an appropriate hammer size and driving system

When sheet pile driving starts again, the contractor should be required to provide driving records consistent with project specifications. These records should include blows per foot of driving. It will also be important to have CH2M HILL's project staff record details about the contractors driving system, including type of helmet and leads.

If the performance of the contractor's driving system upon return to the site later this year is not consistent with CH2M HILL's expectations, consideration should be given to monitoring the installation of several sheet piles using a Pile Driving Analyzer (PDA). Information from the PDA would allow an evaluation of the efficiency of the hammer and the driving stresses during sheet installation. If a PDA system is mobilized to the project site, consideration should also be given to conducting an H-pile/wide-flange test program. During this test program, one or more H-piles or wide-flange sections could also be installed using the same hammer. As with the sheet piles, the PDA system should be used to monitor driving stresses. If further evaluations determine that it is more efficient to use a 14X117 Grade 36 steel H-pile, the test program could also be used to determine if driving stresses can be reduced to an acceptable level by modifying the drive system, such as by using a different helmet, reduced fuel settings, or different hammer cushions.

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Appendix L
Stormwater Modeling Analysis

Memorandum

CH2M HILL, Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

Subject:	**Hydrologic and Hydraulic Memorandum for Downgradient Vertical Barrier Wall Remedial Design**
Project Name:	Velsicol Chemical Corporation Superfund Site
Contract Info:	Contract Number 68HE0519D0007, Task Order Number 68HE0521F0106
Attention:	United States Environmental Protection Agency (EPA) Region 5
From:	CH2M HILL, Inc. (CH2M)[1]
Date:	August 31, 2023
DCN:	GLAES-R5-21F0106-02020

1. Objective

CH2M has prepared this technical memorandum to summarize the hydrologic analysis, parameters, and assumptions that were used to determine the peak flow rates at natural low points along the downgradient vertical barrier wall (DGVBW) alignment. The estimated flows were used to size ditches and outlets along the DGVBW within the project area to manage stormwater. Flows from the 2016 study documented in the Final Basis of Design Report (CH2M, 2016), were also accounted for in determining the peak flow rates reaching the DGVBW alignment.

2. Hydrologic Analysis

The hydrologic analysis was completed using the Soil Conservation Service unit hydrograph method applied within the Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) model version 4.10.

2.1 Basin Delineation and Topography

The Velsicol Chemical Corporation Superfund Site (site) was divided into 13 basins based on topography to estimate the concentrated flow at natural low points. Figure 1 shows the basin boundaries. The topography data used for the basin delineation was compiled from surveys performed by Weston in 2011, Spicer in 2015 and 2017, and Seaworks in 2022. The topography was also used to determine the flow paths for each of the basins.

[1] CH2M HILL, Inc. is a wholly owned subsidiary of Jacobs Engineering Group Inc.

2.2 Rainfall Data (Frequency, Depth, Distribution)

The hydrologic calculations were completed for the 10-year and 25-year, 24-hour storm event. The rainfall data are referenced from *NOAA Atlas 14, Precipitation-Frequency Atlas of the United States* (NOAA, 2013) for St. Louis, Michigan, located at latitude 43.4105 and longitude -84.6176. Table 1 provides the rainfall values corresponding to 24-hour duration for each storm event.

Table 1. Rainfall Data

Return Period (years)	Rainfall Depth (inches)
10	3.52
25	4.41

2.3 Soil Types

The soil survey data (USDA, 2016) were used to identify the soil group type within the project area. Based on the data, the project watershed lies primarily in the hydrologic Soil Group Type A. A portion of two of the basins of the watershed lie within an area of Soil Group Types C/D. For calculations, a weighted average between Soil Group Types A and D was calculated for the two basins. Within this weighted calculation, Soil Group Type D was used for the areas that were designated Soil Group Types C/D because of its larger curve number, making it more conservative. Figure 1 shows the soil type distribution in the project area.

2.4 Land Use Data

The land use type for the project area is determined to be "Newly Graded Area" based on the aerial imagery. The curve numbers corresponding to the land use category are referenced from the *Urban Hydrology for Small Watersheds TR-55* (USDA, 1986). Table 2 includes the curve number for the land use category corresponding to each of the soil group types in the project area.

Table 2. Land Use—Curve Numbers

Cover Type and Hydrologic Condition	Curve Number (Soil Type A)	Curve Number (Soil Type C)	Curve Number (Soil Type D)
Newly Graded Areas (no vegetation)	77	91	94

3. Curve Numbers

Within the HEC-HMS model, the rainfall losses from soil infiltration and other factors were calculated using the Natural Resources Conservation Service curve number method, which is a function of soil type, land cover, and antecedent moisture condition. Table 3 provides a listing of the average curve numbers used for each basin.

Table 3. Basin-specific Curve Numbers

Basin ID	Soil Type(s)	Average Curve Number
BAS01	A	77
BAS02	A	77
BAS03	A and C/D	86
BAS04	A and C/D	85
BAS05	A	77
BAS06	A	77
BAS07	A	77
BAS08	A	77
BAS09	A	77
BAS10	A	77
BAS11	A	77
BAS12	A	77
BAS13	A	77

ID = identification

3.1 Lag Times

Lag time is calculated based on the *NEH Part 630 Hydrology, National Engineering Handbook* (USDA, 2020). Attachment 1 includes the lag time calculations.

After developing the previously described input parameters, the HEC-HMS model was compiled, and the simulations were successfully run for 10-year and 25-year, 24-hour storm events.

3.2 2016 Study Flows

The flow estimates from the 2016 study (CH2M, 2016) that would flow directly into the project area were also identified. These referenced flow estimates will drain into the new basins via culverts or ditches and will enter the proposed ditch alignments and then exit the site through the outfalls along the DGVBW alignment. Therefore, the flow estimates from the 2016 study were accounted for in the sizing of the outfalls. Attachment 2 includes pertinent material from the 2016 study. Figure 1 illustrates the referenced inflow locations.

4. Hydrologic Analysis and Results

Table 4 provides the total flows from each basin along with the referenced flows.

Table 4. Subbasin Flow Summary

Basin ID	Area (acres)	Calculated Basin Flow (cfs)	Reference Flow Definition[a]	Reference Flow (cfs)[a]	Total Flow (cfs)
BAS01	3.35	11.9	--	--	11.9
BAS02	3.57	12.3	--	--	12.3
BAS03	3.44	15.3	--	--	15.3
BAS04	8.61	27.9	2C+ 2D+ 2B + 2A	10.8	38.7
BAS05	3.06	11	3A	5.3	16.3
BAS06	1.04	4.1	--	--	4.1
BAS07	0.51	2	4B + 4C	11.1	13.1
BAS08	0.32	1.3	4E	5.4	6.7
BAS09	0.29	1.3	4D + 4G	17.6	18.9
BAS10	0.94	3.8	--	--	3.8
BAS11	0.81	3.3	--	--	3.3
BAS12	1.70	6.5	--	--	6.5
BAS13	0.76	3.1	5B + 5A + 4F	9.8	12.9

[a] Reference flows are based on the Final *Basis of Design Report – Velsicol Chemical Corporation Superfund Site, Site Preparation Activities, Operable Unit 1 St. Louis, Michigan Former Plant Site Remedial Design WA No.178-RDRD-0532/Contract No. EP-S5-06-01* (CH2M, 2016).
-- = not applicable
cfs = cubic foot (feet) per second

5. Hydraulic Analysis and Results

The outfalls in the DGVBW alignment are located near the low points and are set at an invert elevation of 719.5 feet North American Vertical Datum of 1988 (NAVD88). The capacity of the outfalls was estimated using headwater calculations performed within software HY-8 version 7.5 (Attachment 3). The tailwater condition was set based on the elevation of the Pine River that will be maintained at approximately 719 feet NAVD88. Figure 1 shows proposed outfall locations.

Ditches are proposed along the DGVBW to direct the 25-year flows to the outfalls. The downstream end of the ditches is set at an invert elevation of 720 feet NAVD88, which is 0.5 foot higher than the outfall elevation, to provide additional head at the outfall. The ditches are proposed as a trapezoidal ditch with a bottom width of 2 feet, 4H:1V side slope, Manning's n value of 0.03, and longitudinal slope of 0.01 foot/foot. The depth of the ditches was estimated using normal depth equation. Additional conveyance ditches are provided to connect the onsite flows to the wall outlet location. The slope of the interior ditches was adjusted to catch the existing outfall elevation with the proposed outfall. Any other variation in the design parameters is identified in the calculation summary (Attachment 4) and design drawings.

6. Summary

The intent of this technical memorandum is to facilitate a review of the hydrologic and hydraulic analysis, methodology, and assumptions associated with estimating the peak flows. This technical memorandum also provides proposed ditch alignments, outfall locations, and sizes of the outfalls along the DGVBW alignment.

7. References

CH2M HILL, Inc. (CH2M). 2016. *Basis of Design Report – Velsicol Chemical Corporation Superfund Site, Site Preparation Activities, Operable Unit 1 St. Louis, Michigan Former Plant Site Remedial Design WA No.178 - RDRD - 0532/Contract No. EP - S5 - 06 - 01*. Final. September.

National Oceanic and Atmospheric Administration (NOAA). 2013. *NOAA Atlas 14, Precipitation-Frequency Atlas of the United States*. Volume 8, Version 2.0. https://www.weather.gov/media/owp/oh/hdsc/docs/Atlas14_Volume8.pdf.

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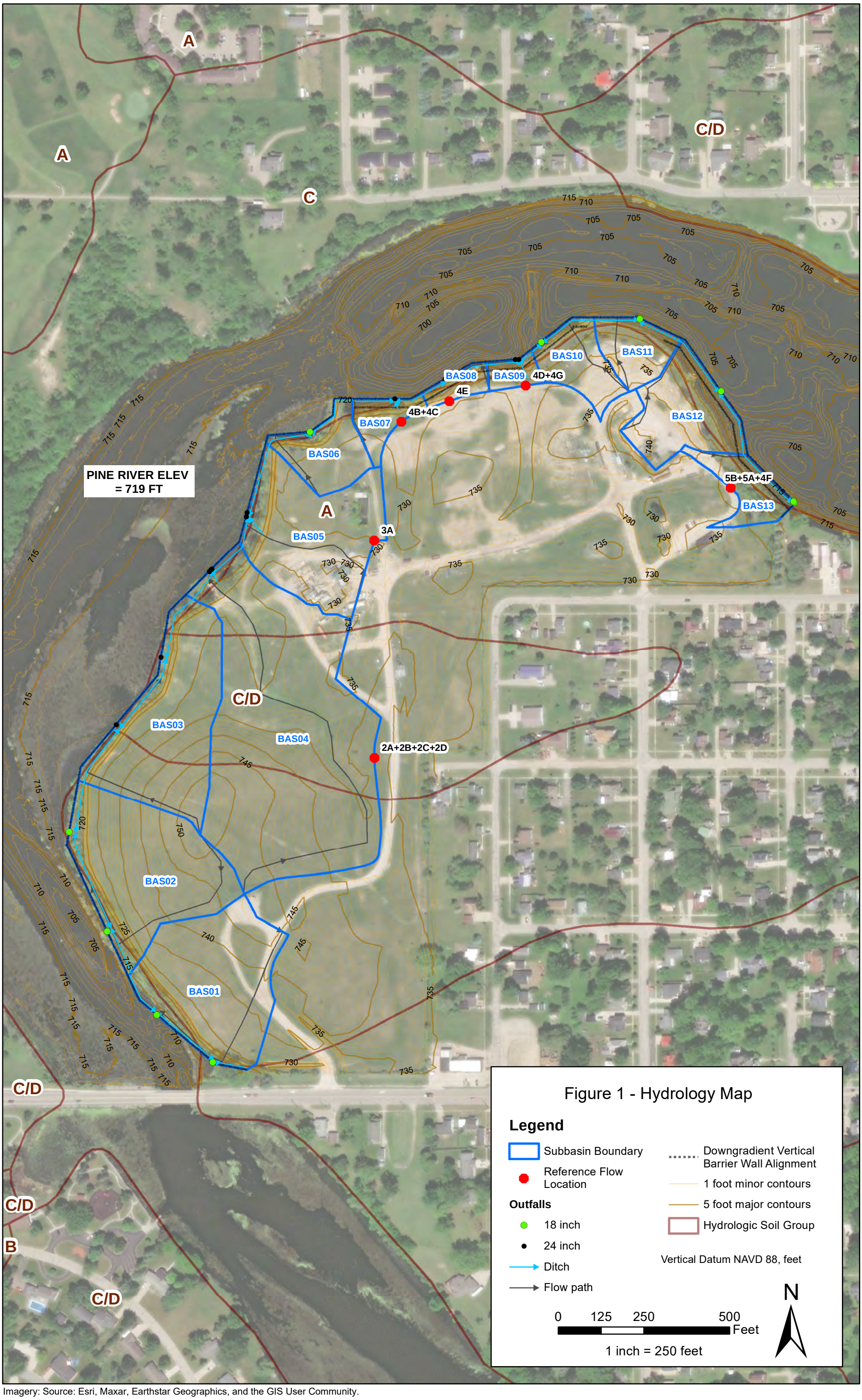
Figure



Imagery: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community.

Attachment 1
Lag Time Calculations

Lag Time

Project Name **Velsicol Chemical Superfund Site**

Revised Date **6/21/2023**

Overland Flow time, tc

$$t_c = \frac{\alpha}{P_2^{0.5}} \left(\frac{nL}{\sqrt{S}} \right)^{0.8}$$

where,
P_2 = 2-year, 24-hour rainfall depth, mm (in)
α = unit conversion constant equal to 5.5 in SI units and 0.42 in CU units.
n = roughness coefficient (see Table 2.1)
L = flow length, m (ft)
S = slope of the surface, m/m (ft/ft)

Channelized Flow time, t_t

$$t_t = \frac{L}{60V}$$

$$V = \alpha k S^{0.5}$$

where,
V = velocity, m/s (ft/s)
S = slope, m/m (ft/ft)
k = dimensionless function of land cover (see Table 2.2)
α = unit conversion constant equal to 10 in SI and 33 in CU units.

Contract No.

Calculated by: **RG**

Lag Time is calculated with reference to USDA NEH - Part 630 Hydrology

SUB-BASIN DATA				OVERLAND (INITIAL) FLOW TIME (t_i)					CHANNELIZED (TRAVEL) FLOW TIME (t_t)								$t_i + t_t$	$0.6xt_c$
Basin Designation	Area	2-yr 24-hr Rianfall P_2	manning's n	Overland Flow Length, Li	U/S Elevation	D/S Elevation	Overland Flow Slope, Si	Overland Flow Time, t_i	Channelized Flow Length, Lt	U/S Elevation	D/S Elevation	Channelized Flow Slope, St	Type of Land Surface	Landcover Coefficient K	Channelized Flow Velocity, Vt	Channelized Flow Time, t_t	Computed t_c	Lag Time
	(sq.mi.)	(inch)		(ft)	(ft)	(ft)	(ft/ft)	(min)	(ft)	(ft)	(ft)	(ft/ft)			(ft/sec)	(min)	(min)	(min)
BAS01	0.0052	2.38	0.05	86	747	744	0.035	3.36	655	744	720	0.037	Nearly bare ground	0.305	1.93	5.66	9.02	5.4
BAS02	0.0056	2.38	0.05	128	753	747	0.047	4.10	579	747	720	0.047	Nearly bare ground	0.305	2.17	4.44	8.54	5.1
BAS03	0.0054	2.38	0.05	200	753	742	0.055	5.48	1234	742	720	0.018	Nearly bare ground	0.305	1.34	15.30	20.78	12.5
BAS04	0.0135	2.38	0.05	183	747	743	0.022	7.38	547	743	720	0.042	Nearly bare ground	0.305	2.06	4.41	11.79	7.1
BAS05	0.0048	2.38	0.05	148	735	731	0.027	5.71	451	731	720	0.024	Nearly bare ground	0.305	1.57	4.79	10.50	6.3
BAS06	0.0016	2.38	0.05	75	733	732	0.013	4.41	246	732	720	0.049	Nearly bare ground	0.305	2.22	1.84	6.25	3.7
BAS07	0.0008	2.38	0.05	100	733	730	0.030	4.02	224	730	720	0.045	Nearly bare ground	0.305	2.13	1.76	6.00	3.6
BAS08	0.0005	2.38	0.05	80	730	721	0.112	1.99	117	721	720	0.009	Nearly bare ground	0.305	0.93	2.08	6.00	3.6
BAS09	0.0005	2.38	0.05	50	730	724	0.120	1.32	121	724	720	0.033	Nearly bare ground	0.305	1.83	1.11	6.00	3.6
BAS10	0.0015	2.38	0.05	105	735	731	0.038	3.80	274	731	720	0.040	Nearly bare ground	0.305	2.02	2.26	6.07	3.6
BAS11	0.0013	2.38	0.05	100	735	731	0.040	3.58	189	731	720	0.058	Nearly bare ground	0.305	2.43	1.29	6.00	3.6
BAS12	0.0027	2.38	0.05	150	742	736	0.040	4.95	376	736	720	0.043	Nearly bare ground	0.305	2.08	3.02	7.96	4.8
BAS13	0.0012	2.38	0.05	100	738	731	0.070	2.86	269	731	720	0.041	Nearly bare ground	0.305	2.04	2.20	6.00	3.6

Attachment 2
Reference Documents

Surface Water Analysis
Site Preparation – Operable Unit 1

EPA Superfund Site
St Louis, Michigan

Prepared for

Velsicol Chemical Corporation

August 2016

ch2m

N

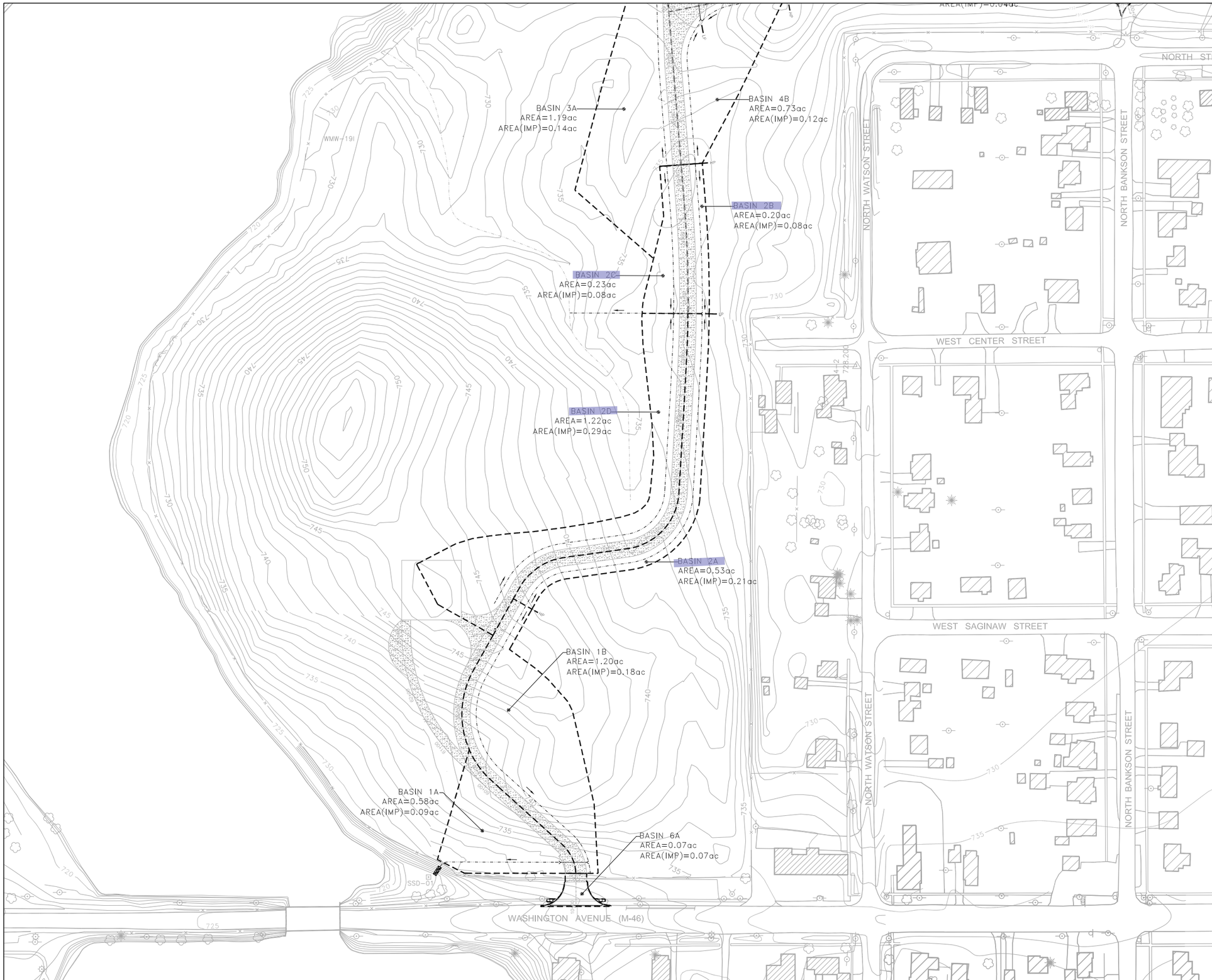
SCALE IN FEET

0 80 160

11" X 17" SHEET

BASIN MAP

ch2m



N

SCALE IN FEET

0 80 160

11" X 17" SHEET

BASIN MAP

ch2m

Summary for Subcatchment 1S: Basin 2A

[49] Hint: Tc<2dt may require smaller dt

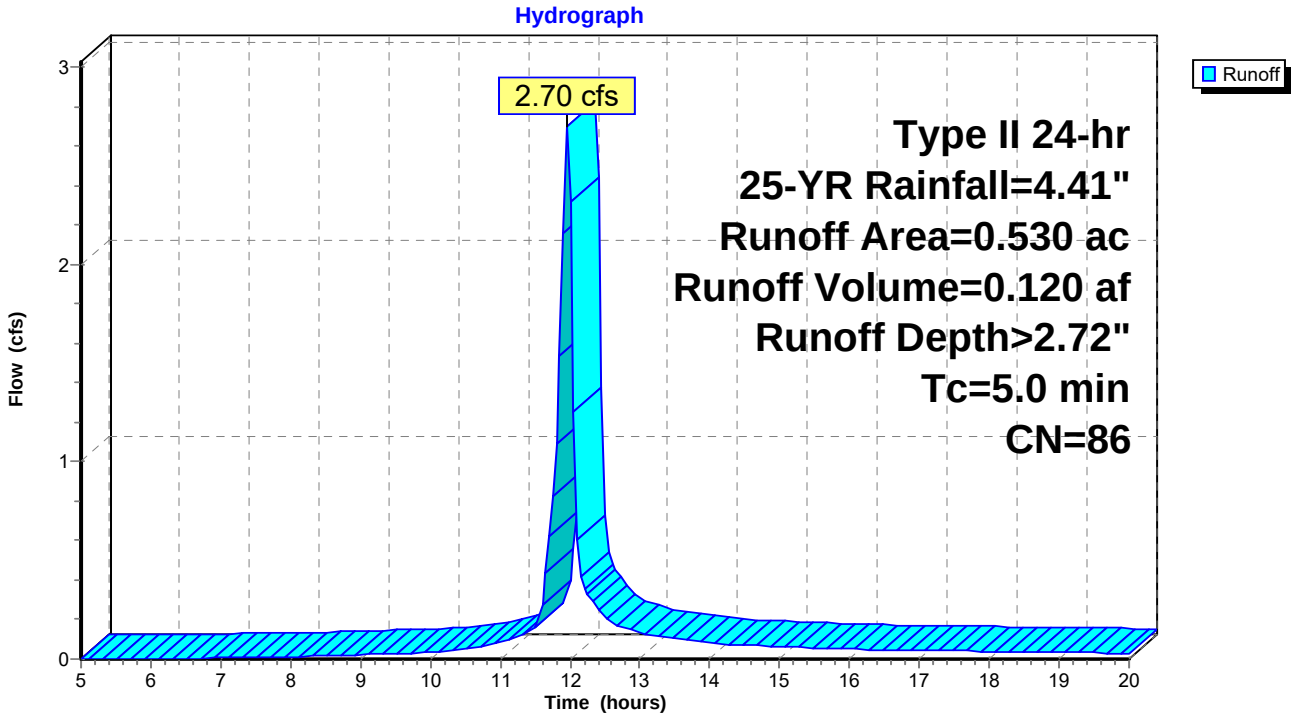
Runoff = 2.70 cfs @ 11.95 hrs, Volume= 0.120 af, Depth> 2.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.320	80	>75% Grass cover, Good, HSG D
0.210	96	Gravel surface, HSG D
0.530	86	Weighted Average
0.530	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 2A



Summary for Subcatchment 1S: Basin 2B

[49] Hint: Tc<2dt may require smaller dt

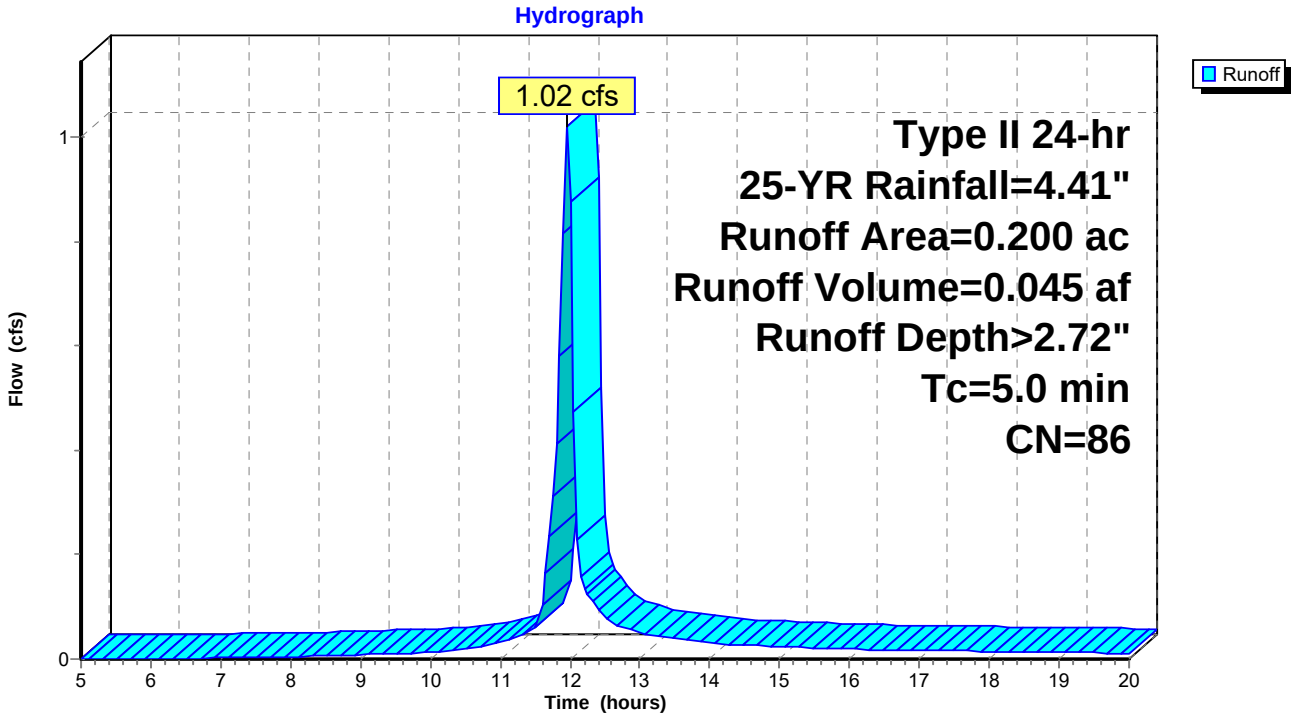
Runoff = 1.02 cfs @ 11.95 hrs, Volume= 0.045 af, Depth> 2.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.120	80	>75% Grass cover, Good, HSG D
0.080	96	Gravel surface, HSG A
0.200	86	Weighted Average
0.200	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 2B



