Pre-Design Investigation Work Plan for Operable Unit OU-09 – Smokes Creek

Former Bethlehem Steel Site
NYSDEC Site No. 915009

Tecumseh Redevelopment Site
2303 Hamburg Turnpike
Lackawanna, Erie County, New York

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Certification

I, Lori E. Riker, P.E., certify that I am currently a NYS registered professional engineer, and Roux QC Manager, and that this May 2026 Pre-Design Investigation (PDI) Work Plan for Operable Unit OU-09 – Smokes Creek was prepared in accordance with all applicable statues and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and DER Green Remediation (DER-31).

5/22/26

Date

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1 Introduction

Roux Environmental Engineering and Geology, D.P.C. (Roux) has prepared this Pre-Design Investigation (PDI) Work Plan on behalf of Tecumseh Redevelopment Inc. (Tecumseh) for Operable Unit OU-9 Smokes Creek within the Corrective Measure Study (CMS) Area of the Tecumseh property (Site; see Figures 1 and 2). The Tecumseh property is the Former Bethlehem Steel Site, NYSDEC Site No. 915099, addressed as 2303 Hamburg Turnpike, Lackawanna, New York.

1.1 Purpose & Scope

This PDI Work Plan presents the approach for collecting additional investigation data prior to implementation of corrective measures outlined in the New York Department of Environmental Conservation (NYSDEC) November 2021 Final Statement of Basis (SOB), Corrective Measures Selection for Operable Units OU-01, 09, and 10 (Ref. 1). Specifically, it addresses SOB requirements for additional data collection needed to design sediment remedial measures within Smokes Creek. The information gathered during the PDI will be presented in a OU-09 Remedial Design/Remedial Action (RD/RA) Work Plan for Smokes Creek.

1.2 Location & Description

OU-09 is comprised of four waterbodies, including Smokes Creek, the North Return Water Trench (NRWT), the South Return Water Trench (SRWT), and the Gateway Metroport Ship Canal. Approximately 8,500 feet of the eastern shoreline of Lake Erie borders the former Bethlehem Steel Site; the primary focus of any remedial work on the Site is to reduce contaminant loading into Lake Erie. The portion of Smokes Creek that is included within the Site is classified as Class C fresh surface water bodies, meaning the most suitable use is for fish, shellfish, and wildlife propagation and survival with water quality expected to be suitable for primary and secondary contact recreation. As outlined in 6 CRR-NY 701.4, Lake Erie is classified as Class A-S, meaning the best usage is a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. Smokes Creek is administratively divided into two parts referred to as the Smokes Creek Upper Reach (SCUR), the 3,900-foot section from Hamburg Turnpike (NYS Route 5) to the bridge on Site Highway 9, and the Smokes Creek Lower Reach (SCLR), the 2,600-foot section from the Site Highway 9 bridge to Lake Erie.

Smokes Creek and Lake Erie are located within the United States Environmental Protection Agency (USEPA) Niagara River Area of Concern (AOC). The focus of the AOC with respect to OU-09 begins at the mouth of Smokes Creek and extends west to Hamburg Turnpike (NYS Route 5) (see Figure 2).

1.3 Smokes Creek Floodway

The portion of Smokes Creek that runs through the Site generally flows east to west, bisecting the Site, and discharging into Lake Erie. During significant storm events, the Creek temporarily flows in the reverse direction due to wind surges, ice jams, and Lake seiche events. Within the Site, the Creek's average top of bank dimensions are approximately 100 feet wide by approximately 17 feet deep with 2:1 (horizontal: vertical) bank slopes.

Local topography is flat, resulting in a low hydraulic gradient and corresponding low velocity. Nominal discharge of the Creek averages 32 million gallons per day (MGD) at the Hamburg Turnpike (NYS Route 5) bridge. This flow is supplemented by Site non-point runoff, groundwater discharge, approximately 10 MGD of point discharge via NYSDEC State Pollutant Discharge Elimination System (SPDES)-permitted Outfalls 216 and 217 (when the intake pump is operational) and effluent discharged from the Erie County Sewer District (ECSD) No. 6 wastewater treatment facility (WWTF), all of which enter Smokes Creek downstream of Hamburg Turnpike (NYS Route 5) at the locations shown on Figure 2.

1.4 Regulatory History

Tecumseh and the NYSDEC executed an Order on Consent (File No. R9-20190927-126) on September 24, 2020 for implementation of corrective action, closure, and post-closure care for the CMS Area (commonly referred to as the Global Order). The complete regulatory history of the Tecumseh CMS Area, including OU-09, is presented in the November 2021 Final SOB.