Summary for Subcatchment 1S: Basin 2C

[49] Hint: Tc<2dt may require smaller dt

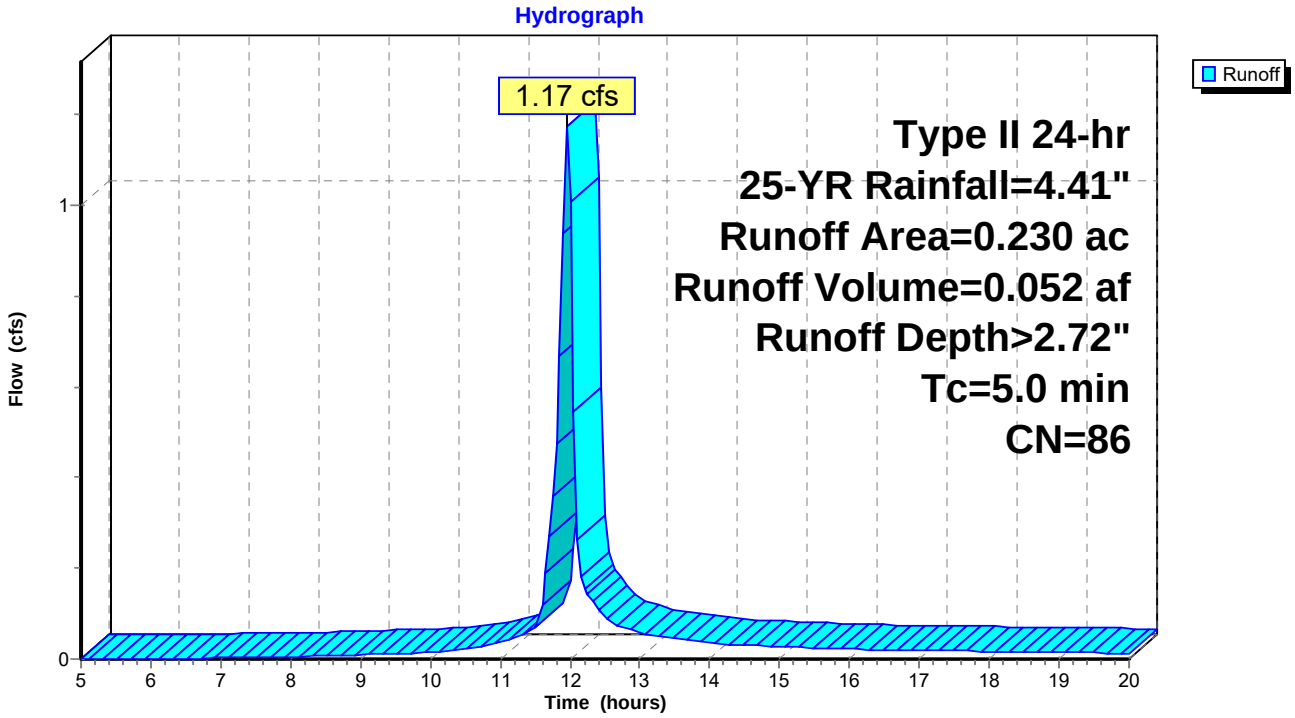
Runoff = 1.17 cfs @ 11.95 hrs, Volume= 0.052 af, Depth> 2.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.150	80	>75% Grass cover, Good, HSG D
0.080	96	Gravel surface, HSG D
0.230	86	Weighted Average
0.230	86	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 2C



Summary for Subcatchment 1S: Basin 2D

[49] Hint: Tc<2dt may require smaller dt

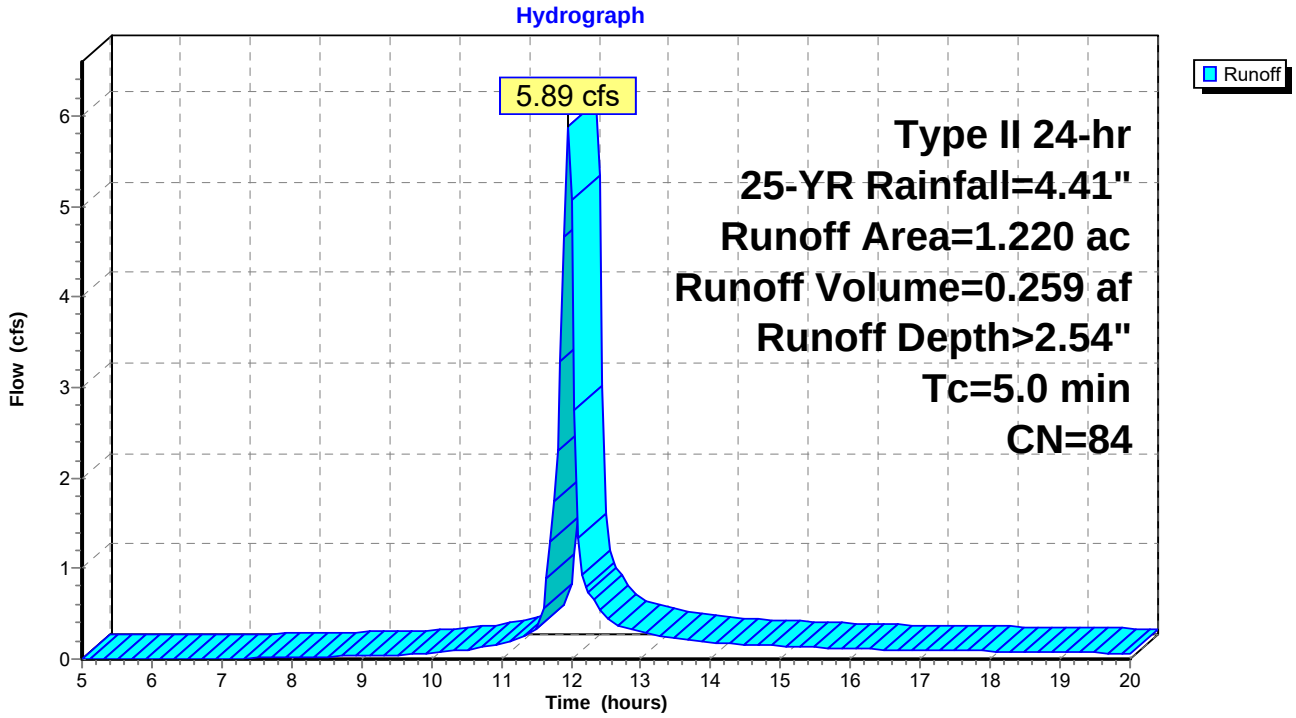
Runoff = 5.89 cfs @ 11.96 hrs, Volume= 0.259 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.930	80	>75% Grass cover, Good, HSG D
0.290	96	Gravel surface, HSG A
1.220	84	Weighted Average
1.220	84	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 2D



Summary for Subcatchment 1S: Basin 3A

[49] Hint: Tc<2dt may require smaller dt

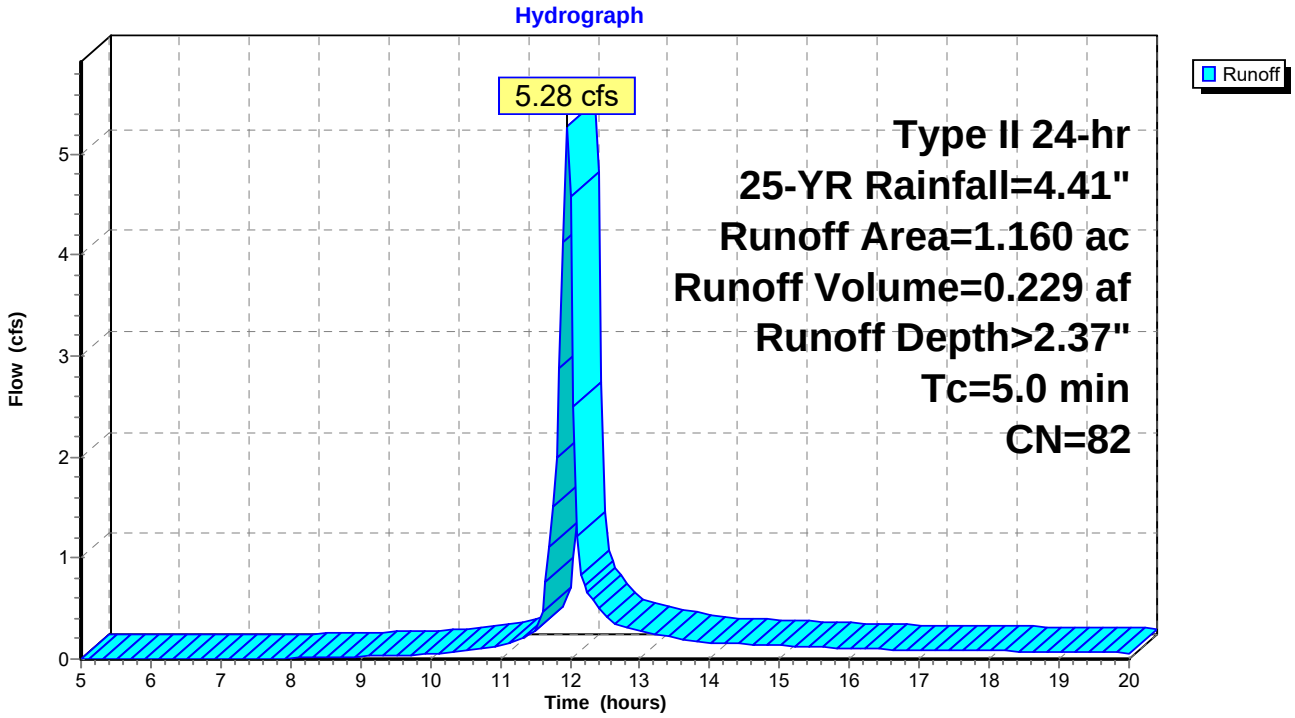
Runoff = 5.28 cfs @ 11.96 hrs, Volume= 0.229 af, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
1.050	80	>75% Grass cover, Good, HSG D
0.110	96	Gravel surface, HSG A
1.160	82	Weighted Average
1.160	82	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 3A



Summary for Subcatchment 1S: Basin 4B

[49] Hint: Tc<2dt may require smaller dt

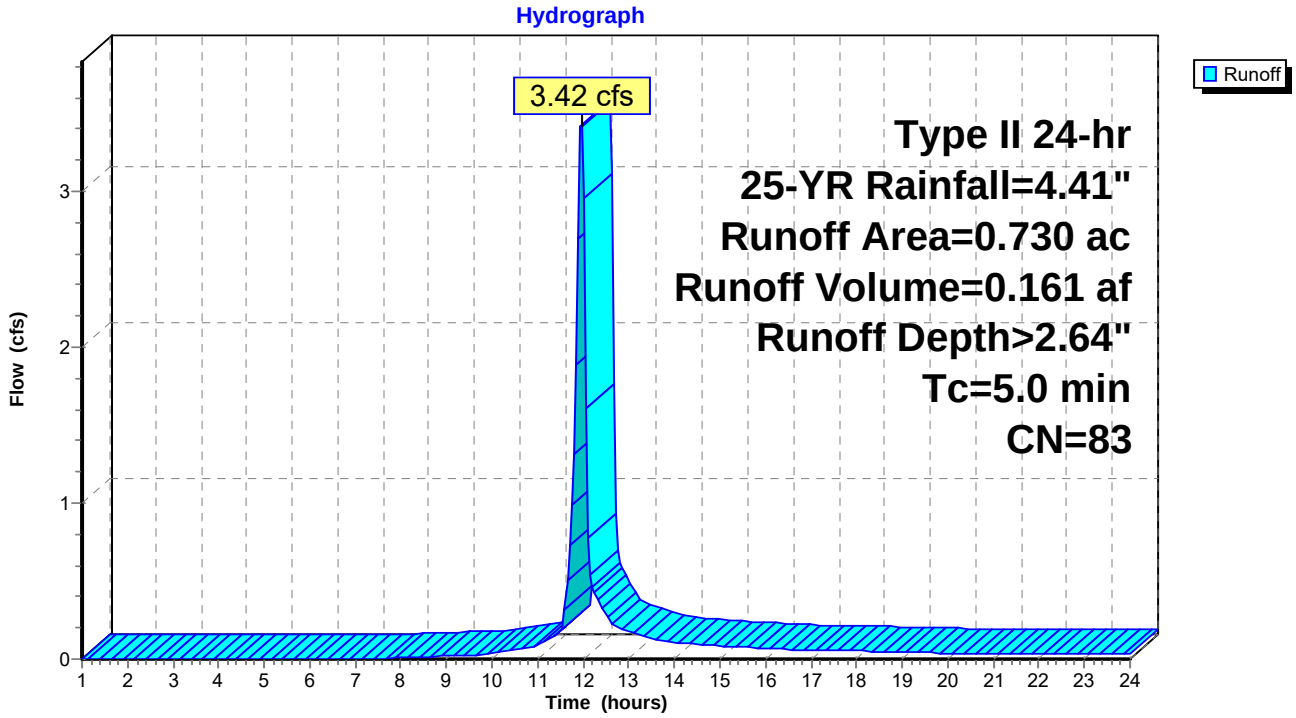
Runoff = 3.42 cfs @ 11.96 hrs, Volume= 0.161 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.610	80	>75% Grass cover, Good, HSG D
0.120	96	Gravel surface, HSG A
0.730	83	Weighted Average
0.730	83	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 4B



Summary for Subcatchment 1S: Basin 4C

[49] Hint: Tc<2dt may require smaller dt

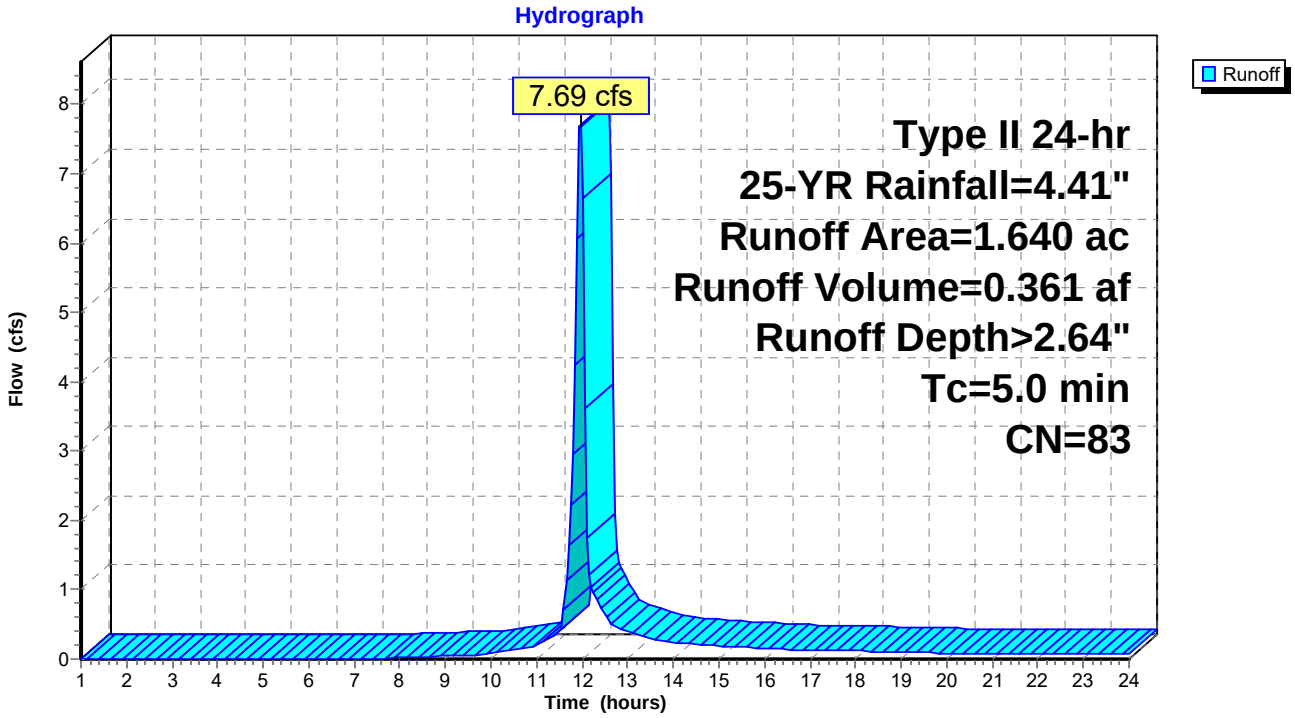
Runoff = 7.69 cfs @ 11.96 hrs, Volume= 0.361 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
1.350	80	>75% Grass cover, Good, HSG D
0.290	96	Gravel surface, HSG A
1.640	83	Weighted Average
1.640	83	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 4C



Summary for Subcatchment 1S: Basin 4E

[49] Hint: Tc<2dt may require smaller dt

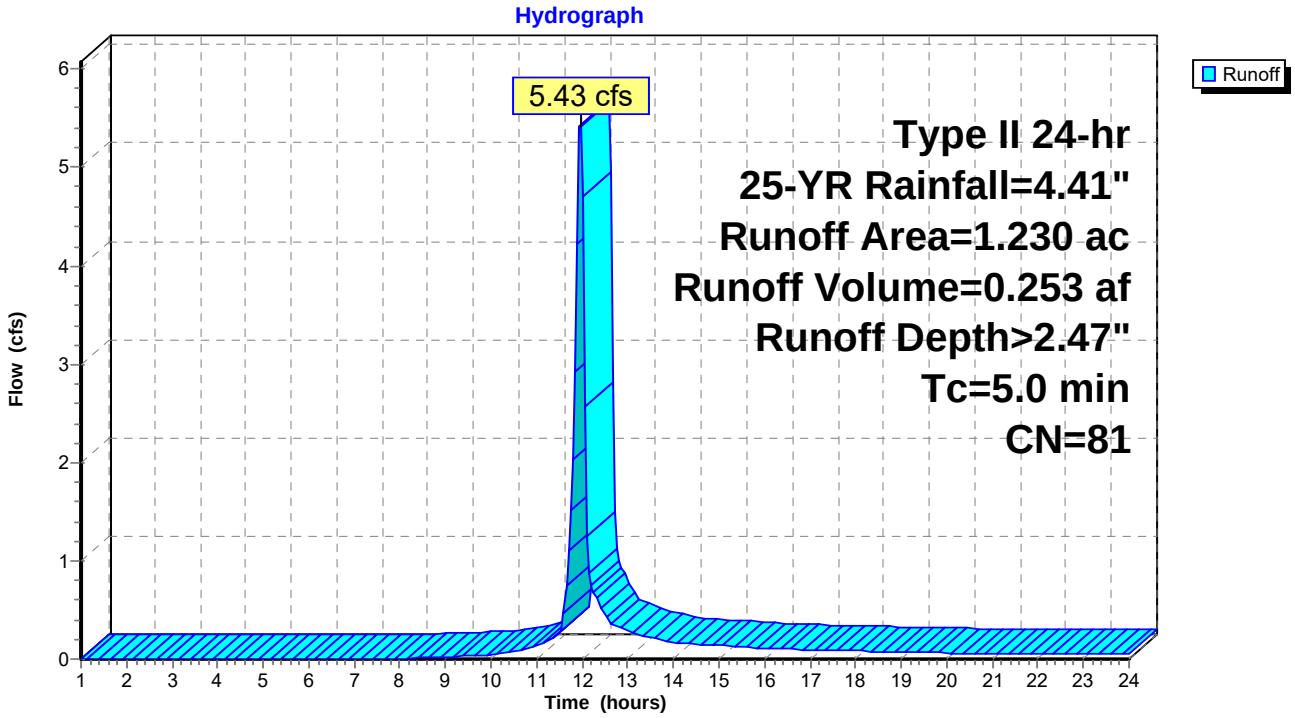
Runoff = 5.43 cfs @ 11.96 hrs, Volume= 0.253 af, Depth> 2.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
1.160	80	>75% Grass cover, Good, HSG D
0.070	96	Gravel surface, HSG A
1.230	81	Weighted Average
1.230	81	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 4E



Summary for Subcatchment 1S: Basin 4D and 4G

[49] Hint: Tc<2dt may require smaller dt

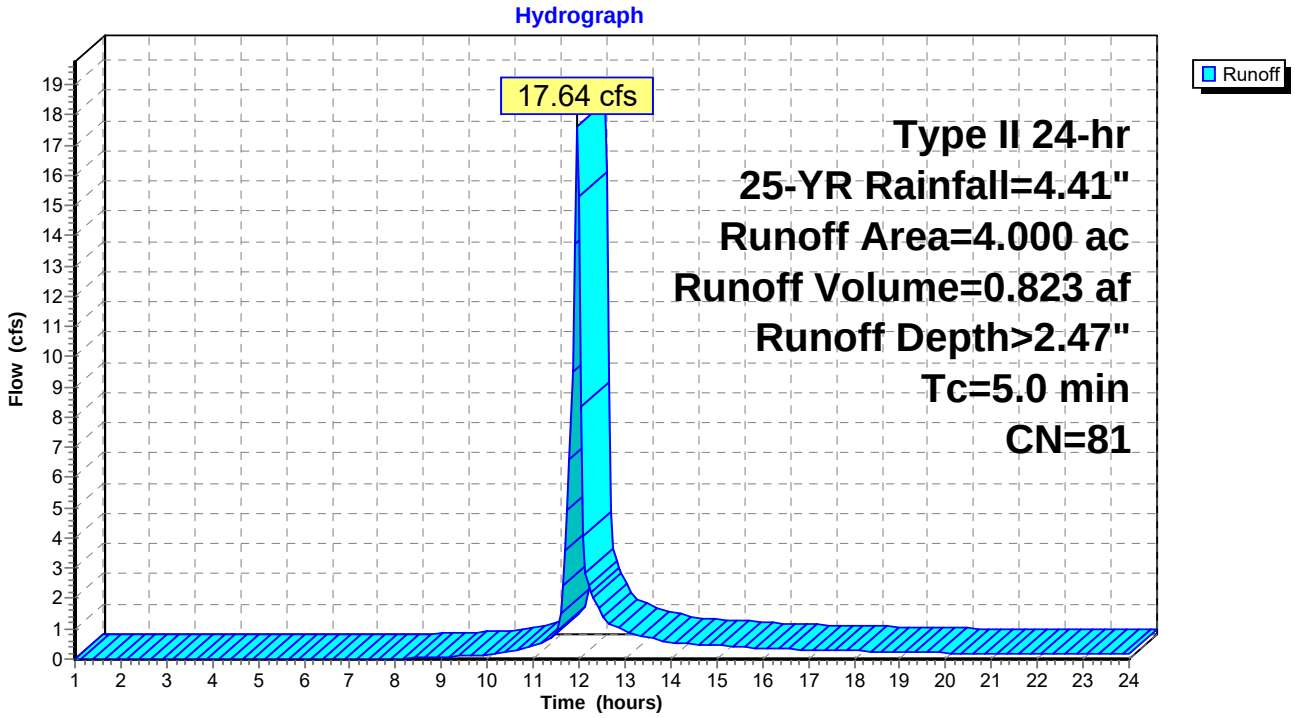
Runoff = 17.64 cfs @ 11.96 hrs, Volume= 0.823 af, Depth> 2.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
3.660	80	>75% Grass cover, Good, HSG D
0.340	96	Gravel surface, HSG A
4.000	81	Weighted Average
4.000	81	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 4D and 4G



Summary for Subcatchment 1S: Basin 4F

[49] Hint: Tc<2dt may require smaller dt

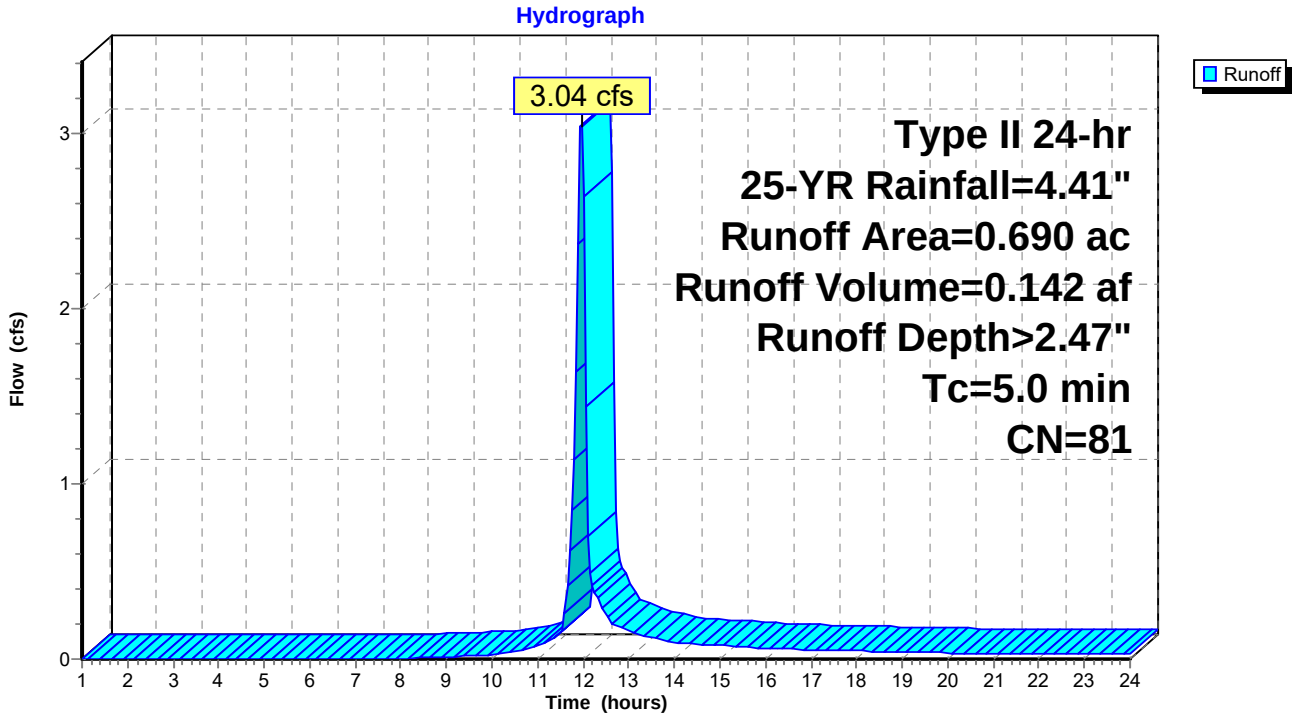
Runoff = 3.04 cfs @ 11.96 hrs, Volume= 0.142 af, Depth> 2.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.650	80	>75% Grass cover, Good, HSG D
0.040	96	Gravel surface, HSG A
0.690	81	Weighted Average
0.690	81	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 4F



Summary for Subcatchment 1S: Basin 5A

[49] Hint: Tc<2dt may require smaller dt

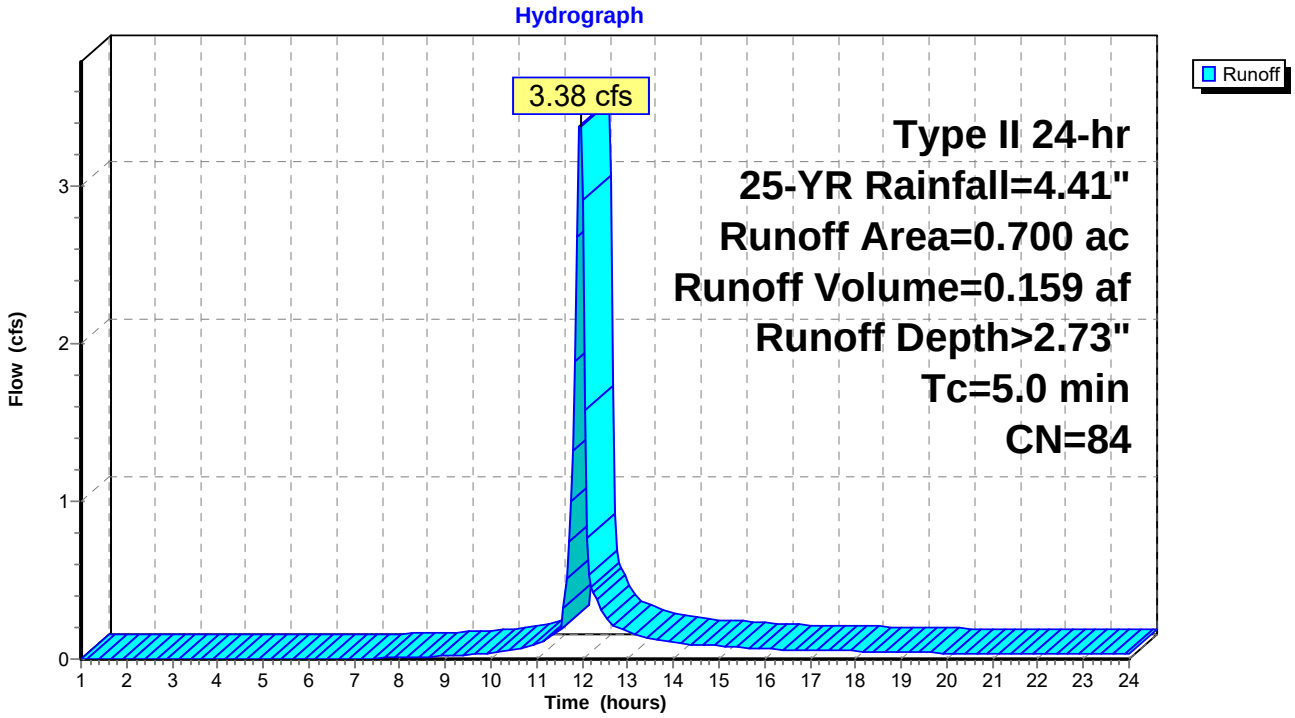
Runoff = 3.38 cfs @ 11.96 hrs, Volume= 0.159 af, Depth> 2.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.520	80	>75% Grass cover, Good, HSG D
0.180	96	Gravel surface, HSG A
0.700	84	Weighted Average
0.700	84	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 5A



Summary for Subcatchment 1S: Basin 5B

[49] Hint: Tc<2dt may require smaller dt

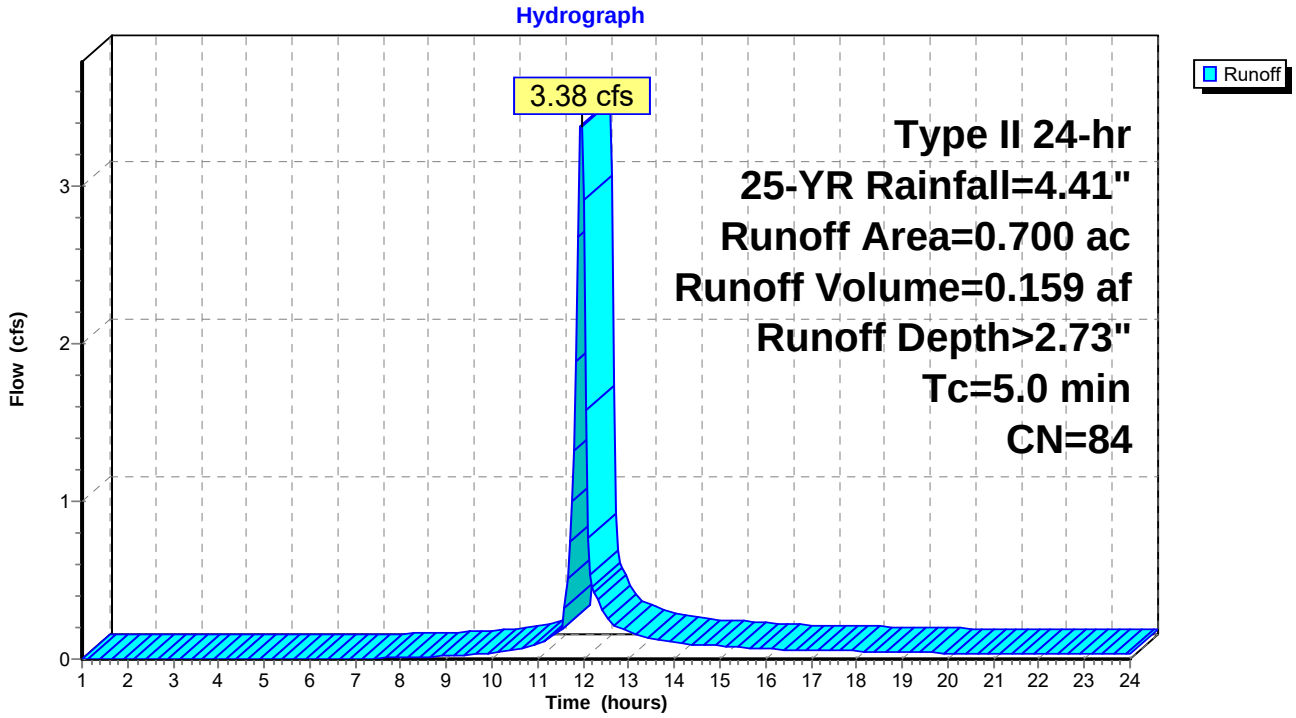
Runoff = 3.38 cfs @ 11.96 hrs, Volume= 0.159 af, Depth> 2.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-YR Rainfall=4.41"

Area (ac)	CN	Description
0.520	80	>75% Grass cover, Good, HSG D
0.180	96	Gravel surface, HSG A
0.700	84	Weighted Average
0.700	84	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1S: Basin 5B



United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Gratiot County, Michigan

March 17, 2016

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:6,840 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 300 600 1200 1800

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

Attachment 3
HY-8 Culvert Analysis Report

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: BAS 06, 10, 11, 12 - 1:18inch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 18inch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
720.48	BAS11	3.30	3.30	0.00	1
720.57	BAS10	3.80	3.80	0.00	1
720.61	BAS06	4.10	4.10	0.00	1
720.98	BAS12	6.50	6.50	0.00	1
723.00	Overtopping	14.88	14.88	0.00	Overtopping

Culvert Data Summary - Culvert 18inch

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Table 2 - Summary of Culvert Flows at Crossing: BAS 01, 02, 13 - 2:18inch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 2:18inch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
720.89	BAS01	11.90	11.90	0.00	1
720.92	BAS02	12.30	12.30	0.00	1
720.97	BAS13	12.90	12.90	0.00	1
723.00	Overtopping	29.75	29.75	0.00	Overtopping

Culvert Data Summary - Culvert 2:18inch

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Table 3 - Summary of Culvert Flows at Crossing: BAS 07, 08: 1-24 inch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 24inch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
720.80	BAS08	6.73	6.73	0.00	1
721.44	BAS07	13.11	13.11	0.00	1
723.00	Overtopping	24.55	24.55	0.00	Overtopping

Culvert Data Summary - Culvert 24inch

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Table 4 - Summary of Culvert Flows at Crossing: BAS 03, 05, 09 - 2:24 inch

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 2-24inch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
720.91	BAS03	15.30	15.30	0.00	1
720.96	BAS05	16.28	16.28	0.00	1
721.09	BAS09	18.94	18.94	0.00	1
723.00	Overtopping	49.11	49.11	0.00	Overtopping

Culvert Data Summary - Culvert 2-24inch

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Table 5 - Summary of Culvert Flows at Crossing: BAS04 - 3:24 inch

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 3-24inch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
719.87	2.00	2.00	0.00	1
720.20	6.80	6.80	0.00	1
720.43	11.60	11.60	0.00	1
720.65	16.40	16.40	0.00	1
720.84	21.20	21.20	0.00	1
721.01	26.00	26.00	0.00	1
721.17	30.80	30.80	0.00	1
721.32	35.60	35.60	0.00	1
721.42	38.70	38.70	0.00	1
721.65	45.20	45.20	0.00	1
721.83	50.00	50.00	0.00	1
723.00	73.66	73.66	0.00	Overtopping

Culvert Data Summary - Culvert 3-24inch

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Attachment 4
Proposed Ditch – Normal Depth Summary

Proposed Ditch - Normal Depth Summary									
Basin ID	Area (acre)	Calculated Basin Flow (cfs)	Reference Flow Definition*	Reference Flow* (cfs)	Total Flow (cfs)	Normal depth (ft)	Wall Side Ditch	Interior Conveyance Ditch	Steel Pipe Outfall
BAS01	3.35	11.9	-	-	11.9	0.78	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	2: 18"
BAS02	3.57	12.3	-	-	12.3	0.79	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	2: 18"
BAS03	3.44	15.3	-	-	15.3	0.87	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	2: 24"
BAS04	8.61	27.9	2C+ 2D+ 2B + 2A	10.8	38.7	1.31	-	Trap: 6' BW, 4:1SS, 0.01 ft/ft, 1.5' deep	3: 24"
BAS05	3.06	11	3A	5.3	16.3	0.90	**Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	Trap: 2' BW, 4:1SS, 0.02 ft/ft, 1.5' deep	2: 24"
BAS06	1.04	4.1	-	-	4.1	0.47	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	1: 18"
BAS07	0.51	2	4B + 4C	11.1	13.1	0.81	**Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1.5' deep	1: 24"
BAS08	0.32	1.3	4E	5.4	6.7	0.59	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	1: 24"
BAS09	0.29	1.3	4D + 4G	17.6	18.9	0.96	**Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	Trap: 2' BW, 4:1SS, 0.02 ft/ft, 1.5' deep	2: 24"
BAS10	0.94	3.8	-	-	3.8	0.45	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	1: 18"
BAS11	0.81	3.3	-	-	3.3	0.42	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	1: 18"
BAS12	1.70	6.5	-	-	6.5	0.59	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	1: 18"
BAS13	0.76	3.1	5B + 5A + 4F	9.8	12.9	0.81	Trap: 2' BW, 4:1SS, 0.01 ft/ft, 1' deep	-	2: 18"
** Grade the top of ditch to a minimum elevation of 421.5 feet NAVD88									

where,
cfs = cubic feet per second;
ft = feet;
BW = bottom width;
SS = side slope (H:V)

Appendix M
Green Remediation Best Management Practices

APPENDIX M

Green Remediation Best Management Practices

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

SITE INVESTIGATION AND ENVIRONMENTAL MONITORING/EPA-542-F-16-002, SEPTEMBER 2016
Project Planning
Schedule activities for appropriate seasons to reduce delays caused by weather conditions and fuel needed for heating or cooling.
Identify the nearest facility to be used for disposing of hazardous waste.
Establish electronic networks for data transfers and deliverables, team decisions, and document preparation, and select electronic products on the basis of comparisons available in the Electronic Product Environmental Assessment Tool (EPEAT).
Reduce travel through increased teleconferencing, compressed work hours, and flexible work locations.
Procurement
Select service providers, product suppliers, and analytical laboratories from the local area and coordinate service and delivery schedules to reduce fuel consumption and associated air emissions.
Energy Use and Renewable Energy
Limit the number of vehicles deployed onsite, and rent electric, hybrid, or hydrogen fuel cell vehicles.
Institute idle reduction plans, such as machinery shutdown after 10 seconds of non-use, except for work requiring intermittent engine use or when in traffic.
Compress shipments to offsite laboratories whenever feasible.
Use rechargeable batteries for handheld data loggers and other field instruments.
Segregate soil and groundwater collected from different areas; in many states, media analytically determined to be clean can be deposited onsite rather than transported for offsite disposal.
Recharge laptop computers and mobile devices in vehicles that are in active motion rather than idling.
Dispose investigation-derived waste at the nearest permitted facility.
Water Use and Impacts on Water Resources
Use ground-penetrating radar, magnetometers, and other geophysical survey instrumentation to locate metal objects and delineate disposal areas.
Steam clean or use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment.
Contain decontamination fluids and prevent their entrance into storm drains or the ground surface.
Use biodegradable hydraulic fluids on hydraulic equipment such as drill rigs.
Quickly restore any vegetated areas disrupted by equipment or vehicles to control stormwater runoff and avoid soil transport to surface waterbodies.
Materials Management and Waste Reduction
Consider products, packing material, and disposable equipment with reuse or recycling potential.
Recycle cardboard boxes and beverage bottles.
Reduce the number of sampling days.
CLEANER FUELS AND AIR EMISSIONS FOR SITE CLEANUPS/EPA 542-F-23-001, March 2023
Operations and Maintenance
Implement an idle reduction plan.
Ensure proper tune ups of vehicles and equipment and maintenance of fuel storage tanks.
Establish routines for daily activities such as using biodegradable lubricants, closely managing petroleum-product waste materials, driving efficiently, and inflating tires properly.
Replace engine oil on a timely basis to avoid worn piston rings that reduce engine efficiency.
Check brake parts such as calipers and pads and promptly replace worn parts to avoid brake drag.
Secure prompt interim maintenance when the vehicle's "check engine" light becomes illuminated.
Implement a transportation plan.
Combine trips to avoid unnecessary stopping and starting of engines. Multiple short trips can use twice as much fuel as one long, multi-purpose trip that covers the same distance while the engine is warm and at its most fuel-efficient temperature.
Use a reliable navigation system that enables selecting the shortest route to destinations and avoiding traffic events that may trigger vehicle idling.
Avoid rapid acceleration, excessive speed, and repetitive hard braking, which lowers gas mileage by as much as 30%.
Track fuel consumption and associated emission of greenhouse gases and air toxics and set reduction goals.
EXCAVATION AND SURFACE RESTORATION/EPA 542-F-19-002, AUGUST 2019
Project Planning for Excavation and Surface
Incorporate green requirements into product and service procurements.
Use dynamic work planning; for example, treated excavation material found unnecessary as backfill can be put to beneficial use at onsite or offsite locations.
Scout early and continuously for onsite or nearby sources of backfill material for excavated areas.
Develop advanced schedules for anticipated onsite activities to minimize traffic between onsite contaminated and clean zones and the days in which work is actively performed in the field.
Identify onsite or nearby sources of topsoil to avoid long-distance transport of clean soil. Options may include onsite manufacturing of topsoil through use of locally sourced industrial byproducts such as compost or silica-based spent foundry sands.
Integrate schedules to allow for resource sharing and fewer days of field mobilization.
Energy Requirements
Reduce fuel requirements.
Use field test kits whenever possible and select the nearest qualified laboratory for confirmatory analyses or contaminants outside the scope of field kits.
Green Procurement
Incorporate green requirements into cleanup and supporting service procurements.
Purchase materials from one supplier of locally produced products to reduce need for delivery fuels.
Select local providers for field operations.
Fuels Used in Transfer of Materials and Wastes
Consider selecting the closest qualified waste facility.
Fuel Consumption by Heavy Construction Machinery and Equipment

APPENDIX M

Green Remediation Best Management Practices

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Select suitably sized and typed equipment for tasks.
Instruct workers to avoid engine idle and use machinery with automatic idle-shutdown devices.
Incorporate electronic intelligence systems to improve productivity within and among field machines. "Smart" systems enable work managers to remotely monitor field operations via machine-to-machine communications and identify changes to be made by machinery operators accordingly.
Use machine models capable of performing assorted tasks, whenever feasible, to avoid field deployment of multiple types of machines. For instance, a single excavator can be equipped with a bucket for digging, a breaker for demolition, or a grapple for land clearing.
Perform routine, on-time maintenance, such as oil changes, to improve fuel efficiency.
Air Emissions
Secure and cover material in open trucks while hauling excavated material, and reuse the covers.
Revegetate excavated areas as quickly as possible.
Limit onsite vehicle speeds to 10 miles per hour.
Impacts to Water
Cover soils with biodegradable tarps and mats, rather than spraying with water, to suppress dust while potentially enhancing soil fertility.
Contain and properly dispose of all decontamination fluids to prevent their entrance into storm drains or ground surfaces.
Use phosphate-free detergents instead of organic solvents or acids to decontaminate sampling equipment (if not required for some contaminants).
Overlay synthetic barriers and fluid collection systems on ground surfaces of staging areas and where excavated material is dewatered.
Use a passive, rather than active, mechanical process to dewater sediment when possible. A passive process relies on natural gravity flow and evaporation of the water rather than equipment such as filter presses powered by slurry pumps.
Avoid use of dewatering coagulants or flocculants containing chemicals that are potentially toxic to aquatic life.
Use dewatering processes that maximize water recycling, and consider automated systems to account for sediment variability.
Material Consumption and Waste Generation
Consider product life cycles when purchasing materials and give preference to products, packing material, and disposable equipment with reuse or recycling potential.
Segregate and stockpile drill cuttings generated by drilling to facilitate onsite reuse of the material.
Choose geotextile fabrics or tarps made of recycled material.
Establish staging areas before any digging.
Combine excavated material with comparable waste generated at nearby sites for consolidated transfer in a single trip or fewer trips to the intended facility or site.
Salvage uncontaminated and pest- or disease-free organic debris for use as infill, mulch, or compost.
Reclaim and stockpile uncontaminated soil for use as fill or other purposes such as habitat creation.
Salvage uncontaminated objects with potential recycle, resale, donation, or onsite infrastructure value, such as steel, concrete, granite, and storage containers; waste coordinators are available in many states to assist in decisions regarding beneficial reuse or exposure risk.
Impacts to Land and Ecosystems
A primary best management practice for minimizing the negative impacts on land and ecosystems is to perform an inventory (including detailed photographs and videos) of ecological species, land contours, and drainage patterns before digging.
Inspect equipment left onsite before renewing field activities to avoid harming animals potentially nesting in the equipment. Operation of equipment with nest debris also could cause equipment inefficiency or breakdown.
Substitute temporary silt fences with biodegradable erosion controls such as tubular devices filled with organic materials. Such devices capture sediment transported by stormwater runoff from or to adjoining slopes while building substrates for future vegetation.
Use geotextile bags or nets when possible to ensure containment of excavated sediment during dewatering and to increase efficiency when handling and transporting the dewatered sediment.
Establish minimally intrusive and well-designed traffic patterns for onsite activities and plans to reduce offsite traffic congestion.
Include plant species that promote colonization of bees and other pollinators.
Identify existing or anticipated ecosystem services to be considered in project designs.
Rescue and relocate wildlife that rely on habitat in areas to be excavated. Many environmental, academic, or community groups offer help in conducting wildlife rescues and compiling wildlife or plant inventories.
Seed or install native rather than non-native species, which typically increases the rate of plant survival and minimizes the need for irrigation and soil or plant inputs.
Replicate the site's original contours during soil grading.
Install silt fences and basins to capture sediment runoff along sloped areas.
PUMP AND TREAT SYSTEMS/EPA-542-F-21-029, DECEMBER 2021
Stormwater Discharge Controls
Maximize vegetative cover across the site.
Use gravel roads, porous pavement, and separated impervious surfaces.
MATERIALS AND WASTE MANAGEMENT/EPA 542-F-13-003, DECEMBER 2013
Purchase of Greener Material
Select products that are environmentally preferable (when compared with other products serving the same purpose) with respect to raw materials consumption, manufacturing processes and locations, packaging, distribution, recycled content and recycling capability, maintenance needs, and disposal procedures.
Choose vendors with production and distribution centers near the site to minimize fuel consumption associated with delivery.
Choose suppliers that will take back scraps or unused materials.
Plan new construction with future deconstruction or material reuse in mind.
Material Reuse or Recycling Versus Disposal
Screen local recyclers and waste haulers to identify organizations that will handle materials in an environmentally responsible manner, including suitable transportation methods and waste destinations.
Salvage uncontaminated demolition and other materials with value for reuse or recycling, resale, or donation.

APPENDIX M

Green Remediation Best Management Practices

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1

Evaluate environmental or other trade-offs involved in onsite reuse of materials versus shipment offsite for reuse or recycling; evaluations can range in effort from qualitative comparisons of options to more rigorous quantification of alternative outcomes.
Procurement
Develop a plan and reporting format to routinely track materials' reuse or recycling and disposal.
INTEGRATING RENEWABLE ENERGY/EPA 542-F-22-001, MARCH 2022
Track Energy Use
Use online calculators or software available from government or non-profit organizations at no cost, such as the NOx and Energy Assessment Tool (NxEAT); U.S. Environmental Protection Agency offers an online compendium of such tools.
Logistics
Incorporate additional security measures to prevent damage or theft of system components.
General Practices
Coordinate early with the local utility when designing a renewable energy system to be tied to the grid to ensure equipment, such as circuit breakers, and all installation methods meet the utility's standards and maximize protection of utility lines as well as onsite power lines.
Schedule sufficient planning time that accounts for operational permitting, availability of preferred installers, and potential backlogs in equipment manufacturing.
Renewable Energy Assessments
Conduct general analysis of the energy demand and make additional recommendations for energy efficiency.
Complete preliminary evaluation of the site's renewable energy resources, which may include multiple sources.
Compile a list of pertinent federal, state, and public utility incentives applying to the site.

Appendix N
Threatened and Endangered Species Documentation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Michigan Ecological Services Field Office
2651 Coolidge Road Suite 101
East Lansing, MI 48823-6360
Phone: (517) 351-2555 Fax: (517) 351-1443

In Reply Refer To: August 21, 2023
Project Code: 2023-0119525
Project Name: Velsicol Downgradient Vertical Barrier Wall

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

Official Species List
The attached species list identifies any Federally threatened, endangered, proposed and candidate species that may occur within the boundary of your proposed project or may be affected by your proposed project. The list also includes designated critical habitat if present within your proposed project area or affected by your project. This list is provided to you as the initial step of the consultation process required under section 7(c) of the Endangered Species Act, also referred to as Section 7 Consultation.

Under 50 CFR 402.12(e) (the regulations that implement section 7 of the Endangered Species Act), the accuracy of this species list should be verified after 90 days. You may verify the list by visiting the IPaC website (https://ipac.ecosphere.fws.gov/) at regular intervals during project planning and implementation. To update an Official Species List in IPaC: from the My Projects page, find the project, expand the row, and click Project Home. In the What's Next box on the Project Home page, there is a Request Updated List button to update your species list. Be sure to select an "official" species list for all projects.

Consultation requirements and next steps
Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize Federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-Federal representative) must consult with the Fish and Wildlife Service if they determine their project may affect listed species or critical habitat.

There are two approaches to evaluating the effects of a project on listed species.

Approach 1. Use the All-species Michigan determination key in IPaC. This tool can assist you in making determinations for listed species for some projects. In many cases, the determination key

will provide an automated concurrence that completes all or significant parts of the consultation process. Therefore, we strongly recommend screening your project with the **All-Species Michigan Determination Key (Dkey)**. For additional information on using IPaC and available Determination Keys, visit https://www.fws.gov/media/mifo-ipac-instructions (and click on the attachment). Please carefully review your Dkey output letter to determine whether additional steps are needed to complete the consultation process.

Approach 2. Evaluate the effects to listed species on your own without utilizing a determination key. Once you obtain your official species list, you are not required to continue in IPaC, although in most cases using a determination key should expedite your review. If the project is a Federal action, you should review our section 7 step-by-step instructions before making your determinations: https://www.fws.gov/office/midwest-region-headquarters/midwest-section-7-technical-assistance. If you evaluate the details of your project and conclude "no effect," document your findings, and your listed species review is complete; you do not need our concurrence on "no effect" determinations. If you cannot conclude "no effect," you should coordinate/consult with the Michigan Ecological Services Field Office. The preferred method for submitting your project description and effects determination (if concurrence is needed) is electronically to EastLansing@fws.gov. Please include a copy of this official species list with your request.

For all **wind energy projects** and **projects that include installing communications towers that use guy wires**, please contact this field office directly for assistance, even if no Federally listed plants, animals or critical habitat are present within your proposed project area or may be affected by your proposed project.

Migratory Birds
Please see the "Migratory Birds" section below for important information regarding incorporating migratory birds into your project planning. Our Migratory Bird Program has developed recommendations, best practices, and other tools to help project proponents voluntarily reduce impacts to birds and their habitats. The Bald and Golden Eagle Protection Act prohibits the take and disturbance of eagles without a permit. If your project is near an eagle nest or winter roost area, see our Eagle Permits website at https://www.fws.gov/program/eagle-management/eagle-permits to help you avoid impacting eagles or determine if a permit may be necessary.

Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your consideration of threatened and endangered species during your project

planning. Please include a copy of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Michigan Ecological Services Field Office
2651 Coolidge Road Suite 101
East Lansing, MI 48823-6360
(517) 351-2555

PROJECT SUMMARY

Project Code: 2023-0119525
Project Name: Velsicol Downgradient Vertical Barrier Wall
Project Type: NPL Site Remediation
Project Description: Velsicol Chemical Corporation Superfund Site in St. Louis, Michigan, Operable Unit 1. The Downgradient Vertical Barrier Wall is one component of the remediation strategy and involves installation of a barrier wall designed to decrease the potential for dense nonaqueous phase liquid and dissolved-phase contaminants to directly discharge to the Pine River from the shallow outwash unit underlying the Former Plant Site. The Project is proposed to be started in 2024 and be completed in approximately 2 years. Although there will some terrestrial impacts related to equipment and materials storage yards, most of the impacts will occur along the existing shoreline and in the adjacent, shallow waters of the Pine River.