1.5 Description of Final Selected Remedy for OU-09 (Smokes Creek)

The remedial alternative selected for OU-09 Smokes Creek is presented as part of Alternative 4 in the SOB, including:

- Excavating or dredging sediment where concentrations exceed Class A sediment guidance values (SGVs); collecting verification samples following sediment dredging to confirm complete removal of contaminated sediment; dewatering sediment at a temporary on-site facility prior to placement in the on-site solid waste corrective action management unit (SW-CAMU).
- Following dredging, designing Smokes Creek to improve hydraulic flow, reduce flooding, as per previous dredging activities conducted by the US Army Corps of Engineers (USACE), and providing climate resilience. Restoring shoreline areas disturbed by the remedial effort in accordance with the flood control easements and USACE requirements currently in place.
- Developing a restoration plan during design to meet the substantive requirements of Article 15 USACE and 6NYCRR Part 608. Enhancing the Smokes Creek riparian zone through the former Bethlehem Steel property through bank clean-up and stabilization for greater aquatic connectivity into the headwaters of Smokes Creek that run through the former Bethlehem Steel site.
- Implementing institutional controls in the form of an environmental easement, Site Management Plan (SMP), groundwater use restriction, and excavation plan.
- A cover system in areas where surface soil exceeds applicable soil cleanup objectives (SCOs) including commercial (passive recreational) use in areas proposed to enhance public access.

1.6 Pre-Design Investigation Activities

The first element set forth in the OU-09 SOB is a Pre-Design Investigation (PDI), which is required to aid in the design and implementation of sediment dredging and bank soil restoration of Smokes Creek. NYSDEC required in its SOB that the PDI Work Plan include the following elements:

- Sediment sampling up to the mean high-water level (MHWL) to further delineate sediment requiring remediation.

- Hydrologic studies to accurately delineate the MHWL.
- An ecological investigation to further delineate the toxicity and mobility of contaminants in sediment.
- Geotechnical sampling to help support the remediation.
- Determining the location of any underground utilities or other obstructions that may impact dredging activities. This information would be used to either re-route these utilities outside the remediation or accommodate their locations and future anticipated maintenance.
- Surveying, including bathymetric as appropriate, the location of any additional soil or sediment sampling and underground utilities to support the remedial design and implementation of the remedy.
- Analysis of any tributaries or drainages contributing within the work area to determine if contaminated sediments are being transported into or out of the Site. Stream profile forms would be documented for restoration of the stream following dredging activities.
- Waste characterization, pore water, hydrodynamic and sediment transport modeling, an ice impact study, and an evaluation of the potential for scour. *Roux does not see the need for these studies since the Smokes Creek sediment and bank soils and groundwater in the vicinity of Smokes Creek are to be remediated.*

Section 2.0 summarizes previous investigation and dredging activities. Section 3.0 describes major design elements and proposed implementation methods for the PDI. Section 4.0 presents documentation and reporting requirements. Section 5.0 provides the tentative project schedule.

2 Summary of Previous Activities

2.1 Sediment Dredging

Dredging activities in the SCLR and SCUR have been performed for various reasons as outlined in the following sections.

2.1.1 Smokes Creek Lower Reach

As part of the U.S. Flood Control Act of 1960 (Public Law No. 86-645), the USACE in the 1960s undertook channel improvements in Smokes Creek from its outlet to Lake Erie across the entire reach of the Creek on the former Bethlehem Steel Site and further upstream to beyond the confluence of the north and south branches in the City of Lackawanna. Flood improvements to the lower reach of the Creek were constructed by Bethlehem Steel in accordance with its Lake Erie land grants from New York State (the Land Patent Agreements), as this portion of Smokes Creek and the adjacent lands were reclaimed from Lake Erie by placement of slag/fill by Bethlehem Steel. Bethlehem Steel was obligated to maintain the flood channel along the SCLR and NYSDEC was obligated to maintain the flood channel along the SCUR in accordance with an Operation and Maintenance Manual issued by the USACE in May 1972.

Tecumseh, as successor and assign to the former Bethlehem Steel property, has effectively assumed the maintenance obligations for the SCLR flood channel on Land Patent lands. Since acquiring the property in 2003, Tecumseh has performed maintenance dredging at the Creek mouth (outlet at Lake Erie) and cleared woody growth from Creek banks nearly annually under nationwide permits issued by the USACE.