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@43.411162250000004,-84.61813533323303,14z

Counties: Gratiot County, Michigan

ENDANGERED SPECIES ACT SPECIES

There is a total of 6 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 1 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949 General project design guidelines: https://ipac.ecosphere.fws.gov/project/DH6E7XSBUVE7RDZIRYZB2Y5CGE/documents/generated/6982.pdf	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Endangered
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

REPTILES

NAME	STATUS
Eastern Massasauga (=rattlesnake) *Sistrurus catenatus*	Threatened

No critical habitat has been designated for this species.
This species only needs to be considered under the following conditions:
- For all Projects: Project is within EMR Range

Species profile: https://ecos.fws.gov/ecp/species/2202
General project design guidelines:
https://ipac.ecosphere.fws.gov/project/DH6E7XSBUVE7RDZIRYZB2Y5CGE/documents/generated/5280.pdf

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus*	Candidate

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/9743

FLOWERING PLANTS

NAME	STATUS
Eastern Prairie Fringed Orchid *Platanthera leucophaea*	Threatened

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/601

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

USFWS NATIONAL WILDLIFE REFUGE LANDS AND FISH HATCHERIES

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

MIGRATORY BIRDS

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds Dec 1 to Aug 31

PROBABILITY OF PRESENCE SUMMARY

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see

below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

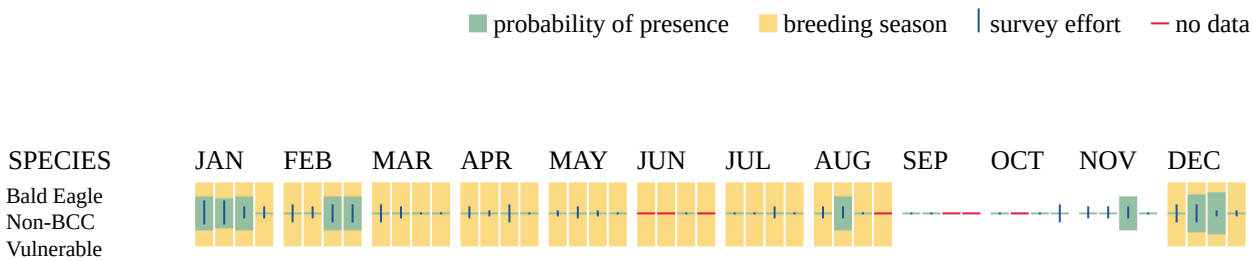
1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

MIGRATORY BIRDS FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and

how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report
The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

WETLANDS

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

LAKE

- L1UBHh

IPAC USER CONTACT INFORMATION

Agency: Environmental Protection Agency
Name: Joe Thacker
Address: 113 Southwood Dr
City: Madison
State: AL
Zip: 35758
Email joseph.thacker@jacobs.com
Phone: 2058073669

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Environmental Protection Agency

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Michigan Ecological Services Field Office
2651 Coolidge Road Suite 101
East Lansing, MI 48823-6360
Phone: (517) 351-2555 Fax: (517) 351-1443

In Reply Refer To: August 21, 2023
Project code: 2023-0119525
Project Name: Velsicol Downgradient Vertical Barrier Wall

Subject: Verification letter for 'Velsicol Downgradient Vertical Barrier Wall' for specified federally threatened and endangered species and designated critical habitat that may occur in your proposed project area consistent with the Michigan Determination Key for project review and guidance for federally listed species (Michigan Dkey).

Dear Joe Thacker:

The U.S. Fish and Wildlife Service (Service) received on **August 21, 2023** your effect determination(s) for the 'Velsicol Downgradient Vertical Barrier Wall' (the Action) using the Michigan DKey within the Information for Planning and Consultation (IPaC) system. The Service developed this system in accordance with the Endangered Species Act of 1973 (ESA) (87 Stat.884, as amended; 16 U.S.C. 1531 et seq.).

Based on your answers and the assistance in the Service's Michigan DKey, you made the following effect determination(s) for the proposed action.

Species	**Listing Status**	**Determination**
Eastern Massasauga (=rattlesnake) (*Sistrurus catenatus*)	Threatened	NLAA
Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)	Threatened	No effect
Indiana Bat (*Myotis sodalis*)	Endangered	NLAA
Monarch Butterfly (*Danaus plexippus*)	Candidate	May affect
Northern Long-eared Bat (*Myotis septentrionalis*)	Endangered	NLAA
Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	NLAA

The Service will notify you within 30 calendar days if we determine that this proposed Action does not meet the criteria for a "may affect, not likely to adversely affect" (NLAA) determination for Federally listed species in Michigan. If we do not notify you within that timeframe, you may proceed with the Action under the terms of the NLAA concurrence provided here. This verification period allows the Michigan Ecological Services Field Office to apply local

knowledge to evaluation of the Action, as we may identify a small subset of actions having impacts that were unanticipated. In such instances, the Michigan Ecological Services Field Office may request additional information to verify the effects determination reached through the Michigan DKey.

Your agency has met consultation requirements by informing the Service of your “No Effect” determination(s). No consultation for is required for species that you determined will not be affected by the Action.

Please provide sufficient project details on your project homepage in IPaC (Define Project, Project Description) to support your conclusions and the Service’s 30-day review period. Failure to disclose important aspects of your project that would influence the outcome of your effects determinations may negate your determinations and invalidate this letter. If you have site-specific information that leads you to believe a different determination is more appropriate for your project than what the Dkey concludes, you can and should proceed based on the best available information.

The Service recommends that you contact the Service or re-evaluate the project in IPaC if: 1) the scope or location of the proposed Action is changed; 2) new information reveals that the action may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the Action is modified in a manner that causes effects to listed species or designated critical habitat; or 4) a new species is listed or critical habitat designated. If any of the above conditions occurs, additional consultation with the Service should take place before project changes are final or resources committed.

Tricolored Bat:
Tricolored bat was proposed for listing as endangered on September 13. 2022. White-nose syndrome (WNS) has caused estimated declines of more than 90 percent in affected tricolored bat colonies and is currently present across 59 percent of the species’ range.

During winter, tricolored bats hibernate in caves, abandoned mines, and tunnels ranging from small to large in size. During spring, summer and fall months, they roost primarily among leaf clusters of live or recently dead deciduous/hardwood trees.

In Michigan, the tricolored bat was rare pre-WNS and is exceedingly rare post-WNS. The species has been observed in 12 Michigan counties to date, largely during the fall or winter (September through mid-March) in or near hibernation sites. Most known hibernacula are abandoned mines in the western Upper Peninsula, although the species has been detected hibernating in three additional Lower Peninsula sites. Observed hibernating populations have been small (e.g., <10 individuals per site) since before WNS. With very few exceptions, the species has not been observed in Michigan in the summer, and no maternity colonies have been documented, despite repeated and extensive mist netting and other survey efforts in suitable summer habitat.

Trees near potential hibernacula are more likely to have tricolored bats present during the fall/spring and possibly summer months. Clearing trees near hibernacula during certain times of the year could result in adverse effects to this species. Trees outside of these areas may be occupied

by migrating tricolored bats seasonally, but cutting trees outside these areas is extremelly unlikely to result in adverse effects (discountable).

If a final rule is published listing the tricolored bat as endangered, the Service will provide additional information on evaluating projects for potential impacts to tricolored bat.

Bats of Conservation Concern:
Implementing protective measures for bats, including both federally listed and non-listed species, indirectly helps to protect Michigan's agriculture and forests. Bats are significant predators of nocturnal insects, including many crop and forest pests. For example, Whitaker (1995) estimated that a single colony of 150 big brown bats (Eptesicus fuscus) would eat nearly 1.3 million pest insects each year. Boyles et al. (2011) noted the "loss of bats in North America could lead to agricultural losses estimated at more than $3.7 billion/year, and Maine and Boyles (2015) estimated that the suppression of herbivory by insectivorous bats is worth >1 billion USD globally on corn alone. In captive trials, northern long-eared bats were found to significantly reduce the egg-laying activity of mosquitoes, suggesting bats may also play an important role in controlling insect-borne disease (Reiskind and Wund 2009). Mosquitoes have also been found to be a consistent component of the diet of Indiana bats and are eaten most heavily during pregnancy (6.6%; Kurta and Whitaker 1998). Taking proactive steps to help protect bats may be very valuable to agricultural and forest product yields and pest management costs in and around a project area. Such conservation measures include limiting tree clearing during the bat active season (April through Octobervaries by location) and/or the non-volant period (June through July), when young bats are unable to fly, and minimizing the extent of impacts to forests, wetlands, and riparian habitats.

Monarch:
In December 2020, after an extensive status assessment of the monarch butterfly, we determined that listing the monarch under the Endangered Species Act is warranted but precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Therefore, the Service added the monarch butterfly to the candidate list. The Service will review its status each year until we are able to begin developing a proposal to list the monarch.

The Endangered Species Act does not establish protections or consultation requirements for candidate species. Some Federal and State agencies may have policy requirements to consider candidate species in planning. We encourage implementing measures that will remove or reduce threats to these species and possibly make listing unnecessary. Please refer to our recommendations in the Monarch and Pollinators section, below.

Bald and Golden Eagles:
Bald eagles, golden eagles, and their nests are protected under the Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d) (Eagle Act). The Eagle Act prohibits, except when authorized by an Eagle Act permit, the "taking" of bald and golden eagles and defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The Eagle Act's implementing regulations define disturb as "…to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially

interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

If the Action may impact bald or golden eagles, additional coordination with the Service under the Eagle Act may be required. For more information on eagles and conducting activities in the vicinity of an eagle nest, please visit https://www.fws.gov/library/collections/all-about-eagles. In addition, the Service developed the National Bald Eagle Management Guidelines (May 2007) in order to assist landowners in avoiding the disturbance of bald eagles. The full Guidelines are available at https://www.fws.gov/media/national-bald-eagle-management-guidelines-0.

If you have further questions regarding potential impacts to eagles, please contact Chris Mensing, Chris_Mensing@fws.gov or 517-351-2555.

Monarch butterfly and other pollinators
In December 2020, after an extensive status assessment of the monarch butterfly, we determined that listing the monarch under the Endangered Species Act is warranted but precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Therefore, the Service added the monarch butterfly to the candidate list. The Service will review its status each year until we are able to begin developing a proposal to list the monarch.

The Endangered Species Act does not establish protections or consultation requirements for candidate species. Some Federal and State agencies may have policy requirements to consider candidate species in planning. We encourage implementing measures that will remove or reduce threats to these species and possibly make listing unnecessary.

For all projects, we recommend the following best management practices (BMPs) to benefit monarch and other pollinators.

Monarch and Pollinator BMP Recommendations

Consider monarch and other pollinators in your project planning when possible. Many pollinators are declining, including species that pollinate key agricultural crops and help maintain natural plant communities. Planting a diverse group of native plant species will help support the nutritional needs of Michigan's pollinators. We recommend a mix of flowering trees, shrubs, and herbaceous plants so that something is always blooming and pollen is available during the active periods of the pollinators, roughly early spring through fall (mid-March to mid-October). To benefit a wide variety of pollinators, choose a wide range of flowers with diverse colors, heights, structure, and flower shape. It is important to provide host plants for any known butterfly species at your site, including native milkweed for Monarch butterfly. Incorporating a water source (e.g., ephemeral pool or low area) and basking areas (rocks or bare ground) will provide additional resources for pollinators.

Many pollinators need a safe place to build their nests and overwinter. During spring and summer, leave some areas unmowed or minimize the impacts from mowing (e.g., decrease frequency, increase vegetation height). In fall, leave areas unraked and leave plant stems standing. Leave patches of bare soil for ground nesting pollinators.

Avoid or limit pesticide use. Pesticides can kill more than the target pest. Some pesticide residues can kill pollinators for several days after the pesticide is applied. Pesticides can also kill natural predators, which can lead to even worse pest problems.

Planting native wildflowers can also reduce the need to mow and water, improve bank stabilization by reducing erosion, and improve groundwater recharge and water quality.

Resources:

https://www.fws.gov/initiative/monarchs
https://www.fws.gov/library/collections/pollinators

Wetland impacts:
Section 404 of the Clean Water Act of 1977 (CWA) regulates the discharge of dredged or fill material into waters (including wetlands) of the United States. Regulations require that activities permitted under the CWA (including wetland permits issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE)) not jeopardize the continued existence of species listed as endangered or threatened. Permits issued by the U.S. Army Corps of Engineers must also consider effects to listed species pursuant to section 7 of the Endangered Species Act. The Service provides comments to the agencies that may include permit conditions to help avoid or minimize impacts to wildlife resources including listed species. For this project, we consider the conservation measures you agreed to in the determination key and/or as part of your proposed action to be non-discretionary. If you apply for a wetland permit, these conservation measures should be explicitly incorporated as permit conditions. Include a copy of this letter in your wetland permit application to streamline the threatened and endangered species review process.

Bat References
Boyles, J.G., P.M. Cryan, G.F. McCracken, T.H. Kunz. 2011. Economic Importance of Bats in Agriculture. Science 332(1):41-42.
Kurta, A. and J.O. Whitaker. 1998. Diet of the Endangered Indiana Bat (Myotis sodalis) on the Northern Edge of Its Range. The American Midland Naturalist 140(2):280-286.
Reiskind, M.H. and M.A. Wund. 2009. Experimental assessment of the impacts of northern long-eared bats on ovipositing Culex (Diptera: Culicidae) mosquitoes. Journal of Medical Entomology 46(5):1037-1044.
Whitaker, Jr., J.O. 1995. Food of the big brown bat Eptesicus fuscus from maternity colonies in Indiana and Illinois. American Midland Naturalist 134(2):346-360.

Summary of conservation measures for your project You agreed to the following conservation measures to avoid adverse effects to listed species and our concurrence is only valid if the measures are fully implemented. These must be included as permit conditions if a permit is required and/or included in any contract language.

Eastern massasauga
Materials used for erosion control and site restoration must be wildlife-friendly. Do not use erosion control products containing plastic mesh netting or other similar material that could entangle eastern massasauga rattlesnake (EMR). Several products for soil erosion and control exist that do not contain plastic netting including net-less erosion control blankets (for example, made of excelsior), loose mulch, hydraulic mulch, soil binders, unreinforced silt fences, and straw bales. Others are made from natural fibers (such as jute) and loosely woven together in a manner that allows wildlife to wiggle free.

To increase human safety and awareness of EMR, those implementing the project must first review the EMR factsheet (available at https://www.fws.gov/media/eastern-massasauga-rattlesnake-fact-sheet), and watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake" video (available at https://youtu.be/~PFnXe_e02w).

During project implementation, report sightings of any federally listed species, including EMR, to the Service within 24 hours.

The project will not result in permanent loss of more than one acre of wetland or conversion of more than 10 acres of EMR upland habitat (uplands associated with high quality wetland habitat) to other land uses.

The project will occur entirely within the EMR active season (April 15 through October 15 in the southern Lower Peninsula; in the northern Lower Peninsula May 1 through October 1).

Listed bats
Any cutting/trimming of potential roost trees for Indiana bat (trees ≥5 inches in diameter [at breast height] with cracks, crevices and/or exfoliating bark) must occur OUTSIDE the non-volant ("pup") season for Indiana bat (June 1 through July 31). Prescribed fire and/or pesticide application must also occur outside June-July where potential roost trees are present.

Tree cutting/trimming and/or prescribed burning will not clear ≥20 contiguous acres of forest or fragment a connective corridor between 2 or more forest patches of at least 5 acres.

The action will not include temporary or permanent lighting of roadway(s), facility(ies), and/or parking lot(s).

Action Description
You provided to IPaC the following name and description for the subject Action.

1. Name

Velsicol Downgradient Vertical Barrier Wall

2. Description

The following description was provided for the project 'Velsicol Downgradient Vertical Barrier Wall':

> Velsicol Chemical Corporation Superfund Site in St. Louis, Michigan, Operable Unit 1. The Downgradient Vertical Barrier Wall is one component of the remediation strategy and involves installation of a barrier wall designed to decrease the potential for dense nonaqueous phase liquid and dissolved-phase contaminants to directly discharge to the Pine River from the shallow outwash unit underlying the Former Plant Site. The Project is proposed to be started in 2024 and be completed in approximately 2 years. Although there will some terrestrial impacts related to equipment and materials storage yards, most of the impacts will occur along the existing shoreline and in the adjacent, shallow waters of the Pine River.

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@43.411162250000004,-84.61813533323303,14z

QUALIFICATION INTERVIEW

1. Are there any possible effects to any listed species or to designated critical habitat from your project or effects from any other actions or projects subsequently made possible by your project?

   Select "Yes" even if the expected effects to the species or critical habitat are expected to be 1) extremely unlikely (discountable), 2) can't meaningfully be measured, detected, or evaluated (insignificant), or 3) wholly beneficial.

   Select "No" to confirm that the project details and supporting information allow you to conclude that listed species and their habitats will not be exposed to any effects (including discountable, insignificant, or beneficial effects) and therefore, you have made a "no effect" determination for all species. If you are unsure, select YES to answer additional questions about your project.

   Yes

2. This determination key is intended to assist the user in the evaluating the effects of their actions on Federally listed species in Michigan. It does not cover other prohibited activities under the Endangered Species Act (e.g., for wildlife: import/export, Interstate or foreign commerce, possession of illegally taken wildlife, purposeful take for scientific purposes or to enhance the survival of a species, etc.; for plants: import/export, reduce to possession, malicious destruction on Federal lands, commercial sale, etc.) or other statutes. Click yes to acknowledge that you must consider other prohibitions of the ESA or other statutes outside of this determination key.

   Yes

3. Is the action the approval of a long-term (i.e., in effect greater than 10 years) permit, plan, or other action? (e.g., a new or re-issued hydropower license, a land management plan, or other kinds of documents that provide direction for projects or actions that may be conducted over a long term (>10 years) without the need for additional section 7 consultation).

   No

4. Is the action being funded, authorized, or carried out by a Federal agency?

   Yes

5. Does the action involve the installation or operation of wind turbines?

   No

6. Are there at least 30 days prior to your action occurring? Endangered species consultation must be completed before taking any action that may have effects to listed species. The Service also needs 30 days to review projects before we can verify conclusions in some dkey output letters. For example, if you have already started some components of the project on the ground (e.g., removed vegetation) before completing this key, answer “no” to this question. The only exception is if you have a Michigan Field Office pre-approved emergence survey (i.e., if you have conducted pre-approved emergence surveys for listed bats before tree removal, you can still answer yes to this question).

   Yes

7. Does the action involve constructing a new communication tower or modifying an existing communications tower?

   No

8. Does the activity involve aerial or other large-scale application of any chemical (including insecticide, herbicide, etc.)?

   No

9. Does your project include water withdrawal (ground or surface water) greater than 10,000 gallons/day?

   No

10. Will your action permanently affect hydrology?

    Yes

11. Will your project have any direct impacts to a stream or river (e.g., Horizontal Directional Drilling (HDD), hydrostatic testing, stream/road crossings, new storm-water outfall discharge, dams, other in-stream work, etc.)?

    Yes

12. Does your project have the potential to indirectly impact the stream/river or the riparian zone (e.g., cut and fill, horizontal directional drilling, hydrostatic testing, construction, vegetation removal, discharge, etc.)?

    Yes

13. Are you applying for one of the following Michigan EGLE/Army Corps of Engineers joint permit application Minor Permit (MP) Categories:
    MP 3 - Boat Hoist; MP 5 - Boal Wells; MP 7 - Completed Enforcement Actions; MP 12 - Dock;
    MP 21 - Fish and Wildlife Habitat Structures;
    MP 22 - Ford Stream Crossings for Commercial Forestry Operations;
    MP 28 - Maintenance and Repair of Serviceable Structures;
    MP 45 - Temporary Recreational Structures;
    MP 48 - Wetland Habitat Restoration and Enhancement?

    Verify the MP category number and associated description matches your project/application (https://www.michigan.gov/documents/egle/WRD-Minor-Project-Categories_733320_7.pdf). If you don't know what category applies for your project, answer no to this question.

    No
14. Are you applying for one of the following Michigan EGLE/Army Corps of Engineers joint permit application General Permit (GP) Categories:
    GP A - Aids to Navigation;
    GP C - Clear Span Bridge;
    GP E - Culverts - Small;
    GP J - Dry Fire Hydrant;
    GP O - Minor Permit Revisions and Transfers;
    GP Q - Mooring Buoy;
    GP W - Scientific Measuring Devices;
    GP X - Snow Road Stream Crossings for Forestry Operations;
    GP Z - Spring Piles and Piling Clusters;
    GP DD - Wetland Habitat Restoration and Enhancement?

    Verify the GP category number and associated description matches your project/application (https://www.michigan.gov/documents/deq/wrd-general-permit-categories_555828_7.pdf). If you don't know what category applies for your project, answer no to this question.

    No
15. Will your action disturb the ground or existing vegetation? This includes any off road vehicle access, soil compaction, digging, seismic survey, directional drilling, heavy equipment, grading, trenching, placement of fill, pesticide application, vegetation management (including removal or maintenance using equipment or chemicals), cultivation, development, etc.

    Yes
16. Is the action a utility-scale solar development project?

    No

17. [Hidden semantic] Does the action intersect the MOBU AOI?

    Automatically answered
    Yes

18. Under the ESA, monarchs remain warranted but precluded by listing actions of higher priority. The monarch is a candidate for listing at this time. The Endangered Species Act does not establish protections or consultation requirements for candidate species. Some Federal and State agencies may have policy requirements to consider candidate species in planning. We encourage implementing measures that will remove or reduce threats to these species and possibly make listing unnecessary. If your project will have no effect on monarch butterflies (for example, if your project won't affect their habitat or individuals), then you can make a "no effect" determination for this project. Are you making a "no effect" determination for monarch?

    No

19. Is this project funded, authorized, or carried out by the U.S. Fish and Wildlife Service?

    No

20. [Hidden Semantic] Does the action intersect the Eastern massasauga rattlesnake area of influence?

    Automatically answered
    Yes

21. In a previous answer in this key, you indicated your project will have permanent effects to hydrology. Will the hydrological impacts result in a significant change in the elevation of surface water upstream or downstream, or in the local groundwater elevations?

    A significant change is one where the elevations are expected to change more than 6 inches or result in inundation.

    No

22. Does your action involve prescribed fire?

    No

23. Will this action occur entirely in the Eastern massasauga rattlesnake inactive season (October 16 through April 14)?

    No

24. Will this action occur entirely in the Eastern massasauga rattlesnake active season (April 15 through October 15)?

    Yes

25. Will the action result in permanent loss of more than one acre of wetland or conversion of more than 10 acres of uplands of potential Eastern massasauga rattlesnake habitat (uplands associated with high quality wetland habitat) to other land uses?

    No

26. Will you use wildlife safe materials for erosion control and site restoration and eliminate the use of erosion control products containing plastic mesh netting or other similar material that could ensnare Eastern massasauga rattlesnake?

    Yes

27. Will you watch MDNR's "60-Second Snakes: The Eastern Massasauga Rattlesnake (EMR)" video, review the EMR factsheet or call 517-351-2555 to increase human safety and awareness of EMR?

    Yes

28. Will all action personnel report any Eastern massasauga rattlesnake observations, or observation of any other listed threatened or endangered species, during action implementation to the Service within 24 hours?

    Yes

29. [Hidden Semantic] Does the action area intersect the area of influence for Eastern prairie fringed orchid?

    Automatically answered
    Yes

30. The project has the potential to affect federally listed bats. Does the action area contain any known or potential bat hibernacula (natural caves, abandoned mines, or underground quarries)?

    No

31. Has a presence/absence bat survey or field-based habitat assessment following the Service's Range-wide Indiana Bat and Northern Long-eared Bat Summer Survey Guidelines been conducted within the action area?

    No

32. Does the action involve removal/modification of a human structure (barn, house or other building) known to contain roosting bats?

    No

33. Does the action include removal/modification of an existing bridge or culvert?

    No

34. Does the action include temporary or permanent lighting of roadway(s), facility(ies), and/or parking lot(s)?

    No

35. Does the action include one or more of the following: (1) tree cutting/trimming, (2) prescribed fire, (3) pesticide (including insecticide and/or rodenticide), and/or (4) herbicide/fungicide application?

    Yes

36. Does the action include herbicide application?

    No

37. Will the action clear >10 acres of contiguous forest (i.e., connected by 1,000 feet or less) or fragment a riparian or other connective forested corridor (e.g., tree line) between 2 or more forest patches of at least 5 acres? For more information, see Appendix II.

    No

38. Does the action area contain potential NLEB bat roost trees (trees ≥3 inches in diameter [at breast height] with cracks, crevices, cavities and/or exfoliating bark)? For more information, see Appendix IV.

    Yes

39. Does the action area contain potential Indiana bat roost trees (trees ≥5 inches in diameter [at breast height] with cracks, crevices and/or exfoliating bark)? For more information, see Appendix III.

    Yes

40. Does the action include emergency cutting/trimming of hazard trees in order to prevent imminent loss of human life and/or property?

    No

41. [Semantic] Is any portion of the action area within 5 miles of a known Indiana or northern long-eared bat hibernaculum?

    Automatically answered
    No

42. Will all tree cutting/trimming, prescribed fire, and/or pesticide application occur OUTSIDE the non-volant ("pup") season for bat (that is, no cutting/trimming, prescribed fire, or pesticide application during June 1 through July 31)?

    Note: that based on the project's location, conducting these activities outside the months of June and July may be sufficient to avoid adverse effects to/take of bat.

    Yes

43. [Hidden Semantic] Does the action area intersect the Indiana bat AOI?

    Automatically answered
    Yes

44. [Hidden Semantic] Does this project intersect the northern long-eared bat area of influence?

    Automatically answered
    Yes

45. [Hidden semantic] Does the action intersect the Tricolored bat AOI/SLA/range?

    Automatically answered
    Yes

46. The tricolored bat was proposed for listing as endangered on September 13, 2022. In Michigan, the tricolored bat was rare pre-white nose syndrome (WNS) and is exceedingly rare post-WNS. The species has been observed in 12 Michigan counties to date, largely during the fall or winter. With very few exceptions, the species has not been observed in Michigan in the summer months, and no maternity colonies have been found. During winter, tricolored bats hibernate in caves, abandoned mines, and abandoned tunnels ranging from small to large in size. During spring, summer and fall months, they roost primarily among leaf clusters of live or recently dead deciduous/hardwood trees.

    Are you making a no effect determination on this project for the tricolored bat?

    No

IPAC USER CONTACT INFORMATION

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LEAD AGENCY CONTACT INFORMATION

Lead Agency: Environmental Protection Agency

Appendix O
SHPO Documentation

Cultural Resources Literature Review

Remedial Design for Operable Units 1 and 3
Velsicol Chemical Corporation Superfund Site

St. Louis, Gratiot County, Michigan

Prepared for:

United States Environmental Protection Agency – Region 5

Prepared by:

CH2M HILL, Inc.
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U.S. Environmental Protection Agency
Contract Number 68HE0519D0007
Task Order Number 68HE0521F0106
DCN: GLAES-R5-21F0106-02024

September 2023

Executive Summary

On behalf of the U.S. Environmental Protection Agency (EPA), Great Lakes National Program Office, CH2M HILL, Inc. (CH2M), a wholly owned subsidiary of Jacobs, has prepared this cultural resources desktop literature review in support of remedial design (RD) components for Operable Units (OUs) in OU1 and OU3 of the Velsicol Chemical Corporation Superfund Site (site) in St. Louis, Michigan (project). The project proposes to install a downgradient vertical barrier wall (DGVBW) in the Superfund site around the Pine River at the Former Plant Site (FPS) in OU1. The vertical barrier wall is one of several components of the OU1 remedy that is being implemented in accordance with the 2012 Record of Decision (EPA, 2012). Contaminated soils would be removed from areas of the Pine River floodplains and riverbanks in OU3. This cultural resources desktop literature review requests concurrence for the findings and recommendations presented for the additional RD components proposed for OU1 and OU3 of the site in compliance with Section 106 of the National Historic Preservation Act (NRHP) (54 *United States Code* [U.S.C.] § 306108).

In 2019, CH2M submitted a technical memorandum with literature review results for RD efforts for the site, which identified no historic properties in the project (Sather et al., 2019). Since the completion of the 2019 technical memorandum, the process pads and work area design have changed slightly for the project but are still within the project footprint and are less invasive than previously proposed, so no further consideration was warranted for RD remedy at the site. This information is provided for informational purposes and context, as the project changes have been minimalized since the submittal in 2019.

The Area of Potential Effects (APE) is defined as the area in which the direct and indirect effects of a project might cause alterations to the character of historic properties (36 *Code of Federal Regulations* 800). The project is constrained to the FPS in OU1 and Pine River floodplains and riverbanks in OU3. The project would surround the riverbank at the FPS with a DGVBW, would excavate, dispose, and replace contaminated floodplain and riverbank soils to a maximum depth of 3 feet below ground surface, and would construct temporary access roads by removing topsoil and adding gravel or composite mats. The APE is any area where ground disturbance would occur and consists of two discontiguous areas in OU1 and OU3 that total approximately 65.8 acres (26.6 hectares). The APE for OU1 comprises 48.5 acres and is the fullest extent of the FPS where the DGVBW would be installed and its vicinity. The APE for OU3 comprises 17.3 acres and includes the river and floodplain areas where contaminated soils would be removed, and temporary access roads would be constructed.

The records review indicates that no previously recorded archaeological sites, aboveground resources, or other cultural resources eligible for or listed in the NRHP are within the APE. In the Study Area, a total of 10 archaeological sites, 44 aboveground resources, 1 historic district, and at least 1 cemetery (which is also counted as an archaeological site) were recorded by previous cultural resources investigations. Of those 56 cultural resources, there is 1 NRHP-listed historic district (St. Louis Downtown Historic District), 3 NRHP-eligible archaeological sites (20GR186, 20GR187, and 20GR199), and 5 NRHP-eligible aboveground resources (P16910, P23218, P23220, P48263, and P52334). All the previously identified cultural resources are in the Study Area, and none are within or adjacent to the APE. In addition to the identified resources, five previous cultural resources surveys have been conducted within the Study Area, none of which are within or adjacent to the APE.

Though the project proposes remedial activities that would not introduce new aboveground features, the project would cause ground distance and tree removal. Some trees would be removed for the construction of temporary access roads and work areas, and the remaining canopy would sufficiently retain the existing

viewshed in or adjacent to the APE. The APE in OU1 was heavily modified by former industrial uses, associated ground disturbance, and prior subsurface remediation within the APE. The APE in OU3 intersects the river and adjacent floodplain and is in relatively intact soils with a moderate potential to yield buried cultural deposits. Therefore, the potential for impacts to previously undiscovered cultural resources in the APE is low in OU1 and moderate in OU3.

It is not feasible to conduct an archaeological survey within the APE because of the high likelihood that contaminated soils would be encountered in the field. However, the APE has not been subject to previous archaeological investigations, and the potential to encounter previously undisturbed soils is present in OU3. Undisturbed soils have the potential to contain submerged and/or terrestrial archaeological resources. Because of the contamination, standard archaeological excavation could pose a hazard to archaeologists, and data recovery should be limited to archaeological monitoring. Thus, archaeological study should be conducted to recover and preserve information and artifacts in areas of the site that could not be avoided by the removal of contaminated soil. CH2M recommends the preparation of a monitoring plan for submerged and terrestrial areas in the APE, which should be implemented prior to and during any ground-disturbing activities in OU3.

In the event that previously undiscovered cultural resource, human burials, and/or graves or grave goods are encountered during construction and remediation activities, all activity around the encountered property shall cease immediately to avoid or minimize harm to the property, which will be defined and specified in the proposed monitoring plan. If Native American human remains and cultural items are located, the consultation and repatriation process should be followed as outlined by the Native American Graves Protection and Repatriation Act (Pub. L. 101-601, 25 U.S.C. 3001 et seq., 104 Stat. 3048). Due to the nature of the proposed project and lack of aboveground resources in the APE, aboveground investigation is not recommended for the project, and no further investigation for aboveground resources is warranted. Therefore, the project would have no adverse effect to historic properties, and no further identification or evaluation of archaeological or aboveground resources is recommended.

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Acronyms and Abbreviations

Acronym	Definition
APE	Area of Potential Effects
BCE	before the common era
bgs	below ground surface
CE	common era
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CH2M	CH2M HILL, Inc.
DDT	dichlorodiphenyltrichloroethane
DGVBW	downgradient vertical barrier wall
DNAPL	dense nonaqueous phase liquid
EPA	U.S. Environmental Protection Agency
FPS	Former Plant Site
HBB	hexabromobenzene
Jacobs	Jacobs Solutions, Inc.
MDEQ	Michigan Department of Environmental Quality
NETR	Nationwide Environmental Title Research
NPS	National Park Service
NRHP	*National Register of Historic Places*
OU	Operable Unit
PBB	polybrominated biphenyl
project	Remedial Design for Operable Units 1 and 3 of the Velsicol Chemical Corporation Superfund Site
RD	remedial design

Acronym	**Definition**
ROD	Record of Decision
SHPO	State Historic Preservation Office
site	Velsicol Chemical Corporation Superfund Site
TRIS	tris-2,3-dibromopropyl phosphate
U.S.C.	*United States Code*
USGS	U.S. Geological Survey

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1. Introduction

On behalf of the U.S. Environmental Protection Agency (EPA), Great Lakes National Program Office, CH2M HILL, Inc. (CH2M), a wholly owned subsidiary of Jacobs, has prepared this cultural resources desktop literature review in support of remedial design (RD) components for Operable Units (OU) in OU1 and OU3 of the Velsicol Chemical Corporation Superfund Site (site) in St. Louis, Gratiot County, Michigan (project). The project involves the excavation of contaminated soils and the installation of a downgradient vertical barrier wall (DGVBW) surrounding the Pine River at the Former Plant Site (FPS) and is constrained to the FPS in OU1 and affected portions of the Pine River floodplain and riverbanks in OU3 (Appendix A, Figures 1 and 2).

Velsicol Chemical Corporation (formerly Michigan Chemical Corp.) produced various chemical compounds and products at the 54-acre FPS in St. Louis, Gratiot County, from 1936 to 1978. Products included the fire retardant polybrominated biphenyl (PBB) and the pesticide dichlorodiphenyltrichloroethane (DDT). To address contamination discovered at the FPS in OU1, Velsicol Chemical Corporation, EPA, and the State of Michigan entered a consent agreement in 1982. From 1998 to 2006, actions taken at the site addressed contamination in the Pine River, including sediment cleanup in the Pine River adjacent to the site. A *Record of Decision for Operable Unit 2 – Pine River Velsicol Chemical Superfund Site, St. Louis, Michigan* was prepared in 1999 (ROD; EPA, 1999).

In the early 2000s, studies showed that the slurry wall and clay cap in the FPS were failing to keep contamination out of the river. In response, EPA and the Michigan Department of Environmental Quality (MDEQ) launched a remedial investigation and feasibility study at the FPS. The resulting report stated that soil and groundwater were contaminated, and, in June 2006, a remedy was selected that included a comprehensive cleanup of the FPS in OU1 and a residential soil cleanup. A ROD was prepared for OU1 in 2012, which included containment, treatment, and minimal wellfield replacement (EPA, 2012; EPA, 2023). The site is subject to five-year reviews, which assess sitewide remedies related to human health and the environment. The first five-year review was completed in 1997, with subsequent reviews having occurred in 2002, 2007, 2012, 2017, and 2022 (EPA, 2023).

In 2019, CH2M submitted a technical memorandum with literature review results for RD efforts at the site, which identified no historic properties in the project (Sather et al., 2019). The site was previously subject to a ROD for the source material of the site and an Interim Action for the site groundwater (EPA, 2015). Since the completion of the 2019 technical memorandum, the process pads and work area design have changed slightly for the project but are still within the project footprint and are less invasive than previously proposed, so no further review was warranted for the RD remedy at the site.

In 2022, a ROD was prepared for a final remedy for contaminated floodplains and streambanks within the Pine River from the St. Louis dam to approximately 1.5 miles downstream (ROD; EPA, 2022).

1.1 Regulatory Framework

Pursuant to Section 106 of the *National Historic Preservation Act of 1996*, as amended, *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) remedial actions are considered federal undertakings and are required to take into account the effects of remedial activities on properties listed in or eligible for listing in the *National Register of Historic Places* (NRHP; EPA, 1989). This assessment was completed in accordance with Section 106 of the *National Historic Preservation Act*

(Section 106), as defined in 54 *United States Code* (U.S.C.) Section 300101 et seq. The EPA Great Lakes National Program Office is serving as the lead federal agency.

This report identifies cultural resources that qualify as historic properties within the Area of Potential Effects (APE) and the 1-mile (1.6-kilometer) radial Study Area(Appendix A, Figure 3). This cultural resources desktop review addresses the proposed RD components in OU1 or OU3. EPA requests concurrence for the findings and recommendations presented for these additional RD components in OU1 and OU3 in compliance with Section 106 of the *National Historic Preservation Act* (54 U.S.C. Section 306108). The EPA has consulted with Native American tribes with interest the site and will remain in consultation for this project.

Research for the project focused on identifying previously recorded cultural resources and previous cultural resource investigations provided by the Michigan State Historic Preservation Office (SHPO). The records request concentrated on a 1-mile (1.6-kilometer) radius Study Area around the APE in order to provide localized information on the types and locations of previously identified cultural resources and to determine the possibility of effects on cultural resources from the project. In addition to the records review, CH2M reviewed historical mapping of the area. Secretary of the Interior Professional Qualified staff prepared this report, which summarizes the results of the cultural resources desktop literature review.

1.2 Project Description

The project proposes to install a DGVBW in the site around the Pine River at the FPS. The vertical barrier wall is one of several components of the OU1 remedy being implemented in accordance with the 2012 ROD (EPA, 2012). The DGVBW will consist of interlocking sealed sheet piles and cylindrical king piles to decrease the potential for dense nonaqueous phase liquid (DNAPL) and dissolved-phase contaminants to directly discharge to the Pine River from the shallow outwash unit (EPA, 2012). This design includes the following ground-disturbing activities:

- Access roads and staging areas
- Soil removal and replacement in the FPS in OU1 and Pine River floodplains and riverbanks in OU3
- Installation of DGVBW

Access roads and staging areas will be constructed from gravel with an approximate width of 15 feet and will remain in place after construction activities are complete to support future site work in OU1. Temporary access roads will be removed after construction, and the disturbed areas will be restored in OU3. It is assumed that equipment and materials will be staged at the FPS. The roads and staging areas will be constructed by stripping the top 6 inches of existing topsoil and top 6 inches of existing clay cap material and placing a geogrid, followed by 12 inches of 0-inch by 3-inch crushed rock. Access roads would be constructed along the north and west perimeter of the FPS in OU1 and would be constructed along the most direct route into each of the three floodplains in OU3. Access roads would be approximately 15 feet in width. In OU1, the total area of proposed disturbance would be approximately 50,000 square feet. In OU3, the total area of proposed disturbance would be approximately 20,000 square feet.

The DGVBW will be a combination wall consisting of driven sheet piles and cylindrical king piles. The DGVBW alignment is within the Pine River to contain contaminated soils present within the FPS soil and groundwater. The sheet piles and king piles will terminate approximately 3 feet below the top of till surface. A till socket will be drilled at each king pile location to 10 feet below the bottom of the king pile. Each king pile will be filled with concrete. The DGVBW's alignment ranges from approximately 10 to 55 feet from the shore into the Pine River, running roughly parallel to the shoreline, with connections at each end into the existing riverbank and connecting with the existing slurry wall.

It is assumed that the DGVBW will be constructed from land and that a barge will not be required for construction. Sheeting and the cylindrical (king pile) units require installation until refusal is reached using a crane and moderate-sized vibratory hammer. Sheet pile and king piles will be installed to an approximate depth of 13 feet below top of sediment surface in the Pine River.

Work at OU3 involves sediment removal in an approximately 1.5 miles long segment downstream from the St. Louis dam in the Pine River floodplains and riverbed. Excavation would remove DDT contamination from the floodplain and riverbank soils to a maximum depth of 3 feet below ground surface (bgs). Contaminated soils would be disposed at an approved landfill. It is anticipated that the floodplains will be excavated to an average depth of 1.5 feet bgs, and river banks will be excavated to an average depth of 2 feet bgs. All excavation will occur above the ordinary high water line and will be completed from land with a small excavator. The floodplains will be backfilled with clean soils to the existing grade and revegetated. The riverbank will be stabilized to prevent further erosion. A total area of disturbance is anticipated to approximately 20,350 cubic yards of contaminated soils (see Appendix A, Figure 2 for project footprint).

1.2.1 Area of Potential Effects

The APE is defined as the area in which the direct and indirect effects of a project might cause alterations to the character of historic properties (36 *Code of Federal Regulations* 800). Properties may be either directly or indirectly affected by an undertaking. Direct effects refer to the causality, not the physicality, of the effect to historic properties. Direct effects are caused by the undertaking and occur at the same time and place. Indirect affects refer to those caused by the undertaking at a later time or farther removed in distance but which are still reasonably foreseeable (National Trust for Historic Preservation v. Todd Semonite [18-5186]).

The project is constrained to the FPS in OU1 and Pine River floodplains and riverbanks in OU3. The project would surround the riverbank at the FPS with a DGVBW, would excavate, dispose, and replace contaminated floodplain and riverbank soils to a maximum depth of 3 feet bgs, and would construct access roads by removing topsoil and adding gravel or composite mats. Access roads in OU1 would remain, and access roads in OU3 would be temporary.

The APE is the area where ground disturbance would occur and consists of two discontiguous areas in OU1 and OU3 that total approximately 65.8 acres (26.6 hectares). The APE for OU1 is 48.5 acres (19.6 hectares) and is the fullest extent of the FPS where the DGVBW would be installed and its vicinity. The APE for OU3 is 17.3 acres (7 hectares) and is the Pine River riverbank and floodplain areas where contaminated soils would be removed, and temporary access roads would be constructed. Aboveground visual changes would be limited to tree removal in OU3 floodplains, though the majority of the tree canopy would remain extant, and the viewshed would remain visually similar to its present condition. The APE includes areas of ground disturbance, an applied buffer around access roads, and the fullest extent of OU1 and OU3 (Appendix A, Figure 2).

1.3 Site Description

The site (National Superfund database identification number MID00722439) is in St. Louis, Gratiot County (Appendix A, Figures 1 and 2). Residential and commercial areas are located near the site, which consists of four OUs:

- OU1, the 52-acre (21 hectares) Velsicol Chemical Superfund Site/Pine River Superfund Site, commonly referred to as the FPS and Adjacent or Nearby Properties.

- OU2, the 38-acre (15.4 hectares) Pine River St. Louis Impoundment and Pine River Mill Pond sediment adjacent to and upstream from the St. Louis hydroelectric dam.
- OU3, the approximately 11-acre (4.5 hectares) Pine River sediments extending from the St. Louis hydroelectric dam to 1.25 miles downstream from the dam.
- OU4, the approximately 597-acre (241.6 hectares) Pine River sediments extending 1.25 miles downstream from the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee rivers.

Velsicol Burn Pit Superfund Site (National Superfund database identification number MID000510389) is a 5-acre (2 hectares) site northwest and separate from the Velsicol Chemical Corporation Superfund Site. It is located approximately 366 meters (1,200 feet) northwest of the Pine River, within the boundary of the Hidden Oaks Golf Course, across the river from the Velsicol Chemical Corporation/Pine River Superfund Site, FPS in OU1.

As described in the 2022 ROD, the 52-acre (21 hectares) FPS in OU1 was used for industrial operations since the mid-1800s, including a lumber mill, oil refinery, salt plant, and chemical plant. To the east of the FPS is the St. Louis Dam. Built in 1901, the St. Louis Dam is a 21-foot-high and 125-foot-long concrete structure. The gravity-feed dam was built for hydroelectric power for the St. Louis region (Romzek, n.d.; Stateman Journal, 2023). The dam is on the south end of Mill Pond in OU2 and is next to the Pine River (OU3). Michigan Chemical Corporation purchased the FPS facility in 1935 and operated a chemical manufacturing business until 1977. Michigan Chemical Corporation merged with Velsicol Chemical Corporation in the mid-1960s. From 1936 through 1977, the plant manufactured a variety of organic and inorganic chemicals, including PBB, hexabromobenzene (HBB), DDT, and tris-2,3-dibromopropyl phosphate (TRIS). This resulted in the closure of the FPS in 1977, and decommissioning activities began in 1978. The aboveground site buildings were razed, and some structures were buried onsite, including storage tanks and process piping. Building and tank foundations were not removed, and a significant amount of debris remains buried at the FPS (EPA, 2022).

2. Environmental Setting

This section provides information on the prehistoric and historical environmental setting of the general APE and identifies the locations and preservation of cultural resources. Environmental variables (e.g., geology or climate) significantly influenced the type and extent of both prehistoric and historical period settlement and subsistence patterns.

2.1 Physiographic Region

The topography of the project area was created almost entirely by depositional and erosional action from the continental glaciers, which deposited till material composed of clay, sand, silt, and gravel over the Jurassic-aged bedrock (MDEQ, 2003). Within this larger context, the project is situated entirely within the Eastern Broadleaf Forest (Continental) Province which stretches across Minnesota, Iowa, Wisconsin, Michigan, Ohio, New York, Illinois, Indiana, Kentucky, Tennessee, Missouri, and Arkansas (Bailey, 1995).

2.2 Geology

Bedrock geology within the APE is generally composed of Jurassic-age sandstone, shale, limestone, and gypsum. The Pennsylvanian Saginaw Formation, Jurassic red beds, and the Pennsylvanian Grand River Formation are all found within Gratiot County. The bedrock geology of the region consists of cyclical formation depositions overlain by beds of till (U.S. Geological Survey [USGS], 2019).

2.3 Soils

Soil distribution within the Study Area is important for understanding the cultural arrangement of the landscape. Soils aid in determining the potential for archaeological sites and can provide a marker for archaeological site formation. Soil types also aid in understanding the pedogenic processes of the area and how archaeological sites and cultural materials are impacted by those processes.

Soils within the APE are predominately composed of two soil types—the Spinks series and the Belleville series. The Spinks soils are formed in sandy eolian or outwash material and consist of very deep, well-drained soil. These soils are typically identified on dunes, moraines, till plains, outwash plains, beach ridges, and lake plains of Wisconsinan Age (United States Department of Agriculture, Natural Resources Conservation Service, 2023).

The Belleville series was formed in sandy glaciofluvial and glaciolacustrine deposits and consists of very deep, poorly drained, or very poorly drained soils. Belleville soils are on lake plains, till-floored lake plains, wave-worked till plains, and till plains. Other minor contributing soils are outlined in Table 2-1.

Table 2-1. Soils within the Area of Potential Effects

Soil Symbol	Soil Name	Landforms	Drainage	Percent of APE
Be	Belleville loamy sand	Till-floored lake plains	Poorly drained	14.1%
BoB	Boyer loamy sand, 0 to 6 percent slopes	Terraces	Well drained	1%
Ce	Ceresco fine sandy loam, gravelly substratum	Flood plains	Somewhat poorly drained	3.7%
MaB	Marlette sandy loam, 2 to 6 percent slopes	Moraines, till plains	Moderately well drained	6.4%
MetaaA	Metamora-Conover complex, 0 to 3 percent slopes	Deltas, wave-worked till plains, nearshore zones (relict)	Somewhat poorly drained	0.5%
SpB	Spinks loamy sand, 0 to 6 percent slopes	Moraines, glacial drainage channels, outwash plains	Well drained	57.6%
W	Water	N/A	N/A	16%

Source: United States Department of Agriculture, Natural Resources Conservation Service Web Soil Survey, 2023

N/A = not applicable

2.4 Hydrology

The APE lies within the Pine River watershed, which drains approximately 265 square miles and flows into the Tippy Dam Impoundment in Manistee County. The river is fed by several tributaries and provides the primary drainage for the APE. The Pine River flows directly adjacent to the APE.

2.5 Flora and Fauna

The flora of this province is dominated by broadleaf deciduous forest. The annual precipitation promotes the drought-resistant oak-hickory association. The forest cover is generally medium-tall to tall, and thins to become savanna-like towards the north. Widespread dominant species are white oak, red oak, black oak, bitternut hickory, and shagbark hickory. In the forest understory, flowering dogwood is common with representation of sassafras and hophornbeam. The shrub layer is distinct, with some evergreens. Many wildflower species occur. Northern areas of the province contain greater variety of species, including maple, beech, and basswood (Bailey, 1995).

Acorns and hickory nuts provide abundant food for the abundant gray squirrel, fox squirrel, and eastern chipmunks. Flocks of blue jays feed on the forest nuts, as well. Seasonal summer species include the scarlet and/or summer tanagers and rose-breasted grosbeaks. Wild turkey is also found here as are cerulean warbler (Bailey, 1995).

2.6 Climate

Knowledge of the past climate is based primarily on palynological evidence that indicates broad floral patterns sensitive to specific climatic characteristics. Eastern United States climatic trends in Late Pleistocene times were shaped by the glaciers that occurred within the APE from points originating in

northern Canada. This sequence developed in the Late Pleistocene, when a moist, cool climate followed a drier, cooler period.

Around 6,000 years before the common era (BCE), a warming/drying trend occurred, which is often referred to as the "Hypsithermal" or "Altithermal." This trend profoundly affected vegetation and faunal patterns until 2000 BCE. Modern floral and faunal patterns were in place sometime after 2000 BCE, by the end of the Hypsithermal period. Warm air masses from the Gulf of Mexico influenced the climatic patterns of the region. The major climatic event during the late Holocene is the "Little Ice Age" or the Neo-Boreal episode, which dates from 1400 to 1900 of the common era (CE). This shift to a cooler climate may have had a dramatic effect on local prehistoric populations, perhaps resulting in a shorter growing season. The impact on Late Prehistoric populations is poorly understood, but some researchers suggest changes in community size and plans, as well as social organization, were a result of this phenomenon.

The modern climate of the APE is characterized as continental, with typically cold winters and hot, humid summers. Thunderstorms are a common occurrence during the summer months, with occasional tornadoes during the spring and summer seasons. Average annual temperatures range from 40 degrees Fahrenheit (4 degrees Celsius) where the summers are hot and there are frequent tornadoes. Precipitation varies from 20 inches (510 millimeters) near the 95th meridian to 40 inches (1,020 millimeters). Most precipitation takes place during the growing season (Bailey, 1995).

3. Cultural Overview

This section summarizes the known prehistoric and early historic period cultures of Gratiot County, Michigan, as well as the historic development of Gratiot County, the City of St. Louis, and Pine River Township area. This information provides a context for sites within the APE, to aid in evaluating NRHP significance of any identified historic properties that may be affected by the project.

3.1 Prehistoric Cultural Setting

3.1.1 Paleoindian Period (13,000 to 8,000 BCE)

The Paleoindian period in North America is the period in which the first human populations came to North America and the last retreat of the Wisconsin glacial period. The defining characteristics of the Paleoindians were:

- The extensive use of exotic cherts
- Specialized lithic technologies
- Small and extremely mobile societies
- Hunter and gatherer lifeway
- Large game mammals as the primary subsistence (Morrow, 1996)

The main characteristic that distinguishes the Early Paleoindian period from the Late Paleoindian period is the use of fluted lanceolate points and subsistence on large-extinct animals, including mammoths, mastodons, and giant bison varieties (Gibbon, 2012; Morrow, 1996; Stoltman, 1998).

The lithic technology of the Early Paleoindian period is characterized by fluted lanceolate points. The fluted styles include Clovis, Gainey, Folsom, and Holcombe Points (Morrow, 2016). Fluting is the removal of a flake from the base of the projectile. The earliest known point type in North America is the Clovis, which dates from circa 9,500 to 8,650 BCE (Morrow, 2016). Clovis points are broad, thin, well-made lanceolate points with concave bases and basal flutes that extend one-half to one-fifth the length of the point. Folsom is the second oldest recorded lithic technology and overlaps with Clovis, dating between 8,900 to 8,400 BCE (Morrow, 1996). Folsom are “thin, finely made, medium sized lanceolate points with a flattened to bi-concave cross section, parallel to convex sides, and broad flutes that cover at least 60 percent of each face” (Morrow, 2016: 128). Gainey points are fluted points that have a “lanceolate outline, deep and rounded basal concavities, and well-defined primary flutes” (Morrow, 2016: 124). Holcombe points are “small, thin lanceolate points with shallow concavities with broadly convex sides and high midpoint above the center” (Morrow, 2016: 132).

The Late Paleoindian period is characterized by the disappearance of fluted lanceolate styles and replaced with non-fluted lanceolate point types. Stemmed points, some heavy stone tools, and the use of Hixton quartzite from western Wisconsin are also characteristics of the Late Paleoindian period (Gibbon, 2012). The point types found in Wisconsin from this period are Agate Basin, Alberta, Angostura, Browns Valley, Eden, Frederick, Midland, Plainview, and Scottsbluff. These artifacts tend to be well made with high-quality craftsmanship (Gibbon, 2012; Morrow, 2016; Stoltman, 1998).

3.1.2 Archaic Period (8000 BCE– 500 BCE)

The environment during the Early Archaic period was becoming increasingly arid. This dry period allowed for the exploitation of areas that were previously inaccessible or undesirable. Throughout

Michigan, this may have accessed areas that were previously too wet for habitation. Even though there is little information known on the Archaic period in central Michigan, Archaic sites are common and typically consist of hunting camps found on uplands, and base camps or villages in riverine settings.