In early 2007, the USACE determined that sediment accumulated in Smokes Creek, particularly the SCLR, was reducing the hydraulic flood flow capacity and contributing to the expansion of the 100-year flood plain in the City of Lackawanna First Ward. To circumvent potential expansion of the 100-year floodplain into the City's First Ward and fulfill Tecumseh's flood channel maintenance obligations, Tecumseh promptly submitted to NYSDEC an Interim Corrective Measures (ICM) Work Plan (September 2008) to dredge the SCLR and restore the flood channel design elevations and cross-sectional area. Pre-dredge sampling and characterization of shallow sediments (i.e., above the floodway elevation) and bathymetric survey of the SCLR was performed by Tecumseh in June 2007.

In September 2008, the NYSDEC approved the Smokes Creek ICM Work Plan to be implemented under an Order on Consent. Tecumseh immediately implemented the ICM, beginning hydraulic and mechanical dredging in October 2008. The ICM was completed in February 2009 after approximately 42,800 cubic yards of sediment were removed and placed into the USACE's Confined Disposal Facility (CDF) No. 4 located adjacent to the northern CMS Area.

In April 2009, post-dredging surface sediment samples were collected along the SCLR at the same 10 locations as pre-dredging sediment characterization samples. Adjacent core pairs were composited for analysis of semi-volatile organic compounds (SVOCs) (Method 8270C), polychlorinated biphenyls (PCBs) (Method 8082), total cyanide (Method 9012A), total organic carbon (TOC; Lloyd Kahn or Method 9060A), and metals (Method 6010B/7471A). In addition, discrete samples were collected from all 10 sampling locations during the pre- and post-ICM events for volatile organic compound (VOC) analysis (Method

8260B). Sediment existing above the SCLR design elevations was targeted during pre-ICM sampling, whereas post-ICM sampling targeted sediment existing at the design elevations.

Table 1 presents a comparison between pre- and post-ICM dredging analytical results for sediment samples collected from the SCLR, provides calculated average concentrations, and compares the analytical data to the Freshwater Sediment Guidance Values (SGVs) contained in the 2014 NYSDEC Screening and Assessment of Contaminated Sediment (Ref. 2) document. As defined in the NYSDEC's 2014 document, Class A sediments are considered low risk to aquatic life; Class B sediments are slightly to moderately contaminated and additional testing is required to evaluate the potential risks to aquatic life; and Class C sediments are considered highly contaminated and likely to pose a risk to aquatic life.

Based on this comparison, it is apparent that a significant reduction of VOC, SVOC, PCB, and total metal impacts to sediment were removed and floodway design elevations were restored during the ICM dredging. Specifically, total VOCs were reduced by 95%; all individual VOC concentrations are below Class A SGVs. One post-ICM sample had two individual PAHs (naphthalene and phenanthrene) with concentrations exceeding SGVs; however, using the site-specific TOC of 9.32% to adjust the SGVs, both naphthalene and phenanthrene concentrations fall below their respective SGVs. After dredging, the sediment in 4 of the 5 sample locations is considered Class C for lead and Class B for the other metals. In general, the concentrations of the other metals are on the lower end of the Class B range.

The results were transmitted to the NYSDEC in June 2009. The NYSDEC confirmed in a letter dated February 8, 2011 that Tecumseh satisfied the terms of the Smokes Creek ICM Work Plan as required by the Order on Consent and, accordingly, Tecumseh's obligations under the Order were terminated.

2.1.2 Smokes Creek Upper Reach

In December 2007 and in support of the NYSDEC's planned maintenance dredging of the SCUR, Tecumseh voluntarily performed a bathymetric survey. Based on that survey, it was estimated that approximately 40,340 cubic yards (CY) of sediment required dredging to restore the SCUR to design floodway elevations. Concurrently in December 2007, SCUR sediment samples were collected from 12 locations primarily targeting the section downstream of the SRWT. The adjacent cores collected downstream and west of the SRWT were composited for SVOCs, PCBs, cyanide, TOC, and metals analyses. East of the SRWT, sediment cores were collected as discrete grab samples for those same parameters, with one exception being location SC-SED-21, which was not sampled due to inadequate sediment recovery. Discrete samples collected from 10 of the 12 locations were analyzed for VOCs.