Artifacts and assemblages from the Archaic are more diverse in function and style, which may indicate diversity in resource exploitation. Artifacts from this period have spread to newer areas and are now recovered with greater regularity and more frequently over more geologically diverse environmental areas. During this period, there was also an increase in populations of groups who likely followed a foraging pattern that was more regionally focused than in the Paleoindian period (Bowen, 1994: 1-5).

During the Archaic period, there was a noted transformation in tool styles and possibly in tool use. Artifacts such as ground stone and slate first appeared during this time. Typical tool assemblages often encompass such artifact types as beveled and/or serrated notched knives, unifaces, gravers, end scrapers, and side-notched, corner-notched, and bifurcated projectile points. Produced from 7500 through 4500 BCE, beveled hafted bifaces (i.e., Thebes, Lost Lake, or St. Charles varieties) were likely specialized animal-processing knives (Stothers and Abel, 1991). Local lithic sources seem to have been used regularly, but there was still some reliance on exotic stone materials, including high-quality chert.

The Late Archaic period consists of a variety of artifact types. Typically, local chert materials are reflected in the utilitarian assemblages. Burial goods from this period provide evidence of some long-distance movement of goods. There is also an increased variation in projectile point styles with small side-notched and corner-notched points becoming common and also taking a variety of shapes and forms. Scrapers, both side and end, are often present in assemblages, with a reduced occurrence of graver spurs present on scrapers. Slate is often used in the production of ornamental artifacts. Ground and polished stone artifacts reached a high point in development such as ground stone grooved axes, celts, bannerstones, and other slate artifacts. At the end of the Late Archaic period pottery appears for the first time (Stothers and Abel, 1991).

3.1.3 Woodland Period (500 BCE–AD 1620)

There is a change in subsistence and in cultural characteristics during the Early Woodland period. During this time, cultures became increasingly adapted to their local environments. The use of the environment is probably through a horticultural subsistence base and perhaps a consistent and productive hunting-gathering, which may have assisted in the development of the Adena ceremonial florescence (Tuck, 1978). At this period, people lived in circular housing structures that were likely in permanent villages. It also seems that there was some seasonal mobility from campsites and/or rockshelters. The introduction of ceramics appears to indicate a decrease in regional nomadism.

In central Michigan, there are a few mounds or village sites that indicate an Early Woodland occupation of the area. During this period, it appears that people hunted seasonally at certain locations. The Adena-like bifaces and tools are commonly found in river and stream valleys that drain into Lake Erie, as well as in the uplands. It is assumed that Early Woodland inhabitants used these areas for little more than hunting and gathering subsistence. The Early Woodland period is not well known in Michigan due to a lack of material evidence (Murphy and Ferris, 1990).

The Middle Woodland indicates that people in present-day Michigan were being influenced by the Hopewell culture and were part of the Hopewell Interaction Sphere. The Hopewell Interaction Sphere was the propagation of ideas about social organization and relationships, technology, and economic activities from the Hopewellian culture centers in Illinois and Ohio (Perry, 1996). The Havana tradition in Michigan is considered to be part of this interaction sphere. This period had an increase in the population,

and social organization appears to have been more complex. Middle Woodland sites may reflect a seasonal exploitation of their environments and may revolve around extensive earthen ceremonial centers. Little information is known about the Middle Woodland period of south-central Michigan. This may be due to a poor representation of artifacts from this period or because the area is not directly associated with the Hopewell culture (Murphy and Ferris, 1990).

It appears that the Late Woodland is characterized by the appearance of the bow and arrow, the building of defensive walls and ditches, and mound building. The occupations in southern Michigan possibly developed from the Western Basin Middle Woodland tradition. The Western Basin Tradition originated from people who lived in the western basin of Lake Erie and who were not part of the Hopewell Interaction Sphere. This tradition slowly expanded to the region of southeastern Michigan and northwestern Ohio by 500 CE (Murphy and Ferris, 1990). The Late Woodland period is best defined by the appearance of numerous ceramic traditions, including the Western Basin Tradition. In Michigan, this tradition consists of three phases: The Riviere au Vase, the Younge (Fitting, 1965), and the Springwells phase.

The Riviere au Vase phase dates between 500–1000 CE. This phase is evolved from Wayne wares. The typical Wayne wares are small and thin-bodied, with low, uncollared and uncastellated vertical to weakly everted rims. The necks of these vessels constrict with well-defined shoulders, globular to somewhat elongated bodies, and rounded to semi-conoidal bases (Murphy and Ferris, 1990). The exterior is typically cordmarked or fabric-marked from the base to the lip. The necks/rims of the Wayne wares usually have vertical to slightly oblique cordmarkings. The Riviere au Vase settlement and subsistence were similar to those of the Late Archaic/Early Woodland period (Stothers, 1978). Resource exploitation was based on two seasonal migrations. The spring-autumn months were spent using the riverine environments, while the winter months were spent in the uplands.

The Younge phase (1000 to 1200 CE) ceramics are remarkably similar to Riviere au Vase phase ceramics and can be difficult to distinguish the two. The Younge Phase Ceramics are characterized by a wide range of vessel forms, sizes, and decorative motifs. This may be due to informal, non-fixed martial and residential patterns among these people or due to a high amount of experimentation for the craftsman. The one distinguishing characteristic of this phase is the use of the extended neck for elaborate and varied decorative motifs. The people lived in seasonal villages that were occupied in spring, summer, and fall, yet never became “formalized” villages (Bechtel and Stothers, 1993; Murphy and Ferris, 1990).

The Springwells phase (1200 to 1300 CE) follows the Younge Phase and is very distinct. Typically, the Springwells-phase vessels had rims that were collared and castellated and were characterized by a number of horizonal, oblique, and cordmark motifs. The collars were well-defined, and the vessel neck became increasingly elongated, cylindrical, and only slightly constricted. The neck would merge into the body without a distinct neck-shoulder junction. The vessels became longer and with round or semi-conoidal bases (Murphy and Ferris, 1990) The people during this phase had similar settlement and subsistence patterns. Villages were occupied during the spring, summer, and fall (Bechtel and Stothers, 1993; Murphy and Ferris, 1990). However, settlements did not become “formalized” villages. The decline of the Springwells phase was due to the rise of the Sandusky tradition around 1300 CE (Stothers, 1973, 1975a, 1975b, and 1978).

The Late Prehistoric period is characterized by the use of earth lodge dwellings, crop surplus, improved storage techniques, and the development of complex social organization within villages (Carroll, 2013). Permanent villages were associated with a heavy dependence on farming, which included growing maize,

beans, and squash. These villages were often located on the meander belt zones of river valleys. Villages were often strategically located on bluff top (Brashler and Holman, 1985).

3.2 Historic Cultural Setting

3.2.1 Historic Period (*Post-1620*)

The first Europeans arrived in the area around 1620. The French were the first to send missionaries and fur trappers and traders to the area, with Etienne Brule being the first to step within present-day Michigan boundaries. Many of these early explorers were in search of a waterway that led to the Pacific Ocean. In 1634, Jean Nicolet was one of the first to search for a route, which led him around Michigan. After reaching the area that is now Green Bay, Wisconsin, Nicolet encountered a Siouan-speaking tribe, some of whom accommodated Nicolet on his return to Quebec. In 1673, French explorers Louis Joliet and Jacques Marquette led an expedition to continue the search for this river route. They also believed that this river could led to the Pacific Ocean and become an established trade route to China. However, the river they encountered turned out to be the present-day Mississippi River, which they confirmed led to the Gulf of Mexico. By 1701, an early trading post was established by Antoine de Lamothe Cadillac on the Detroit River, located at present-day Detroit in southeastern Michigan (Detroit Historical Society, 2019).

In 1715, the French built Fort Michilimackinac at the Straits of Mackinac to help secure the area and to maintain their territories. Tension grew with the French and British as they fought for fur-trade routes in and control over North America. With their respective Native American allies, the French and English fought a war from 1754 to 1763, which became known as the French and Indian War. The conflict ended in 1763 with the Treaty of Paris, which gave the British control over the area from present-day Michigan to the Mississippi River (U.S. Department of State, 2023).

With the signing of the Treaty of Paris in 1783, following the American Revolutionary War, the new United States gained an enormous territory east of the Mississippi River that was ceded by the British. The future Michigan came into possession of the new nation as part of the Northwest Territory. In 1805, the Michigan Territory was created with Detroit as the seat of government. The first governor of the territory was William Hull. During the War of 1812, the British gained control of Detroit and held onto it until 1813. In the 1820s and 1830s, settlers from the New England states and other new immigrants began arriving in the Michigan Territory, starting the long dispossession and resettlement of tribal nations, such as the Ojibwe. After the establishment of the territory, Euro-Americans came to farm the region's rich soils. In 1837, Michigan was admitted as the 26th state to the United States (May 1995; Michigan State University, 2018; Powers, 1912).

3.2.2 Railroad Development

In the mid-1800s, construction of railroads was started throughout the United States, beginning with the first railroad built near Baltimore, Maryland, in 1831 (Schwieder, 2000). The first railroad tracks to reach the Michigan Territory began in 1833 with the construction of the Erie and Kalamazoo Railroad. The railroad eventually connected Adrian, Michigan, with Toledo, Ohio, and relied on horsepower. The first steam locomotive to be in service in Michigan, the Adrian, also began operating on the Erie and Kalamazoo Railroad. Other railroads began to be constructed, including the Detroit and Pontiac Railroad in 1843, the Michigan Southern and Michigan Central railroads in 1852, and the Grand River Valley Railroad in 1870. By 1880, a total of 3,823 miles of railroad had been built in Michigan and peaked at 8,734 miles of track in 1920. The railroad helped to create the current settlement pattern and economic

development in Michigan. Also, for the first time, people could travel any time of the year (Michigan Department of Transportation, 2014).

In Gratiot County, the Toledo Ann Arbor and North Michigan Railway built a railroad in 1882-1884. The 85-mile-long railroad reached north to south from present-day Hamburgh to St. Louis, and a segment of the route extended through or near what is now the FPS in OU1 in the APE. The railroad was transferred to the Ann Arbor Railroad in 1895 before the segment between Ithaca and St. Louis was abandoned in 1897. A second railroad segment built by the Toledo Ann Arbor and Mount Pleasant Railway was located in the Study Area. The 9-mile-long railroad extended from northeast-to-southwest from St. Louis to Lansing. This railroad was transferred to the Toledo Ann Arbor and North Michigan Railway in 1887, before it merged with the Ann Arbor Railroad in 1895, and like the other route, was abandoned in 1897 (Mississippi Rails, 2020). The structures appear to have been removed, and no evidence of the former railroad grade is present in aerial imagery of the APE.

3.2.3 Gratiot County

Gratiot County was defined by an act of the territorial legislature on March 2, 1831. The county was officially organized on February 3, 1855. The county was named for General Charles Gratiot, who was an army officer under the command of William Henry Harrison during the War of 1812. During the first half of the nineteenth century, many of Gratiot County's early European settlers were from New England and settled in the Gratiot County communities of Alma and Ithaca. In 1825, the 363-mile-long Erie Canal was completed from New York state to Lake Erie. The canal served as an impetus for increased settlement from the east into the Great Lakes region (Flagg, 1915; Tucker, 1913).

John Jeffrey established a post office at Gratiot Center in 1855. In 1856, Gratiot Center was named the county seat. Gratiot Center was renamed Ithaca, to honor Ithaca, New York, in 1857 (City of Ithaca, 2019). By 1870, the population of Gratiot County grew to approximately 12,000 people. By 1890, the population of the county had more than doubled to over 28,000. The county began experiencing a relatively steady growth in population between 1930 and 1990. In that span of time, the county grew from just over 30,000 to more than 42,000 (population.us, 2023). Today, the county covers 572 square miles. According to census data, the population of the county in 2000 was 42,476 people (United States Census Bureau, 2023).

3.2.4 St. Louis and Velsicol Chemical Company

Joseph Clapp established the town of St. Louis in 1853; although it was not officially known by this name until 1865. Clapp had followed a preexisting Native American trail to the Bethany Lutheran Indian Mission, which was a religious acculturation school for Native American children (1848-1931). The Bethany Lutheran Indian Mission and its associated cemetery are located near the present-day Main Street Bridge across the Pine River. Clapp and other early settlers constructed an early dam and sawmill on the Pine River. In 1856, Clapp sold his sawmill, lumberyard, and other holdings, including 1,500 acres (607 hectares) of forest. The local economy was dominated by lumber milling. However, St. Louis soon became known as a health resort with the discovery of mineral springs in 1869. The mineral springs popularity helped its population grow to 2,246 people by 1890 (United States Census Bureau, 2023).

During the first half of the 20th century, the town's population greatly fluctuated until the Michigan Chemical Corporation was founded in 1936. The plant provided jobs to the region and helped retain population. The plant was built on the banks of the Pine River on a 14-acre (5.7 hectares) parcel that had been the long-time home of the former sawmill, a salt block and bromine plant (now known as the FPS in

OU1). The Michigan Salt Company opened its associate business onsite in 1937. The Michigan Chemical Company continued to grow, especially following World War II (post-1945) when it expanded into a series of buildings and storage tanks. The complex was a major employer and revenue generator for the town. The company changed its name in the 1960s to Velsicol Chemical Company.

The Velsicol Chemical Company ceased operation in 1977, and the site was razed in 1978. Among the many products manufactured onsite was the fire retardant, PBB, which was called Firemaster; an agricultural insecticide, DDT; and a supplemental cattle feed called Nutrimaster. In 1973, due to a mix-up in the labeling and use of bags for the Firemaster and Nutrimaster brands, the fire retardant product was mistakenly shipped out for use as feed, contaminating cattle across the state and ultimately, the people of Michigan. Subsequent lawsuits led to intense scrutiny of the Velsicol plant. With the United States banning the use of DDT in 1972, Velsicol's operations in St. Louis were further compromised. As a result of these issues, the Michigan Department of Natural Resources initiated an investigation of the facilities, land, and river, ultimately finding that the entire site, including the river, was significantly contaminated (City of St. Louis, 2023; EPA, 2023).

In 1990, the Pine River Correctional Facility was constructed in St. Louis. The town now has three prisons that support the local economy. The town has notoriety as being the geographic center of Michigan with the moniker "Middle of the Mitten" (City of St. Louis, 2023).

4. Records Review

CH2M conducted a desktop review to develop a context for the prehistoric and historic landscape documented in the region. Research was conducted in person at the Michigan SHPO office in Lansing, Michigan, between June 19 and 29, 2023. Research focused on the APE and a 1-mile (1.6-kilometer) Study Area. For the records review, CH2M consulted the following resources:

- Michigan SHPO Reports and Documents
- NRHP Finding Aids for Single and Multiple Property Listings (National Park Service, 2015a and 2015b)
- National Historic Landmarks finding aid (NPS, 2015c)
- NRHP Online Map and Database
- Cultural Resource Management Reports
- Cemetery and Burial Registry Survey Files
- County Histories and Atlases
- EPA Reports and Documents

In the Study Area, a total of 10 archaeological sites, 44 aboveground resources, 1 historic district, and at least 1 cemetery (also recorded as an archaeological site) were recorded by previous cultural resources investigations. Of those 56 cultural resources, one resource is an NRHP-listed historic district, and 8 resources are individually eligible for listing in the NRHP. All previously identified cultural resources are in the Study Area, and none are within or adjacent to the APE. In addition to the identified resources, five previous cultural resources surveys have been conducted within the Study Area, none of which are within or adjacent to the APE (Appendix A, Figure 3).

4.1 National Register of Historic Places

One NRHP-listed historic district was identified within the Study Area; however, it is not within or adjacent to the APE. The St. Louis Downtown Historic District (Site ID #P47958) includes buildings located along the eastern and western sides of North Mill Street in St. Louis, Michigan. As described in the nomination form for the district:

> The St. Louis Downtown Historic District encompasses the historic core area of St. Louis' central business district, located along three blocks of North Mill Street between West Washington Avenue and North Avenue. It also includes a small number of buildings on two cross streets, West Saginaw Avenue and West Center Avenue, west of Mill. The district contains thirty-six commercial buildings, dating from the 1870s to the 1990s, with most of them constructed in the late nineteenth and early twentieth centuries. The buildings are predominantly brick, one and two stories in height, and range in style from Victorian to International style. Nine of the thirty-six buildings are noncontributing due to extensive alterations or dates of construction less than fifty years ago.

According to the state inventory, the St. Louis Downtown Historic District is listed on the NRHP and has 27 contributing and 9 noncontributing resources (Appendix A, Figure 3) (Table 4-1).

Table 4-1 NRHP-Listed Historic Property Within Study Area

Michigan Site No. (NRHP ID No.)	Property Name	Location	Period of Significance	Property Type	Areas of Significance	NRHP (Date Listed)
P47958 (14000976)	St. Louis Downtown Historic District	3-block central business district from North Mill Street to West Washington Avenue and North Avenue in St. Louis	1870s to 1964	District	Commerce, Social History, Entertainment/Recreation, and Architecture	Listed under Criteria A, B, and C (2014)

Source: Michigan SHPO records; Taylor, 2014

4.2 Previously Identified Archaeological Sites

Ten previously recorded archaeological sites are documented within the Study Area; however, none are within the APE (Appendix A, Figure 3). Of the 10 archaeological sites, 6 are prehistoric archaeological sites (20GR004, 20GR168, 20GR194, 20GR076, 20GR167, and 20GR195), 2 are historic archaeological sites (20GR187 and 20GR003), and 2 are multicomponent archaeological sites (20GR186 and 20GR199). Three archaeological sites (20GR186, 20GR187, and 20GR199) are eligible for listing in the NRHP, but are located outside of the APE. The seven remaining archaeological sites are either unevaluated for NRHP eligibility or have no reported eligibility status (Appendix A, Figure 3). Table 4-2 lists previously identified archaeological resources, and archaeological resources summaries follow the table.

Table 4-2. Previously Identified Archaeological Sites Within Study Area

ID Num	Site Name	Culture	Affiliation	Site Type	Date Recorded	NRHP
20GR004	-	Prehistoric	Unknown	Cemetery	1975	More Information Needed/Unevaluated
20GR168	Knapp	Prehistoric	Unknown	Lithic Scatter	1987	More Information Needed/Unevaluated
20GR194	Demas	Prehistoric	Unknown	Lithic Scatter	1986	More Information Needed/Unevaluated
20GR076	Kremsreiter	Prehistoric	Unknown	undetermined	-	More Information Needed/Unevaluated
20GR186	Bethany Mission	Multicomponent	Unknown Prehistoric, Nineteenth Century: AD 1848-1865	Mission, School, Cemetery, Lithic Scatter	1959	Eligible for Listing in the NRHP
20GR187	Bethany Settlement	Historic	Nineteenth Century: AD 1842-1865	Village	1984	Eligible for Listing in the NRHP

Table 4-2. Previously Identified Archaeological Sites Within Study Area

ID Num	Site Name	Culture	Affiliation	Site Type	Date Recorded	NRHP
20GR199	Shin-gwah-koos-king	Multicomponent	Nineteenth Century, Unknown Prehistoric	Occupation, Mission, Undetermined	1985	Eligible for Listing in the NRHP
20GR003	-	Historic	Unknown	Village	-	More Information Needed/Unevaluated
20GR167	Mikek	Prehistoric	Unknown	Isolated Find, Undetermined	1987	More Information Needed/Unevaluated
20GR195	Pavlik	Prehistoric	Woodland	Artifact Scatter	1986	Not Eligible for Listing in the NRHP (determined 2003)

Source: Michigan SHPO records

4.2.1 20GR004

Site 20GR004 is a prehistoric-period cemetery, with an unidentified temporal affiliation, in the northeast quarter of Section 19 of Township 12 North, Range 2 West (Bethany Township). The site is nearest to the APE than any of the previously recorded sites. According to the site file obtained from Michigan SHPO, the location of this site has not been verified; however, a 1976 investigation identified this site as a "cemetery east of St. Louis on creek" (Luke et al., 1976). According to the site form, this site may reference the Bethany Mission Cemetery site (refer to 20GR186), which is approximately (1.5 miles) to the north and east of site 20GR004. The site has not been evaluated for NRHP eligibility. The site is within the Study Area, but outside the APE.

4.2.2 20GR186 (Bethany Mission)

Site 20GR186 is the Bethany Mission site, which is the location of the Lutheran Mission established by Edward Baierlein at a Saginaw Chippewa Settlement in 1848. It is located approximately 0.82 mile north of the APE near Riverside Drive and west of Pine River. The mission was established after the Ogemaw Pay-mo-se-Gay invited German Lutherans at Frankenmuth to come to the Shin-gwah-koos-king settlement. A log cabin was built in 1851, and in 1854 the mission obtained land and assigned parcels to mission converts. By 1858 however, the mission was mostly deserted after the Treaty of 1855 provided 80 acres (32.4 hectares) to Chippewa families in Isabella County that drew many away. Excavations conducted in 1986 northwest of the cemetery revealed historic clusters as well as prehistoric FCR and lithic material located mainly near the stream (Beld, 1986). Additional excavations in 1987 centered on the historic clusters (Beld and Stafford, 1987). In all, elements of the mission, school, cemetery, and prehistoric lithic scatter have been identified (Beld and Martin, 1990; Beld, 1991 and 1992). Today, a maintained Bethany Indian Cemetery remains extant near the site. The site is recommended eligible for listing in the NRHP.

4.2.3 20GR187 (Bethany Settlement)

Site 20GR187 is recorded as the Bethany Settlement site and is located approximately 0.9 mile north of the APE. It is also known as Shin-gwah-koos-king and is the settlement established by Saginaw Chippewa from the Tittabawassee River area in 1842, which later became associated with Bethany Mission (site 20GR186). Between 1851 and 1853, the settlement's wigwams mostly were replaced by log cabins after the mission was established. The settlement was mostly abandoned by 1858, and by 1865 the church was removed as well.

Excavations at the site (as well as at 20GR186) have identified multiple clusters of artifacts and residential features likely relating to the Ojibwe or Chippewa family cabins, some of which showed signs of being burnt (Beld, 1986 and 1992; Beld and Stafford, 1987; Beld and Martin, 1990). The site is recommended eligible for listing in the NRHP.

4.2.4 20GR199 (Shin-gwah-koos-king)

Site 20GR199 is also associated with the Bethany Mission and Shin-gwah-koos-king settlement (sites 20GR186 and 20GR187). The site is located 0.93 mile north of the APE on the east side of Pine River, opposite of 20GR187. Investigations at the site between 1985 and 1989 have resulted in both prehistoric and historic period artifact clusters (Beld and Stafford, 1987, Beld and Martin, 1990). Prehistoric material included lithic material and polychrome hand-painted earthenware. Historic material included multiple likely cabin sites and a range of historic artifacts typical of the 1850s. This site is recommended eligible for the NRHP.

4.2.5 20GR194 (Demas)

Site 20GR194 is approximately 0.26 mile to the northwest of the APE, near the Pine River's western riverbank. The Demas Site is a small lithic artifact scatter located in a small stand of trees along the western banks of the Pine River (Beld and Stafford, 1987). According to the state site form, the site is unevaluated for NRHP eligibility. The site is within the Study Area, but outside the APE.

4.2.6 20GR003

Site 20GR003 is recorded in the Hinsdale Atlas and is likely a reference to the Bethany Mission village (Shin-gwah-koos-king). It is located 0.74 mile northeast of the APE and is adjacent to site 20GR199. The site form indicates that the site is unevaluated. However, investigation at the associated sites 20GR186, 20GR187, and 20GR199 have revealed prehistoric and historic period material related to the Bethany Mission and Settlement and are recommended as eligible for the NRHP.

4.2.7 20GR076 (Kremsreiter)

Site 20GR076 is recorded as a prehistoric private collection that has been unevaluated for NRHP eligibility. No additional details regarding the collection's contents are included on the site form. It is located approximately 1 mile northwest of the APE.

4.2.8 20GR167 (Mikek)

Site 20GR167 is an isolated find of a scraper made of Bayport chert. It is located 0.80 mile northeast of the APE east of Pine River and is unevaluated for NRHP eligibility.

4.2.9 20GR168 (Knapp)

Site 20GR168, the Knapp Site, is a small lithic artifact scatter located in a plowed agricultural field along the eastern banks of the Pine River. According to the state site form, the site is unevaluated for NRHP eligibility. The site is within the Study Area, but outside the APE.

4.2.10 20GR195 (Pavlik)

Site 20GR195, also known as the Pavlik site, is recorded as an isolated find 0.78 mile northwest of the APE. The isolated find consists of a notched projecting point, one possible flake, and some historic items. The isolated find is recommended not eligible for listing in the NRHP.

4.3 Aboveground Resources

Review of the Michigan SHPO and NPS data indicates that 44 aboveground resources and 1 historic district are previously identified in the study are, and all of these resources are outside the APE (Appendix A, Figure 3). In addition to the 1 historic district, there are 44 aboveground resources that include 1 road bridge and 43 buildings. The historic district is listed in the NRHP and contains 27 buildings that are contributing resources and 9 buildings that are noncontributing resources. Of the remaining buildings, 5 are individually eligible, and 3 are unassessed or require more information (Table 4-3).