Table 2 summarizes the pre-dredging analytical results and average concentration for each parameter in the SCUR. The pre-dredging sediment at all SCUR locations was considered Class A for VOCs. Two individual PAHs exceeded the PAH SGVs presented in Table 7 of the 2014 Guidance. However, using the site-specific TOC to adjust these SGVs, only phenanthrene remained slightly above its PAH SGV at one location (24 ppm compared to the SGV of 23 ppm). The pre-dredging sediment in the SCUR was considered Class A for PCBs except for one location. Six of seven sample locations were considered Class C for lead. Cadmium (one location), chromium (one location), and silver (two locations) concentrations were also considered Class C; the remaining metals/locations were considered Class A or B. Mercury concentrations in two locations barely exceeded the SGV of 0.2 ppm for Class B. The types of contamination identified in the sediments of Smokes Creek (e.g., VOCs and PAHs) are commonly found in urban watershed areas.

The sampling and analytical results are reflective of sediment removed during maintenance dredging by the NYSDEC.

NYSDEC dredged the SCUR in 2015 under the flood protection project; however, post-dredging sediment samples were not collected because the NYSDEC dredging was for flood control purposes only.

2.2 Summary of Nature & Extent of Contamination

2.2.1 Sediment Contaminant Levels

Sediment in Smokes Creek was found to be impacted with SVOCs, PCBs, and metals above the Class C SGVs[1] as summarized below (Class C SGV in parentheses):

- SCLR
  - Lead was detected at a maximum concentration of 837 ppm (130 ppm)
  - Silver was detected at a maximum concentration of 11.8 ppm (2.2 ppm)
  - Total PCBs were detected at 3.6 ppm (1 ppm)
- SCUR
  - Lead was detected at a maximum concentrations of 1,370 ppm (130 ppm)
  - Silver was detected at a maximum concentration of 11.8 ppm (2.2 ppm)
  - Total PAH-17 and total PAH-34 were detected at maximum concentrations of 55.5 ppm and 70.3 ppm (35 ppm)

2.2.2 Sediment Toxicity

In 2019/2020, the United States Geological Survey (USGS) performed limited sediment toxicity testing in the SCLR (two locations) and SCUR (three locations) to assess the condition of benthic macroinvertebrate communities and the toxicity of Creek bed sediments. The *Chironomus Dilutus* (*C. dilutus*) survival in sediment collected from the downgradient end of the SCUR was 100% but 0-5% survival was observed for the other four locations. The *Hyalella Azteca* (*H. azteca*) survival in sediment collected from the downgradient end of the SCUR was approximately 85% whereas the survival in the upgradient end of the SCLR was approximately 35% with 0-10% survival observed at the other three areas. The toxicity testing scope and results are presented in the December 30, 2022 article by USGS entitled "*Assessing Impaired Benthic Communities using Sediment Toxicity and Contaminant Concentrations from Reference Sites Inside the Niagara River Area of Concern*" published in the Journal of Great Lakes Research (see Appendix A).

The USGS and Tecumseh collected additional sediment samples June 29-30, 2022 from areas previously designated as Class B and Class C to determine if the toxicity results require the sediment to be removed. Tecumseh collected five sediment samples at previously sampled locations (see Figure 3). The samples were shipped overnight to EA Engineering, Science, and Technology, Inc.'s ecotoxicology laboratory in

[1] As defined in the NYSDEC's 2014 document, Class C sediments are considered highly contaminated and likely to pose a risk to aquatic life.

Hunt Valley, MD. The sediment samples were evaluated using 10-day survival and growth toxicity tests with the freshwater amphipod *H. azteca,* and the midge *C. dilutus* (formerly *tentans*). The objective of the toxicity testing was to evaluate the toxicity of each of the sediment samples based on the survival and growth of the test organisms, as compared to the control. Appendix A includes EA's September 30, 2022 toxicity report, which details the testing procedures and results. After 10 days of exposure, the *C. dilutus* sediment toxicity tests indicate mean survival between 6% and 44% whereas the laboratory control had 100% survival. The highest survival rates (44% and 35%) were in sediment collected in the SCLR (SC1-4-D and SC1-8-D). The *H. azteca* sediment toxicity tests indicate mean survival in the sediment between 6% and 88% whereas the laboratory control had 95% survival. The survival rate of 4 of the 5 samples were between 46% and 88%, the highest survival in sediment collected near Hamburg Turnpike (NYS Route 5) (i.e., SC2-10-B) and the second highest survival rate (79%) collected at the downstream end of the SCUR (SC2-1-B). The results indicate high variability in the toxicity of both SCLR and SCUR sediments.

USGS provided benthic community and sediment toxicity results from the 2022 assessment in an updated USGS data release. On September 26, 2023, Barry Baldigo of USGS indicated in an email that "While the 2022 data from Smokes Creek and other sites are quite interesting, we currently have no plans (funds) to interpret and publish those findings in a peer-reviewed paper or report." Appendix A includes a summary of the 2022 data using the data tables provided by USGS. As indicated, survival rates range between 0% and 100% for *C. dilutus* and 10% and 100% for *H. azteca*.

3 Pre-Design Investigation Technical Approach

3.1 General

As indicated in Section 3.5.4, toxicity results from testing in 2020 and 2022 identify low survival rates and, as such, Tecumseh intends to remove all sediment to the 1965 Flood Control Project design elevation. Based on previous dredging and post-dredging bathymetric surveys, the soft sediment ends at or above the design elevation.

3.2 Data Quality Objectives

Data quality objectives (DQOs) summarize the type, quantity, and quality of information needed to ensure that sufficient data are collected to support the remedial design. Consistent with the project goals set forth in the Agreement, this Work Plan targets two DQOs:

- **DQO 1:** Determine the quantity of sediment above the design elevation to be dredged.
- **DQO 2:** Characterize the chemical/physical composition of sediment below the design elevation of Smokes Creek and bank soils up to the MHWL to determine quantity, if any, of sediment requiring removal due to exceedances of cleanup objectives presented as Exhibit B of the SOB (included as Appendix B).

Table 3 includes the DQO process to demonstrate resulting data meet the project objectives.

3.3 Pre-Mobilization Tasks

Appendix C includes the Site-Wide Health and Safety Plan (HASP) for the CMS Area. Since the field activities described herein require working on Smokes Creek, a site-specific job safety analysis (JSA) identifying potential hazards associated with this aquatic field work will be prepared and included in the HASP along with other appropriate JSAs. Appendix D includes the Field Operating Procedures for the PDI. Appendix E includes the Quality Assurance Project Plan (QAPP). Appendix F includes the Project Documentation Forms.

3.3.1 Permits and Notifications

Sampling will be performed within navigable waters of the United States and, therefore, requires a USACE permit that will be covered under Nationwide Permit No. 6 Survey Activities. The proposed work also requires a NYSDEC Protection of Waters Permit and consultation with the NYSDEC Division of Fish and Wildlife and the State Historic Preservation Office (SHPO). The project is anticipated to be considered "Minor," which streamlines the permitting process.

On August 22, 2025, Roux submitted a draft New York State joint permit application. On September 24, 2025, USACE Buffalo District responded that the survey activities can be covered under non-reporting (no application needed) NWP No. 6 and the blanket Section 401 Water Quality Certification (WQC) but that an Individual Coastal Consistency is required. Pursuant to 15CFR Part 930.41 and 930.43, the New York State Department of State (NYSDOS) concurs with the USACE's consistency determination for this NWP, with

which all general and all Buffalo and New York District regional conditions are complied, and with the additional condition(s), as follows:

- The NYSDOS concurs with the USACE' consistency determination where the activities to be authorized would be limited to sample plots or transects for wetland delineations and historic resource surveys.

Since these activities do not comply with the above condition, the NYSDOS objects to the USACE's consistency determination and therefore, an individual consistency determination from NYSDOS is required for this NWP to be valid in the New York coastal area. On September 25, 2025, Roux contacted the NYSDOS explaining the project and asking if a coastal consistency review is required. NYSDOS responded on October 6, 2025 that a consistency review is required for sediment core sampling under NWP No. 6 and requested a federal permit application, federal consistency assessment form, maps outlining the survey areas and core locations, and a policy analysis using the City of Lackawanna Local Waterfront Revitalization Program policies.

On October 1, 2025, Roux completed the submission to SHPO. On November 7, 2025, Roux received a letter from SHPO indicating, Based upon this review, it is the opinion of the New York SHPO that no historic properties, including archaeological and/or historic resources, will be affected by this undertaking."

EPA GLNPO took the lead on the Section 106 Tribal requirements and submitted a Tribal consultation request on October 27, 2025. The Nations have 30 days to respond. On November 26, 2025, EPA GLNPO informed Roux that neither of the Nations responded to the consultation request; the 30-day response window ended November 24, 2025.