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P16910	207 Pine Street	207 Pine Street, St. Louis	Building	1995	Eligible
P23218	Stiles Kennedy House	310 West Washington Street, St. Louis	Building	1991	Eligible
P23220	Unknown	Unknown	Unknown	Unknown	Eligible
P45726	Unknown	Unknown	Unknown	Unknown	More information needed/ Unassessed
P45958	Unknown	Unknown	Unknown	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P48263	Saint Louis Railroad Depot, St. Louis Area Historical Society	109 North Mill Street, St. Louis	Building	2004	Eligible
P52334	SW Corner of Pine and Center	223 North Pine Street, St. Louis	Building	2015	Eligible
P57128	Zion Evangelical Lutheran Church	123 Main Street, St. Louis	Building	2016	More information needed/Unevaluated
P61293	Cheesman Road Bridge over Pine River	Cheesman Road over Pine River, St. Louis	Structure	1982	More information needed/Unevaluated

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P61859	Warehouse Apartments	215 West Center Avenue, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61860	Expressions Beauty and Boutique	112 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61861	“ “	“ “	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61862	“ “	“ “	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61863	“ “	“ “	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61864	“ “	“ “	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61865	“ “	“ “	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61866	Colonial Theater Block, Young’s Department Store	101 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P61867 - 69	Martin and Guff Block, Betty Barry Shop	109 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61870	E.C. Phillips, T. Jefferson Hoxie Building	119 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61871	A and P Store	121 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61872	Brewer's Meat Market, Adams Grocery	123 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 1400976)
P61873	Piccolo Brothers, John Miner's Pool Room	127 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61874	Harrington House, Commercial State Bank	137 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61875	Candyland, Good's Corner	201 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61876	Unknown	203 North Mill Street, St. Louis	Building	2014	Noncontributing resource to the St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P61877	Liberty Theater, Gem Theater	205 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61878	Charles Building	217 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61879	Harding Hardware, Drake Accounting	219 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61880	City Bakery, Sportsmen's Barbershop	221 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61881	Clark's Bakery, Blue Shamrock Pub, Friendly Tavern	223 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61882	V-Care Pharmacy	225 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61883	Hofstetter Building	227 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61884	Jim's Barber Shop	229 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P61885	Doctor Near Office	235 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61886	Holcomb's Opera House Block, Tyroler's Department Store, Gratiot County Bank	305 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Michigan Site No. P47958, NRHP ID No. 14000976)
P61887	Shirley's Furniture	307 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)
P61888	D-Tails	317 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)
P61889	Humphrey and Ostrander Hardware Store, Pain Pantry, Noettling's Pain and Wallpaper	321 North Mil Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)
P61890	Apartment Building, Capital Business Service	214 West Saginaw Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)
P61891	Bartstow's Doctor's Office	215 West Saginaw Stret, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (No. P47958, NRHP ID No. 14000976)
P61892	Brewer-Bouchey Monument Company	207-209 North Mill Street, St. Louis	Building	2014	Noncontributing resource to St. Louis Downtown Historic District (No. P47958, NRHP ID No. 14000976)
P61893	Brewer-Bouchey Monument Company	211 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)

Table 4-3. Previously Identified Aboveground Resources Within Study Area

Michigan Site No.	Name	Address	Type	Date Recorded	NRHP Eligibility Status
P61894	Brewer-Bouchey Monument Company, McDonald and Rehl Furniture and Undertakers	215 North Mill Street, St. Louis	Building	2014	Contributing resource to St. Louis Downtown Historic District (Site No. P47958, NRHP ID No. 14000976)
P659	John Elwell House	103 Delaware Street, St. Louis	Building		More Information Needed/Unevaluated

4.4 Cemeteries

Review of the Michigan SHPO data indicates that no recorded cemetery resources are located within the Study Area. However, the Bethany Indian Cemetery is a maintained cemetery located along the west side of Riverside Drive 0.87 mile north of the APE. The cemetery is associated with the Bethany Mission (20GR186), Bethany Settlement (20GR187), and Shin-gwah-koos-king (20GR199) and includes multiple Saginaw Chippewa and Lutheran missionary burials.

4.5 Cultural Resource Management Investigations

Review of the Michigan SHPO data indicates that five systematic surveys for cultural resources have been conducted within the Study Area, but none intersect with the APE. Previous investigations with associated archaeological sites are in the northeast quarter of the Study Area and are located around the Pine River to the north and east of OU3.

In 1986, Scott G. Beld investigated Sections 1-3, 7, 8, 10-12, 15-18, 27, and 32 of Bethany Township and identified three archaeological sites (20GR194, 20GR195, and 20GR196). The three sites contained lithic scatter, a projectile point, and a Late Woodland potsherd, and were recommended for further work. Beld also investigated the Bethany Mission Site (20GR186-187), a multicomponent site, and recommended the site eligible for listing in the NRHP. In 1987, Beld further investigated the Study Area and identified eight archaeological sites (20GR194, 20GR195, 20GR196, 20GR197, 20GR198, 20GR199, 20GR186, and 20GR187). 20GR199, 20GR186, and 20GR187 contribute to the Bethany Mission complex (circa 1848) and include an Ojibwa Indian village and a German Lutheran mission. Because the Bethany Mission complex (20GR186) is the only intact occupation of its kind in the state, the site is eligible for listing in the NRHP under Criterion D for its potential to yield important information in prehistory and history and is also assumed eligible under Criteria A, B, and C. In 1990, Beld further investigated three archaeological sites (20GR186, 20GR187, and 20GR199), which resulted in the NRHP-eligible recommendation for the sites (Beld, 1986, 1987, and 1990).

4.6 Historic Maps and Atlases

Table 4-4. Previous Cultural Resource Management Investigations within the Study Area

ID Num	Bibkey	Project Name	Title	Author (Year)
S86-227	3637; 00015	Gratiot County Ph IV Random Sample	Preliminary Report - Gratiot County Archaeology Phase IV, S86-227; Random Sample Survey of Bethany Township, Gratiot County, Michigan.	Beld (1986); Beld (1987)
S89-273	11452	Gratiot County Ph V: Shin-Gwah-Koos-King / Bethany Mission	Gratiot County Archaeology, Phase V, S89-273: Shin-Gwah-Koos-King/Bethany Mission (20GR186/187/199) Part I.	Beld (1990)
Unknown	Unknown	Unknown	A Random Sample Survey of Arcada and Sumner Townships, Gratiot County, Michigan, 1977.	Luke (1978)
ER89508j	-	Great Lakes Gas Pipeline (See ER-890508)	Unknown	Unknown
ER97434d	03790; 05322; 14048; 14047; 03671; 01562; 03556	Great Lakes Gas Transmission Limited Partnership: 300 Expansion project, formerly 42-inch pipeline Expansion Project (FERC)	Unlabeled Elmwood Hills Country Club Investigation	Unknown

Source: Michigan SHPO records

In addition to a review of previously recorded cultural resources, available online historic mapping was also reviewed. In Gratiot County, historic atlases, including details for Pine River and Bethany Townships from 1889, 1901, and 1914, were reviewed, and USGS topographic maps from 1935 were examined. Aerial images from 1954, 1956, 1972, 1981, 1998, 2005, 2011, 2013, 2015, and 2022 were also reviewed.

The 1889 atlas of Gratiot County shows a “Saw and Planing Mill” as well as a “Dry Kiln” associated with the “St. Louis Hoop & Stave Co.” at the northern end of the former chemical plant site along the southern bank of Mill Pond (Pine River) (Hays, 1889). The mill is shown along the north side of Jackson Street and north the intersections of Jackson Street with Wattson and Bankson streets. A railroad spur line also travels into the mill from the south. This spur line runs south to north between Wattson and Water streets through the middle of the parcels platted between those streets. The spur connects to the Toledo Ann Arbor & North Michigan Railroad to the south of Washington Avenue. Structures labeled “Bromine Works” are also shown south of the mill and rail spur and extend onto Jackson Street. A “Salk Block Office” is depicted at the northeast corner of Jackson Street and Bankson Street, south of the “Bromine Works.” A parcel named “City Pound” is shown bordering Mill Pond on Delaware Street. Other structures are shown within parcels west of Wattson Road, including a residence belonging to “Geo. D.” at the northeast corner of Wattson Street and North Street, a “Depot” along the railroad line between Center and Saginaw streets and structures labeled “Elevator” and “Martin & Merrill” at the southeast corner of Washington Avenue and Wattson streets. Additionally, two rail spurs are shown traveling west from Water Street toward Pine River. The area west of Water Street and the railroad line is mainly depicted as open land, with one structure attributed to “W. E. Glasby” near the bend in Pine River (Hays, 1889). Two other larger parcels in this area are owned by “H. Shippey” and “H.L. Holcomb” (Hays, 1889)

The 1889 atlas shows that Pine River and Mill Pond fork to form two small islands south of Prospect Street, north of North Street, and west of Midland Street (Hays, 1889). "Jas Henry" is shown as the owner of these areas. A bridge is also depicted crossing these islands and three branches of Pine River that spans north to south connecting Prospect Street to Mill Street. Near the southern most span of the bridge, the "Well City Water Works" facility is depicted on the eastern island north of Mill Street. Additionally, a structure associated with "Edison Electric Light & Sewer Power Co." is located near the southern point of the eastern island. A spring named "Magnetic Spring" is also shown at the southern point of the island, south of the "Edison Electric Light & Sewer Power Co." structure. A footbridge is shown connecting to the island near the spring. This bridge first crosses east to west over Pine River from Midland Street to the parcels along Mill Street, and then crosses again over the fork in Pine River to "Magnetic Spring". A small branch of Pine River or canal is also depicted west of the main course of Pine Creek and runs south to north through the eastern portions of the parcels along Mill Street and reconnects with Pine Creek near the Mill Street bridge. This branch is shown flowing through a "Foundry" structure at the corner of Center Street and Midland Street, and passing between a number of structures between Mill Street and Pine Creek including a "Park House," "Bath Rooms," "St. Louis Mills," a "Mrs. Bates" structure, and "St. Louis Magnetic Mineral Works Co." buildings.

An "Iron Bridge" is also shown crossing north to south over Pine River between Midland Street to Main Street (Hays, 1889). From this bridge, the river runs west to east north of Saginaw Street. A small bridge is depicted crossing Pine River north to south, located northeast of the intersection of Saginaw Street and East Street. This small bridge is also located to the rear of structures along Saginaw Street, including one noted as a residence of "C.W. Giddings". From here, the river continues east until it bends again to the north toward Hemlock Street. The "Giddings Riverside Park" and "Picnic Grounds" are depicted along the western bank of the river as it bends to the north. No structures are shown within the park. The river continues north with several other bends that largely follow the course of the river as seen today, and no other bridges are depicted. Additionally, no additional structures are shown adjacent to the river. The nearest visible structures to the river are one located south of the river on the west side of Clinton Street, and another on a parcel belonging to "Jas. Redmond" east of the river and west of North Union Road.

The next available atlas of the APE from 1901 shows several changes throughout the area. The railroad spur is still shown running through the APE west of Wattson Street toward the saw and planing mill (National Publishing Company, 1901). However, the mill, bromine works, and salt block office are no longer shown. A new structure is located on a parcel at the corner of Jackson Street and Bankson Street near the bank of Mill Pond labeled "Ashery." The railroad spur also connects to a line renamed as the Pere Marquette Railroad. Multiple other structures continue to be depicted along the rail line between Wattson and Water streets. Further, five new structures are shown along both sides of Center Street, which runs east to west and ends at the eastern bank of Mill Pond (National Publishing Company, 1901).

By 1901, the two islands formed by the forks in the Pine River have been filled in and are inundated by Mill Pond (National Publishing Company, 1901). The bridge crossing Mill Pond from Mill Street to Prospect Street is still in place, as is one of the structures associated with the "Well City Water Works" shown on the 1889 atlas. The footbridge crossing Pine River from Midland Street, the "Edison Electric Light & Sewer Power Co." structure, and "Magnetic Spring" are no longer shown. Instead, a dam is shown crossing Pine River from Midland Street toward Mill Street, damming the water within Mill Pond. South of the dam a structure labeled "Water Works" is connected to the west bank of the Pine River. The 1901 atlas also shows that the canal visible on the 1889 atlas only extends to an "Elevator & Mill" facility along Mill Street and does not extend down to a foundry near Center Street and Main Street as before. This waterway is labeled as a race and also attaches to an extension of Pine River labeled as "Overflow." A new footbridge is shown crossing the overflow extension east of the mill. Additionally,

the bridge over Pine River between Main Street and Midland Street remains in place. However, the small bridge depicted crossing Pine River near the Giddings residence is no longer shown, and a structure is shown near the north bank of the river near to where the bridge crossed (1901a). The remaining area appears much like what is illustrated in the 1889 atlas.

Review of the 1914 atlas of Gratiot County indicates that the area appears largely unchanged from 1901 and does not provide detail on the location of individual structures (Chadwick, 1914). The next available USGS topographic map of the APE from 1935 shows that Water Street has been removed to the west of North Watson Street (NETR, 2023a). However, the railroad line is still visible in the area west of Watson Street extending to the north. Center Street is also shown running east to west and ending near the eastern bank of Mill Pond where it bends to the west. Several structures are also depicted along both sides of Center Street. Additional structures are located west of the railroad spur as well as along the west side of Watson Street. To the north, Bankson Street is depicted as extending to the southern shore of Mill Pond and wrapping around to the west to join North Street. Several structures as shown along these streets but lack detailed descriptions. No additional bridges or major changes to Pine River are evident on the 1935 topographic map.

A 1954 aerial image shows that the area west of Watson Street and north of North Steet has been developed with the addition of the chemical plant (NETR, 2023b). The development is mainly clustered around facilities north of Washington Avenue and North Street. The facilities near North Street include parking lots, several industrial buildings, and storage tanks. Additional storage tanks and structures are located north of Washington Avenue. The railroad line travels through the plant area as well and leads to the cluster of structures at the north end. The area to the east of Watson Street is developed with many residences. The 1954 aerial image also shows a dam between Pine River and the eastern end of Mill Pond. Two connected structures are also shown on the western side of Pine River near the dam, east of Mill Street. No race or overflow extensions to Pine River are visible in the 1954 aerial, and the area of the former mill is developed with a swimming pool (now the WT Morris Memorial Swimming Pool).
The area south of the swimming pool appears developed with commercial and residential properties along Mill Street. On the north side of Pine River, an athletic track and associated building are also visible in 1954 (now the St. Louis Sharks Football field). A small bridge is also visible crossing north to south across Pine River and connects the athletic facility to St. Louis High School on Saginaw Street. The North Main Street and North Mill Street bridges are the only other visible crossings of Pine River. The area to the east of the athletic track and field has been developed with five small structures or cabins with a larger associated structure located to the north. The 1954 aerial also shows a pipeline or utility crossing over Pine River west of North Union Road. This crossing is still visible today west of the Central Michigan Correctional Facility. The remaining banks of Pine River to the east and north remain wooded and undeveloped.

An aerial image from 1956 shows that the chemical plant has expanded with new storage tanks and buildings throughout the property (NETR, 2023b). The next available aerial image from 1972 shows that the facility has expanded again with additional storage tanks associated with the plant (NETR, 2023b). Near the northern end of the facility, an extension into Mill Pond or docking area is visible. A substation has also been added west of the structures associated with the dam across Pine River, east of North Mill Street. Additionally, the area south of the swimming pool along North Mill Street has been redeveloped with a commercial structure and a parking lot (now the location of the St. Louis Farmers Market, St. Louis Police Department, and St. Louis City Assessor). One residence also remains adjacent to Pine River, north of West Center Avenue. Further, the area east of the St. Louis High School track and field has been cleared for an athletic field, and the area to the north has been redeveloped into what is now TSN Middle School.

By 1981, aerial imagery shows that the chemical plant and its associated structures and storage tanks have been removed from the property (NETR, 2023b). The railroad spur has also been removed by this time. Visible dark, discolored, and mottled soil suggests heavy disturbance across the property as a result of the demolition of structures. A retention pool is also visible on the property northwest of the corner North Watson Street and North Street. Aerial imagery from 1998 shows that the area formerly occupied by the chemical plant appears to be covered with grass and vegetation (Google Earth, 2023). An access road also makes its way north from North Bankson Street and follows the bank of the Mill Pond before reaching the retention pool.

Imagery from 2005 shows that the northern area along the Bankson Street access road has been cleared of vegetation, and a structure has been constructed north of North Street (Google Earth, 2023). Numerous vehicles and pieces of equipment are visible in the aerial imagery through this area. An extension has also been constructed running east from the area of the new structure before turning north to connect with the norther side of Pine River. Retaining walls or fencing is also now in place through the middle of Pine River, and discolored soil or water is visible within the north portion. By 2006, the extension crossing Pine River has been removed, and the areas of discoloration are located south of the retaining walls (Google Earth, 2023). Aerial imagery from 2011 shows that the structure in this area has been removed, and the area has been partially recovered with vegetation, leaving only access roads and a storage yard. Review of images between 2013 and 2015 shows continued vehicle traffic throughout the entire former plant area, as well as equipment storage and staging areas (Google Earth, 2023). The retaining wall in the middle of Pine River is also removed between 2013 and 2015. The most recent aerial imagery from 2022 shows an access road extending north through the area from West Washington Avenue that connects with a new staging area south of the retention pool. Numerous pieces of equipment, vehicles, and storage sheds are shown across the area. The immediate areas along the banks of Pine River to the east of St. Louis High School have remained wooded throughout.

5. Summary and Conclusions

The records review indicates that no previously recorded archaeological sites, aboveground resources, or other cultural resources eligible for or listed in the NRHP are within the APE. In the Study Area, a total of 10 archaeological sites, 44 aboveground resources, 1 NRHP-listed historic district, and at least 1 cemetery (which is also counted an archaeological site) were recorded by previous cultural resources investigations. Of those 56 cultural resources, there are 1 NRHP-listed historic district (St. Louis Downtown Historic District), 3 NRHP-eligible archaeological sites (20GR186, 20GR187, and 20GR199), and 5 NRHP-eligible aboveground resources (P16910, P23218, P23220, P48263, and P52334). All previously identified cultural resources are in the Study Area, and none are within or adjacent to the APE. In addition to the identified resources, five previous cultural resources surveys have been conducted within the Study Area, none of which are within or adjacent to the APE.

Given the current land use surrounding the APE, the project will not create visual impacts to identified historic-era aboveground resources within the Study Area, but outside the APE. Due to the proposed project's nature and lack of aboveground resources in the APE, no aboveground resources would be affected, and no further aboveground investigation is recommended for the project.

Though the project proposes remedial activities that would not introduce new aboveground features, the project would cause ground disturbance and tree removal. Some trees would be removed for the construction of temporary access roads and work areas, and the remaining canopy would sufficiently retain the existing viewshed in or adjacent to the APE. Historic record and imagery review confirm that the APE in OU1 was heavily modified by former industrial uses, associated ground disturbance, and prior subsurface remediation within the APE. Therefore, the potential for impacts to previously undiscovered cultural resources within OU1 is low, and no further archaeological work is recommended for this area.

The APE in OU3 intersects the river and adjacent floodplain and is in relatively intact soils with a moderate potential to yield buried cultural deposits. Given the presence of archaeological sites within the surrounding landscape, and that this area of the APE has never been subject to cultural resources investigation previously, the potential for impacts to undiscovered cultural resources within OU3 is moderate. Undisturbed soils could contain submerged and/or terrestrial archaeological resources within the proposed work in OU3. Thus, archaeological study should be conducted to recover and preserve information and artifacts in areas of the site that could not be avoided by the removal of contaminated soil.

However, due to the high likelihood that contaminated soils would be encountered in field, a Phase I archaeological survey of the APE is not feasible. Because of the contamination, standard archaeological excavation could pose a hazard to archaeologists, and data recovery should be limited to archaeological monitoring. CH2M recommends the preparation of a monitoring plan for submerged and terrestrial areas in the APE, which should be implemented prior to and during any ground-disturbing activities in OU3.

In the event that previously undiscovered cultural resource, human burials, and/or graves resources are encountered during construction and remediation activities, all activity around the encountered property shall cease immediately to avoid or minimize harm to the property as specified in the proposed monitoring plan. If Native American human remains and cultural items are located, the consultation and repatriation process should be followed as outlined by the Native American Graves Protection and Repatriation Act (Pub. L. 101-601, 25 U.S.C. 3001 et seq., 104 Stat. 3048). Therefore, the project would

have no adverse effect to historic properties, and no further identification or evaluation of archaeological or aboveground resources is recommended.

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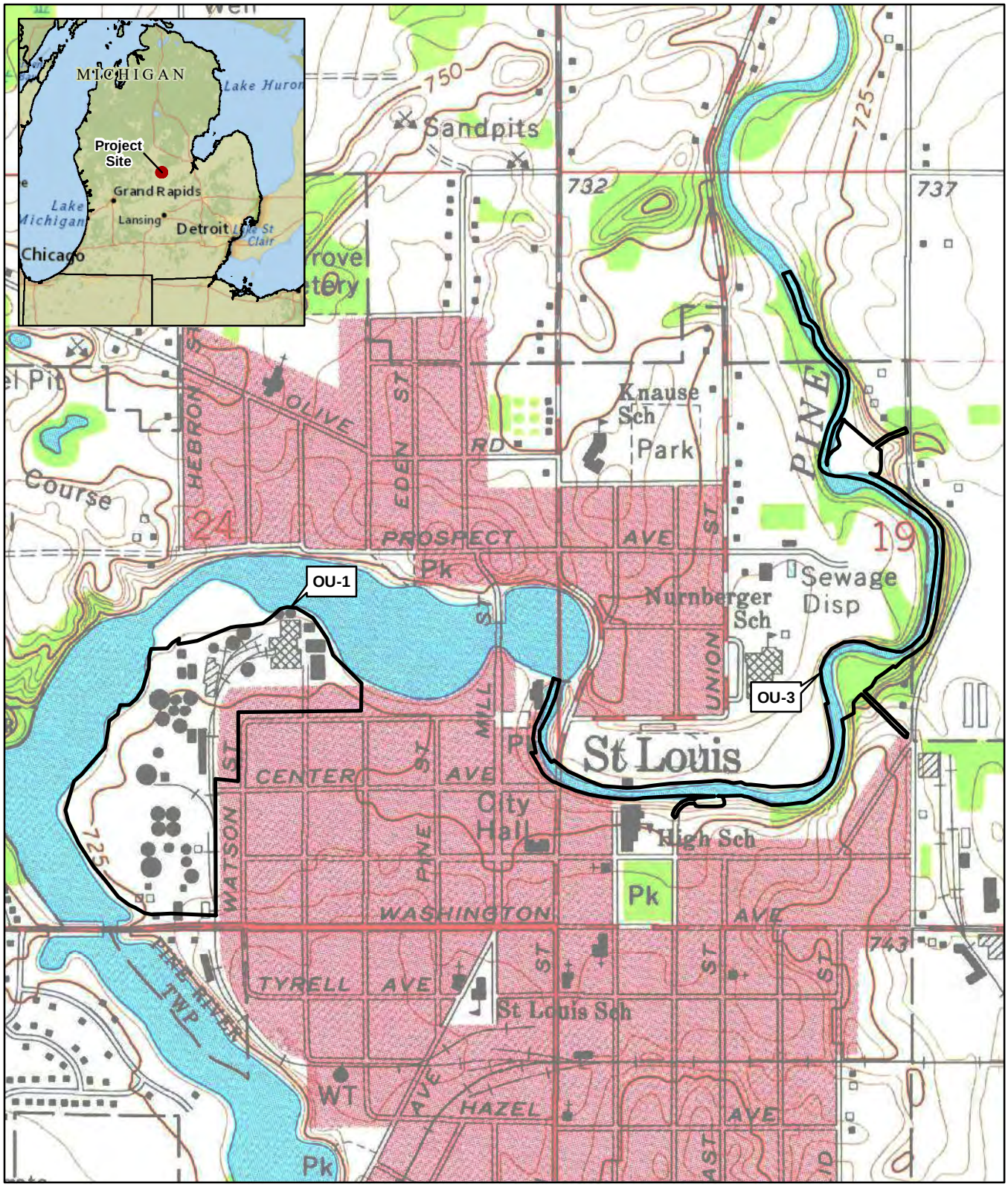
Appendix A
Figures



LEGEND

Area of Potential Effects

Note:
USGS 7.5 Minute Quadrangle Topographic Map, St. Louis, Michigan; 1972.

N

0 500 1,000
Approximate scale in feet

Figure 1.
Project Location
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

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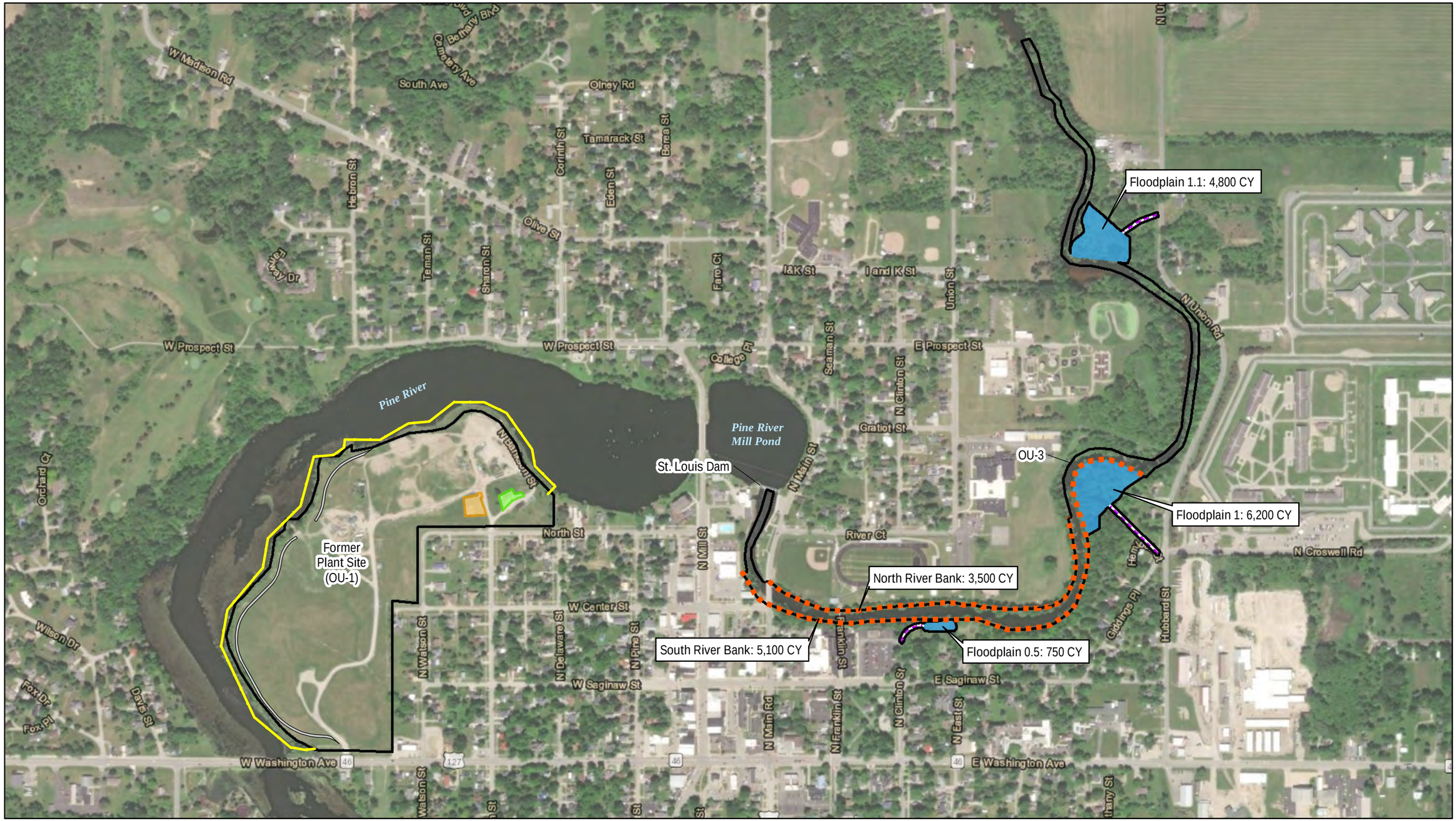
ch2m



LEGEND

- Proposed Access Road
- Bank Soils Removal Area
- Wall
- Gravel Road
- Proposed Borrow Material Stockpile Area
- Proposed Refueling Area
- Area of Potential Effects
- 2020 Floodplain Removal Area

Note:
1. The total area where soils will be removed is 20,350 CY.
2. CY = Cubic Yards