Appendix G includes the information submitted to all agencies along with determinations received. The NYSDEC Project Manager will be notified 10 days in advance of field activities.

3.3.2 Mean-High Water Level Determination

Since the NYSDEC SOB requires sampling up to the MHWL, Roux analyzed historic water levels in Smokes Creek between March 2011 and January 2022 using monthly readings from staff gauge SG-06 near the South Linde Area as well as readings from the data logger near the ATP (used for the ATP Assessment project) measure at staff gauge SG-02B between March 31, 2023 and September 20, 2023 to determine the MHWL in Smokes Creek (see Appendix H). For the 2011-2022 data, the average peak water level across the data set was calculated as 574.46 feet. The data logger recorded a level every 10 minutes. A monthly high-water level was determined for each month and the average maximum level was calculated as 574.47 feet. Therefore, the MHWL in Smokes Creek will be set at 574.5 feet. The MHWL is different from the USACE ordinary high-water mark (OHWM), a jurisdictional benchmark for administering its regulatory program in navigable waterways. According to USACE website, Lake Erie's low water datum (LWD) is 569.2 and ordinary high-water datum (OHWD) is 573.4 using the 1985 International Great Lakes Datum (IGLD 1985).

3.4 Temporary Construction Facilities

Roux's office located at 2558 Hamburg Turnpike, Buffalo, NY 14218 will operate as the field office.

3.5 Surveying

3.5.1 Bathymetric Survey

A bathymetric survey will be conducted by 360 Land Survey, DPC using a boat-mounted sonar to survey the existing bottom and conventional survey methods to survey the banks of Smokes Creek. The bathymetric survey transects are projected to be ±100 feet apart as shown on Figure 4, with data being collected between previous bathymetric surveys in the SCLR and SCUR. The bathymetric survey is performed at survey grade accuracies (centimeter) and assigned to a real-world coordinate system and elevation datum (i.e., US State Plane and NAVD88). The proposed survey transects will be uploaded into the GPS equipment (RTK GPS) as well as the hydrographic software. In addition to the data collected along the proposed transects, water and sediment depths will be measured continuously along the Creek centerline. The collection of this data requires minimal additional effort but helps provide data at bridges and embankments where transects may not be located. Site survey control points have been established on the Tecumseh Site for previous remediation projects and shall be used as bathymetric survey control for this project.

3.5.2 Survey Control

Water depths in Smokes Creek can vary dramatically based on prevailing wind, elevation of Lake Erie, wave action, seasonality, and in response to storm runoff. For the planned characterization to be valid and considering the variable water depth in Smokes Creek, careful vertical and horizontal survey control throughout the sample collection effort is critical. Prior to sampling, Roux survey personnel will stake out each sampling transect along the north and south banks of Smokes Creek in accordance with the coordinates shown on Table 4 and the locations identified on Figure 6. Survey coordinates for each transect line will be referenced to the New York State Plane, West Zone Coordinate System. The horizontal survey lateral control will be performed using global positioning system (GPS) equipment and existing Site benchmarks.

To maintain vertical control, sediment elevations will be obtained at each sample location. Each day prior to sample collection, a Smokes Creek surface water elevation will be taken to verify the current top of water elevation. Concurrently, as each sample is obtained, the vertical distance from top of water surface to the top of sediment will be measured as described below and documented to compute a vertical elevation. The datum used to establish vertical control will be consistent with National Geodetic Vertical Datum of 1929 (NGVD29), the same datum the 2007 samples and USACE 1965 Flood Control Project record drawings reference.

3.5.3 Sediment Assessment

Sediment probing will aid in estimating the quantity of sediment above the flood control design elevation and below the MHWL, along the Creek bottom and banks. Manual sediment probing will be conducted by Roux to ground-truth the sub-bottom profiling data collected by the depth sonar. Probing will be conducted manually using a surveying range pole. At three locations along each transect, a 1-foot by 1-foot piece of metal plate will be lowered until the top of sediment is identified. The depth of water to the sediment will be recorded. The water depth will be subtracted from the surveyed surface water elevation to determine the top of sediment elevation. For the ground-truth locations, the depth to sediment measured by manual probing will be analyzed for confidence against the depth to sediment measured by the depth sonar.

3.6 Sample Collection and Processing

Based on previous dredging projects, soft sediment does not extend below the design floodway elevation and, as such, all soft sediment will be removed during dredging activities. Sediment samples will be collected from immediately below the 1965 USACE flood control design bottom elevations (see Appendix I and Table 4) along the Creek bottom and banks (referred to as hard sediment) up to the MHWL to confirm the vertical limits of sediment requiring removal. Sample collection will be accomplished by Atlantic Testing Laboratories (ATL) using a pontoon boat and Vibracore sediment sampler. The Vibracore will advance through the soft sediment and two feet into the hard sediment. A 3.5-inch diameter core containing the soft and hard sediment will be recovered. Samples of the hard sediment will be collected from 0-12 inches and 12-24 inches below the flood control design elevation. At each transect, two samples will be collected on both the north and south banks and one sample at the center of the Creek bottom as shown on Figure 5. Recovered samples will be photo documented and a visual description will be recorded. If the water level in Smokes Creek is below the MHWL at the time of bank sampling, CAMP stations will be used for periodic monitoring of volatile organics.

As shown on Figure 6 and in Table 4, sampling will occur along 10 transects in the SCLR and 14 transects in the SCUR. Five sample locations will be demarcated at each of the 24 total transects for total of 120 sample locations. Two samples will be taken at each sample location for a total of 240 samples taken, exclusive of additional QA/QC samples.

Samples will be processed by Roux as described in FOP 049.1 (Appendix D). In summary, once the Vibracore sediment core is back on the barge, the Vibracore liner will be laid on a table, sliced open, and scanned with a photoionization detector (PID). Excess water will be decanted if needed based on the liquid content of the sediment sample. The hard sediment will be placed in a disposable aluminum pan. The sample will be mixed to achieve homogenization before placing in the sample jars. Because the Vibracore sampling sleeves are one time use only, a new sleeve will be needed for each sample. The Vibracore barrel will be decontaminated between samples as described in SOP 19901. FOP 032.2 describes management of IDW.

3.6.1 Sample Analysis and Validation

The 0- to 12-inch and approximately 20% of the 12- to 24-inch samples will be analyzed via USEPA SW 846 methodology for TCL VOCs, TCL SVOCs, , Target Analyte List (TAL) metals (including mercury), PCBs, cyanide, and TOC. The remaining 12- to 24-inch samples will be frozen and placed on hold pending the results of the 0- to 12-inch samples. QAPP Table 5 provides the holding times for the samples. One blind duplicate and a matrix spike/matrix spike duplicate (MS/MSD) will also be analyzed per 20 samples for quality assurance/ quality control (QA/QC) purposes as outlined in the QAPP included as Appendix E.

Testing will be performed by Pace Analytical Services, LLC (Pace) Westborough, MA, an independent, NYSDOH Environmental Laboratory Approval Program (ELAP)-approved laboratory. An equivalent Category B deliverables package will be furnished with the data to allow data evaluation by Data Validation Services (DVS), a qualified, independent data validation expert. Specifically, a Data Usability Summary Report (DUSR) will be prepared, with appropriate data qualifiers added to the results. The DUSR will follow NYSDEC format per the September 1997 DUSR guidelines and May 2010 DER-10 guidance (Ref. 3).

3.6.2 Benthic Assessment

Benthic (meaning “bottom-dwelling”) macroinvertebrates, which are small aquatic animals and the aquatic larval stages of insects, are commonly used as indicators of the biological condition of waterbodies. Since Tecumseh analyzed sediment from five locations in June 2022 and USGS analyzed sediment from another five locations, no additional soft sediment will be collected and analyzed for toxicity. Tecumseh intends to remove all sediment to the design elevation and, based on previous dredging and post-dredging bathymetric surveys, the soft sediment ends at or above the design elevation.

4 Documentation & Reporting

Roux will be on-site performing and documenting all field activities. Such documentation will include, at minimum, field activity daily logs (FADLs), sediment sampling logs, analytical results, and photographs. In addition, all sample locations will be surveyed as described in Section 3.4.1 and coordinates used to accurately plot sample points on figures to be submitted with the RD/RA Work Plan.

4.1 Construction Monitoring

Standard reporting procedures for Site activities will include preparation of a daily report and, when appropriate, problem identification and corrective measures reports. Appendix F contains sample project documentation forms. Information that may be included on the daily report form includes:

- Investigation locations
- Samples collected
- Equipment used and personnel (including subcontractors) on-site

The NYSDEC will be promptly notified of problems requiring modifications to this PDI Work Plan prior to proceeding with or completing the item. Problem identification and corrective measures reports will be completed whenever major field problems are encountered and corrective measures are necessary. The completed reports will be submitted to the NYSDEC/NYSDOH by the end of the following workday. Photo documentation of PDI activities will be prepared by Roux throughout the duration of the project to convey typical work activities, changed conditions, and special circumstances.