N

0 600 1,200
Approximate scale in feet

Figure 2.
Project Elements
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

ch2m

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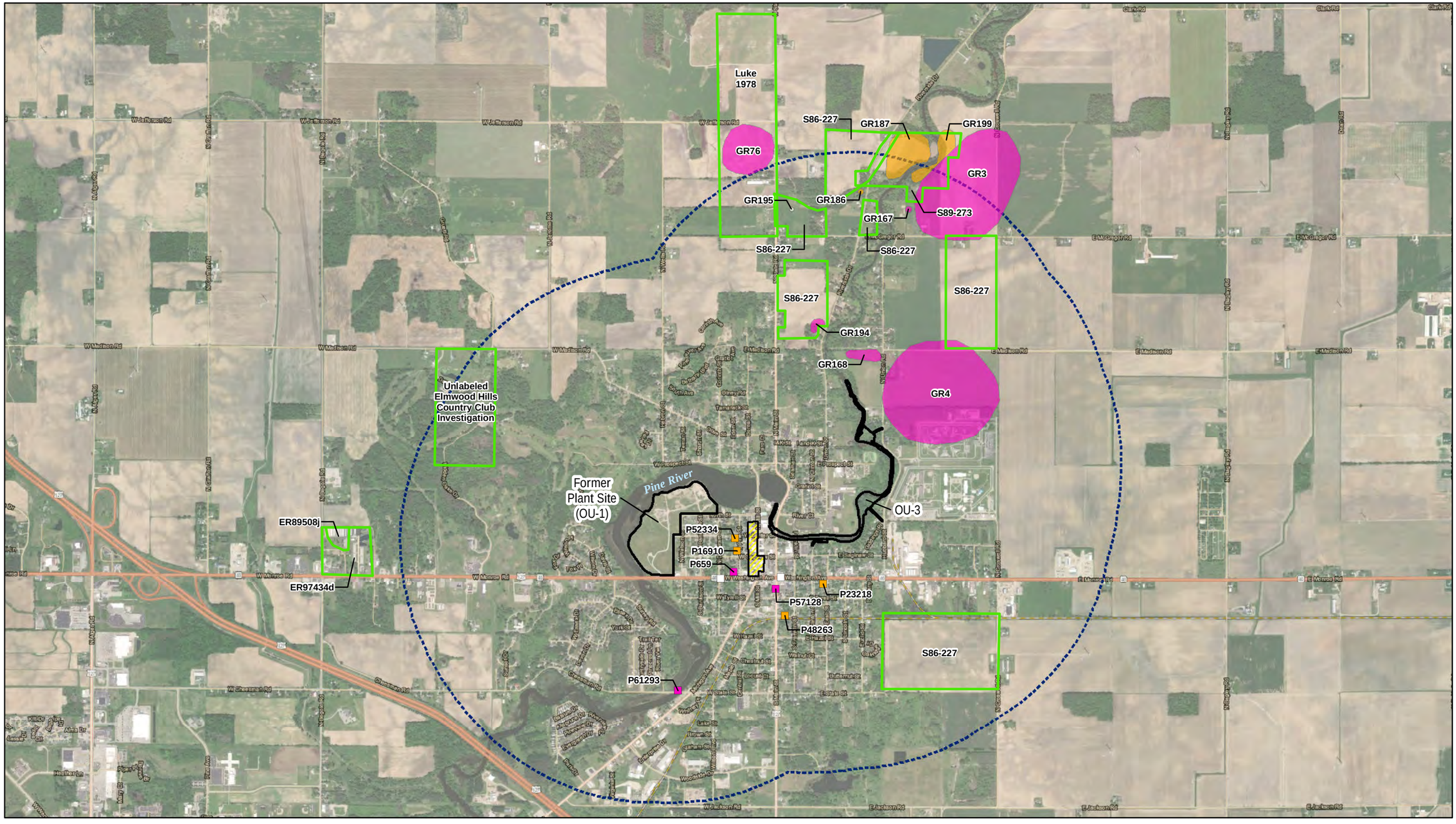


LEGEND

Aboveground Resources
NRHP Category
- Eligible
- Not Eligible
- More Information Needed/Unevaluated

Archaeological Sites
NRHP Category
- Eligible
- Not Eligible
- More Information Needed/Unevaluated

- Cultural Resources Survey
- Historic District
- Area of Potential Effects
- 1-Mile Study Area

Note:
1. NRHP = National Register of Historic Places

Source:
Michigan State Historic Preservation Office (MI SHPO)

0 2,200 4,400
Approximate scale in feet

Figure 3.
Cultural Resources Results
Velsicol Chemical Corporation Superfund Site
St. Louis, Michigan

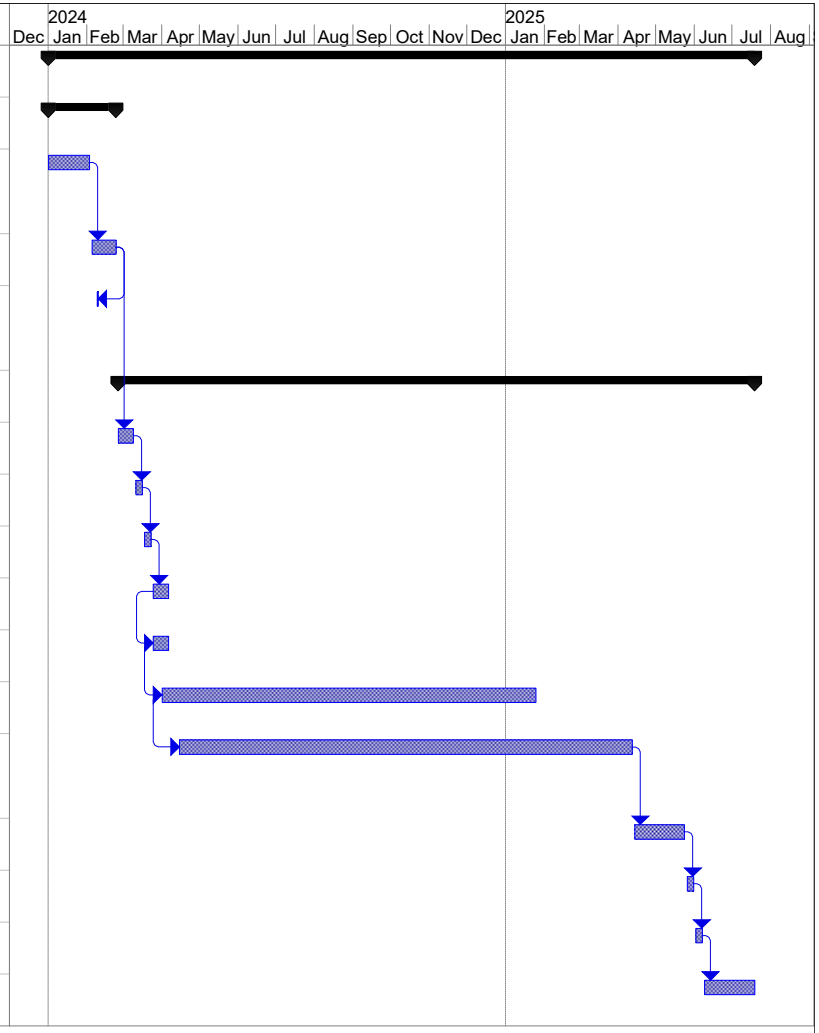
NOT FOR DISTRIBUTION

ch2m

\\DC1VS01\GISPROJE\EPA\VELSICOL_SUPERFUNDSITE\MAPFILES\2023\CULTURAL\FIGURE_3_CULTURAL_RESOURCES_RESULTS.MXD AESPEJO 9/13/2023

Appendix P
Construction Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Remedial Action**	**405 days**	**Mon 1/1/24**	**Fri 7/18/25**	
2	**Preconstruction Activities**	**40 days**	**Mon 1/1/24**	**Fri 2/23/24**	
3	Development of Site-Specific Plans & Borrow Source Identification	25 days	Mon 1/1/24	Fri 2/2/24	
4	EPA Review of Site-Specific Plans	15 days	Mon 2/5/24	Fri 2/23/24	3
5	Coordination Meeting with RA Contractor, City of St Louis, EGLE, and EPA	1 day	Fri 2/9/24	Fri 2/9/24	4FF-10 days
6	**Downgradient Vertical Barrier Wall Construction**	**365 days**	**Mon 2/26/24**	**Fri 7/18/25**	
7	Mobilization and Site Control	10 days	Mon 2/26/24	Fri 3/8/24	4
8	Utility Locates	5 days	Mon 3/11/24	Fri 3/15/24	7
9	Preconstruction Survey	5 days	Mon 3/18/24	Fri 3/22/24	8
10	Temporary Road Construction	10 days	Mon 3/25/24	Fri 4/5/24	9
11	Clearing and Grubbing	10 days	Mon 3/25/24	Fri 4/5/24	10SS
12	Installation of Downgradient Vertical Barrer	215 days	Mon 4/1/24	Fri 1/24/25	11SS+5 days
13	Backfill Between Downgradient Vertical Barrier and Existing Shoreline	260 days	Mon 4/15/24	Fri 4/11/25	12SS+10 days
14	Site Restoration	30 days	Mon 4/14/25	Fri 5/23/25	13
15	Final Site Survey	5 days	Mon 5/26/25	Fri 5/30/25	14
16	Demobilization	5 days	Mon 6/2/25	Fri 6/6/25	15
17	Remedial Action Report	30 days	Mon 6/9/25	Fri 7/18/25	16



Project: Anticipated Construction Schedule for the Velsicol Downgradient Vertical Barrier Wall

Task		External Milestone		Manual Summary Rollup	
Split		External Milestone		Manual Summary	
Milestone		External Milestone		Start-only	
Summary		External Milestone		Finish-only	
Project Summary		External Milestone		External Tasks	
External Tasks		Inactive Milestone		External Milestone	
External Milestone		Inactive Summary		Progress	
External Milestone		Manual Task		Deadline	
External Milestone		Duration-only			

Appendix Q
Cost Estimate

Appendix Q
Final Basis of Estimate

Remedial Design of the
Velsicol Chemical Corporation Superfund Site
Downgradient Vertical Barrier Wall

St. Louis, Michigan

Prepared for:

United States Environmental Protection Agency – Region 5

Prepared by:

CH2M HILL, Inc.
A wholly owned subsidiary of Jacobs Engineering Group Inc.
6312 S. Fiddler's Green Circle
Suite 300N
Greenwood Village, CO 80111

U.S. Environmental Protection Agency
Contract Number 68HE0519D0007
Task Order Number 68HE0521F0106
DCN: GLAES-R5-21F0106-02027

September 2023

Project Name: Velsicol Chemical Corporation Superfund Site, St. Louis, Michigan—Downgradient Vertical Barrier Wall

Class Estimate: AACE International Class 2 Project Budget Estimate

Project Manager: Scott Pratt

Senior Technical Consultant: Jason Cole

Estimated By: Mark Allen

Estimate Date: September 27, 2023

Acronyms and Abbreviations

BODR	basis of design report
CH2M	CH2M HILL, Inc.
DGVBW	downgradient vertical barrier wall
EPA	U.S. Environmental Protection Agency
FPS	Former Plant Site
OU	operable unit
RA	remedial action
site	Velsicol Chemical Corporation Superfund Site

1.1 Purpose of Estimate

This Basis of Estimate is included as Appendix Q to the *Final Basis of Design Report, Remedial Design of the Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, St. Louis, Michigan* (BODR; CH2M, 2023) and should only be viewed in conjunction with the BODR. This budget estimate provides an engineer's estimate of budgetary costs for the installation of the downgradient vertical barrier wall (DGVBW) at the Velsicol Chemical Corporation Superfund Site (site). The following sections outline assumptions that apply to this estimate.

This Basis of Estimate should be reviewed in conjunction with Attachment 1, which outlines the anticipated costs for the project.

1.2 General Project Description

The site is in St. Louis, Michigan, and includes four operable units (OUs) (Figure 1-1 of the BODR [CH2M, 2023]). The site is in a predominantly residential area. A city park borders the Pine River's northern bank across from the Velsicol Chemical Corporation property. The Pine River flows along the western and northern sides of the Former Plant Site (FPS) into Mill Pond, where the St. Louis hydroelectric dam is located (about 0.25 mile east of the site). The 52-acre land parcel, commonly referred to as the FPS, was once occupied by a chemical processing plant and is designated as OU1. The plant was closed in 1978 and was demolished between 1982 and 1984.

Several blocks of residential properties that surrounded the FPS are also included in OU1 and are referenced as the adjacent and nearby properties in site documents. The Pine River and Mill Pond border two sides of the FPS; OU2 consists of sediment within these features (approximately 38 acres). Removal of contaminated sediments from OU2 took place from 1999 through 2006. The area of the Pine River downstream of the St. Louis hydroelectric dam is designated as OU3. OU4 contains Pine River sediments stretching from approximately 1.25 miles downstream of the St. Louis hydroelectric dam to the confluence of the Pine, Chippewa, and Tittabawassee Rivers. Two nearby properties are also part of the former Velsicol Chemical Corporation operations and are referred to as the former creamery warehouse and Velsicol property 1. Environmental restoration of the Burn Pit, a third parcel that historically supported Velsicol Chemical Corporation operations, is also necessary and will progress on an independent path and timeline from the FPS.

Remedial activities for OU1 will occur in several phases spanning many years, as described in the *Record of Decision—Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan* (EPA, 2012). The cost estimate described herein is for the DGVBW only.

1.3 Project Objective

The remedial action (RA) objectives applicable to the DGVBW listed in the 2012 Record of Decision (EPA, 2012) are to prevent ingestion, inhalation, and direct contact of site-related chemicals of concern in soil by human and ecological receptors; to prevent migration of site-related chemicals of concern from unsaturated and saturated subsurface media to the groundwater or surface water beyond the point of compliance; and to eliminate offsite migration of dense nonaqueous phase liquid to prevent the contamination of the surface water and recontamination of sediments of the Pine River.

The U.S. Environmental Protection Agency's (EPA's) RA contractor and a primary subcontractor will perform the work. There will also be supporting subcontracts for laboratory analysis, waste disposal, and other services. The following are major components that form this Basis of Estimate:

- Mobilization and site preparation:
  - Performing utility locates
  - Conducting a preconstruction site survey
  - Installing soil erosion and sediment controls and stormwater management
  - Constructing or establishing temporary facilities, such as field trailers, material storage facilities, and sanitary facilities
  - Constructing temporary roads
  - Delivering and assembling equipment
  - Installing turbidity control measures
  - Installing site and environmental controls
  - Conducting a migratory bird survey and bat surveys if construction occurs within restricted nesting or roosting periods
  - Establishing site security and coordination
- Construction of the DGVBW:
  - Clearing and grubbing
  - Surveying
  - Characterizing soil and liquid waste
  - Installing a vertical barrier along the downgradient perimeter of the FPS
  - Placing backfill on the land side of the DGVBW
  - Placing toe stone along the river side of the DGVBW
- Offsite transportation and disposal of waste
- Ditch construction and site restoration
- Demobilization

1.4 Administration and Remedial Action Contractor Oversight

This budget estimate assumes that, in addition to the RA contractor cost shown on the Class 2 Cost Estimate Summary (Attachment 1), administration and RA contractor oversight will be necessary. The administration and RA contractor oversight cost presented are per EPA's direction.

1.5 Assumptions

This estimate is based on the quantities, sizes, and calculations presented in the BODR (CH2M, 2023). Section 3 of the BODR presents key design assumptions. The following exclusions and assumptions supplement Section 3 of the BODR and are presented as conditions for the budget estimate in Attachment 1:

- The estimate is based on 2023 pricing. A detailed schedule has not been developed at this time because RA activities on the FPS require Prioritization Panel review and a start determination from EPA.
- CH2M HILL, Inc. (CH2M) prepared the drawings used for this estimate (Appendix A of the BODR).
- This budget estimate is not an offer to contract or procure the work, but it does represent the engineer's best opinion of cost before bidding documents are developed and released to prospective RA contractors.
- The budget cost estimate does not include cost allowance for unforeseen site conditions.

1.6 Overall Costs

The following is a summary breakdown of the costs. Attachment 1 provides additional detailed information.

Low Range	Estimate Range	High Range
-15%	**Total Cost**	+20%
$27,432,100	$32,273,000	$38,727,600

1.7 Cost Factors

The following cost factors were applied to the estimate:

- Estimate Contingency 15%
- Bond/Insurance 2.50%
- RA Contractor Markup 8%
- Escalation Rate (project to be executed in 2024) 8%

CH2M developed the cost estimate for this design using 2023 dollars and adjusted the estimate to account for the planned work in 2024. Attachment 1 provides the detailed budget estimate.

1.8 Estimate Classification

This budget estimate is a Class 2 cost estimate, as defined by AACE International, and is considered to have an accuracy of +20% to -15% based on the current level of the design documents.

CH2M prepared the budget estimate for guidance in project evaluation and implementation from the information available at the time of the estimate. The final cost of the project depends on competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein.

1.9 Cost Resources

The following are various cost resources used to develop the rough-order-of-magnitude estimate:

- CH2M engineers' estimate with assumptions as noted in Attachment 1
- RSMeans 2023 Heavy Construction Cost Data as noted in the budget estimate
- Estimator judgment and experience
- Prior RA site experience
- Quantity takeoff of anticipated activities
- Detailed built-up approach to price quantities: Crews with Davis Bacon labor rates for Gratiot County, Michigan; construction equipment based on 2023 Rental Rate Blue Book rental or cost recovery rates for Michigan; materials based on budgetary quotations
- CH2M estimator's experience to determine production rates; RSMeans 2023 Heavy Construction Cost Data and bids received for similar work to determine rates of other items
- Direct cost report (basic detailed level of estimate)
  - Broken down by bid item and activities that are different items of work required to execute the project
  - Each activity estimated on direct cost basis as either a detailed level of effort method or a lump sum unit price method
  - Activities contain all resources, including labor hours, equipment, materials, and services, to accomplish

Oversight labor unit prices reflect a burdened rate, including the following: workers compensation, unemployment taxes, fringe benefits, and medical insurance.

1.10 Estimate Methodology

This cost estimate is considered a bottom rolled-up type of estimate with detailed direct cost breakdown of labor, materials, and equipment. Nonbinding cost quotations for materials and services were obtained when possible. Estimator judgment and experience were used to price materials and services whenever nonbinding cost quotations were not available. The estimate may include allowance cost for certain components of the estimate (for example, weather delays, production restraints).

1.11 Labor Costs

This budget estimate is based on current local knowledge of construction labor rates. CH2M estimated labor costs using Davis Bacon labor rates for Gratiot County, Michigan.

1.12 Sales Tax

This budget estimate does not include sales tax separately; cost for applicable sales tax is included in the individual line items.

1.13 References

CH2M HILL, Inc. (CH2M). 2023. *Final Basis of Design Report, Remedial Design of the Velsicol Chemical Corporation Superfund Site, Downgradient Vertical Barrier Wall, St. Louis, Michigan*. Prepared for the U.S. Environmental Protection Agency – Region 5. September.

U.S. Environmental Protection Agency (EPA). 2012. *Record of Decision—Velsicol Chemical Corporation/Pine River Superfund Site, Former Plant Site – Operable Unit 1, St. Louis, Michigan.* June 19.

Attachment 1
Budget Estimate

Prefinal Design Cost Estimate - Velsicol Downgradient Vertical Barrier Wall Construction
Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1, St. Louis, Michigan
Final Basis of Design Report, September 2023

Item No.	Item	Qty.	Unit	Unit Price	Total (Rounded)	Notes
Preconstruction Activities						
	Site Specific Plans and Submittals	1	LS	$ 99,000	$ 99,000	Preparation of site specific plans and submittals, including revisions based on Owner comments until approval is obtained.
	Coordination Meeting	1	LS	$ 44,000	$ 44,000	Coordination meeting with EPA, EGLE, and the City of St. Louis.
	Permitting	1	LS	$ 50,000	$ 50,000	Allowance.
Mobilization and Site Preparation						
	Utility Locate	6	DY	$ 2,800	$ 16,800	Utility locate within an estimated 3.1-acre area.
	Soil Erosion and Sediment Controls	4,200	LF	$ 13	$ 54,600	Install, maintain, and remove soil erosion and sediment controls throughout the project.
	Tempoary Facilities and Laydown Areas	12	MO	$ 19,130	$ 229,600	Field office trailers, storage trailers, temporary utilities, laydown areas, stockpile areas, decontamination facilities, etc. Includes costs for trailer and utilities for USACE.
	Temporary Road Construction	47,200	SF	$ 8	$ 377,600	Assumes temporary roads will be constructed by stripping the top 6 inches of topsoil and top 6 inches of clay cap material, compacting the existing material below the stripped material, placing geogrid over the prepared subgrade, and then placing a 12 inches of 0- by 3-inch crushed rock. Assumes roads will be 15-ft wide.
	Turbidity Control	4,400	LF	$ 40	$ 176,000	Installation of turbidity control measures and monitoring equipment. Assumes three monitoring locations.
Surveying						
	Construction Surveys	30	DY	$ 3,400	$ 102,000	Initial and clearing and grubbing payment survey, DGVBW installation surveys, backfill surveys, and final/as-built survey.
Downgradient Vertical Barrier Wall Construction						
	Clearing and Grubbing	3	AC	$ 16,438.21	$ 51,000	Clearing and grubbing along existing shoreline between Pine River and fence line.
	Sheet Pile Equipment Mob/Assembly/Demob	1	LS	$ 101,000	$ 101,000	Mobilization, assembly, and demobilization of equipment for sheet pile installation.
	King Pile Material Costs	1,524	TN	$ 3,010	$ 4,587,200	King pile materials and delivery.
	Sheet Pile Material Costs	617	TN	$ 3,010	$ 1,857,200	Sheet pile materials and delivery.
	King Pile Installation	10,801	LF	$ 42	$ 453,600	King pile installation.
	King Pile Cleanout	10,801	LF	$ 47	$ 507,600	King pile cleanout after installation.
	King Pile Embedment Drilling (10' embedment)	5,250	LF	$ 450	$ 2,362,500	Drilling for king pile sockets. Includes managing/solidifying drill cuttings and T&D of drill cuttings as non-hazardous waste.
	King Pile Rebar	295,768	LB	$ 3.74	$ 1,106,200	Purchase, delivery, construction, and placement of rebar cage into king pile.
	King Pile Concrete	3,943	CY	$ 600	$ 2,365,800	Concrete for socket and king pile. Unit price estimate from similar project.
	Sheet Pile Installation	56,722	SF	$ 20	$ 1,134,400	Sheet pile installation. Unit price estimate from similar project
	Install Cover/Cap on Combination Wall	4,332	LF	$ 49	$ 212,300	Tack weld cover onto combination wall.
	Turbidity Monitoring	340	DY	$ 930	$ 316,200	Assumes three monitoring locations throughout preconstruction activities (for background data collection) and DGVBW construction activities.
	Dust Monitoring	340	DY	$ 500	$ 170,000	Assumes three monitoring locations throughout preconstruction activities (for background data collection) and DGVBW construction activities.
	Dewatering and Liquid Waste Management	1,600,000	GAL	$ 1.33	$ 2,121,100	Assumes water will be treated and discharged back into the Pine River. It is assumed that water treatment will consist of a weir tank, 4 sand filters, and (2) 2,000 lb carbon vessels.
	Backfill Activities - Stone Fill	8,900	CY	$ 65	$ 578,500	Placement of stone fill to elevations shown on drawings. Assumes #3 stone will be used.
	Backfill Activities - Aggregate Fill	5,250	CY	$ 99	$ 519,800	Placement of aggregate fill to elevations shown on drawings. Assumes #57 stone will be used.
	Backfill Activities - Granular Fill	15,150	CY	$ 70	$ 1,060,500	Placement of granular fill to meet site grading plan. Assumes 870 CY of clay cap material removed during access road and staging area construction can be reused, and is therefore not included in quantity.
	Backfill Activities - Geotextile (non-woven)	282,890	SF	$ 0.71	$ 199,600	Geotextile placed between native material and stone fill and also between aggregate fill and granular fill.
	Toe Stone Rip Rap and Geotextile	1,685	TN	$ 80	$ 134,800	Cost for materials. Assumes toe stone will be placed 2 ft vertically up the DGVBW and a maximum of 6 ft out from the DGVBW. Assumes MDOT Plain Rip Rap will be used. Assumes 16 oz non-woven geotextile.
	Toe Stone Placement	4,332	LF	$ 10	$ 43,300	Equipment and labor to place geotextile and rip rap (toe stone) at the base of the king pile wall. Assumes access along the wall is available for placement from land side; crew of two laborers in the water during placement (in a boat in areas >3-ft deep)
	T&D of Materials Offsite	1,000	TN	$ 90	$ 90,000	Allowance for clearing and grubbing material that cannot be chipped and spread onsite, misc. debris generated during construction, etc.; assumes all material will be nonhazardous. T&D of drill cuttings included in King Pile Embedment Drilling line item
	Ditch Construction	330	CY	$ 170	$ 56,100	Placement of D50=6" rip rap along bottom of stormwater ditches at existing culverts and at stormwater outlets.
	Site Restoration - Topsoil Placement	4,087	CY	$ 70	$ 286,100	Topsoil placement. Assumes 870 CY of topsoil removed during access road construction can be reused and is therefore not included in quantity.
	Site Restoration	267,675	SF	$ 0.24	$ 64,800	Hydroseeding, watering, and maintenance of disturbed areas and backfilled area between DGVBW and existing fence line. Assumes temporary access roads and facilities will remain in place.

Prefinal Design Cost Estimate - Velsicol Downgradient Vertical Barrier Wall Construction

Velsicol Chemical Corporation Superfund Site Downgradient Vertical Barrier Wall, Operable Unit 1, St. Louis, Michigan

Final Basis of Design Report, September 2023

Item No.	Item	Qty.	Unit	Unit Price		Total (Rounded)		Notes
Demobilization and Postconstruction Documentation								
	Demobilization	1	LS	$	171,506	$	171,500	
	Preparation of RA Completion Report	1	LS	$	75,000	$	75,000	
	Total Construction Cost					**$**	**21,775,700**	
	P&P Bond (2%) and Insurance (0.5%)	2.5%	of	$	21,775,700	$	544,400	
	Contingency	15%	of	$	21,775,700	$	3,266,400	
				Subtotal Capital Costs:		**$**	**25,587,000**	**Rounded**
	RA Contractor Markup	8%	of	$	25,587,000	$	2,047,000	
	Administration/RA Contractor Oversight					$	2,400,000	Assumption based on in-person discussion with EPA.
	Escalation - Project to be executed in 2024	8%	of	$	27,987,000	$	2,239,000	
				Total Capital Costs:		**$**	**32,273,000**	**Rounded**
		Class 2 Estimate Range:			**20%**	**$**	**38,727,600**	
					-15%	**$**	**27,432,100**	

This budget estimate is not an offer for construction or project execution. These AACE International Class 2 cost estimates are intended to reflect the actual installed costs within the range of -15% and +20% of the costs indicated. The budget estimate has been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs and competitive variable factors. Because of this, project feasibility and funding needs must be carefully reviewed before making specific decisions to help ensure proper project evaluation and adequate funding.