4.2 RD/RA Work Plan

The RD/RA Work Plan will include all remedial actions to be undertaken and include pre-design investigation results.

5 Project Schedule

PDI activities are expected to begin in April 2026. The NYSDEC Project Manager will be notified 10 days in advance of field activities. The tentative schedule for PDI activities is as follows:

- March 2026: NYSDEC review and approval of revised PDI Work Plan
- April 2026: EPA review and approval of PDI Work Plan
- May 2026: Bathymetric survey, sediment probing and sample collection
- June-July 2026: Laboratory analyses and validation
- September 2026: RD/RA Work Plan to NYSDEC/NYSDOH
- October 2026-March 2027: Prepare detailed design drawings, plans/specifications, and engineer's estimate of remedial costs.

6 References

1. New York State Department of Environmental Conservation. Final Statement of Basis, Corrective Measures Selection, Bethlehem Steel (Tecumseh Redevelopment, Inc.) Site. November 2021.
2. New York State Department of Environmental Conservation. Division of Fish, Wildlife, and Marine Resources, Bureau of Habitat. *Screening and Assessment of Contaminated Sediment*. June 24, 2014.
3. New York State Department of Environmental Conservation. *DER-10/Technical Guidance for Site Investigation and Remediation*. May 3, 2010.
4. New York State Department of Environmental Conservation. *DER-31/Green Remediation*. January 20, 2011.

TABLES

1. Summary of Pre- and Post-ICM Dredging Analytical Data in SCLR (2007 and 2009)
2. Summary of Pre-Dredging Analytical Data in SCUR (2007)
3. DQO Process
4. Summary of Sampling Locations and Analyses

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TABLE 1
SUMMARY OF PRE- AND POST-ICM DREDGING ANALYTICAL DATA IN SCLR (2007 AND 2009)

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Parameter [1]	Sample Location, Analysis, and Sample Date [3,4]																		Pre-ICM Average Concentration [5] (mg/kg)	Post-ICM Average Concentration [5] (mg/kg)	Sediment Guidance Values [7] (mg/kg)		
	SC-SED-01	SC-SED-02	SC-SED-01	SC-SED-02	SC-SED-03	SC-SED-04	SC-SED-03	SC-SED-04	SC-SED-05	SC-SED-06	SC-SED-05	SC-SED-06	SC-SED-07	SC-SED-08	SC-SED-07	SC-SED-08	SC-SED-09	SC-SED-10	SC-SED-09	SC-SED-10			Class A	Class B	Class C
	pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM						
	06/27/07		04/01/09		06/27/07		04/23/09		06/27/07		04/24/09		06/27/07		04/24/09		06/27/07		04/24/09						
TCL VOCs (Method 8260B) (mg/kg)																									
Acetone	0.17 B	0.078 B	ND	ND	0.12 B	0.088 B	0.055 B	0.046 B	0.076 B	0.035 BJ	0.039 B	0.045 BJ	0.022 BJ	0.058 B	0.067	0.059	0.082 BJ	0.022 BJ	0.041 J	0.039 J	*0.075*	*0.049*	--	--	--
Benzene	8.8 D	0.005 J	ND	ND	0.002 J	0.003 J	ND	0.0038 J	0.003 J	0.009	ND	0.0089 J	0.014	0.012	0.005 J	0.0038 J	0.44	0.008	0.0097 J	0.021	*0.93*	*0.0087*	**< 0.53**	**0.53 - 1.9**	**> 1.9**
2-Butanone	0.044 J	0.016 J	ND	ND	0.027 J	0.023 J	ND	ND	0.012 J	ND	ND	ND	ND	0.013 J	0.014 J	ND	ND	ND	ND	ND	*0.023*	*0.014*	--	--	--
Carbon Disulfide	0.017	0.003 J	ND	ND	0.003 J	0.006 J	ND	0.0025 J	0.002 J	0.002 J	ND	ND	0.005 J	0.005 J	0.0047 J	ND	0.029	0.006	ND	0.0053 J	*0.0078*	*0.0042*	--	--	--
Cyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002 J	ND	ND	0.02	ND	ND	ND	*0.011*	*ND*	--	--	--
Ethylbenzene	0.002 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.49	0.006	0.0095 J	0.025	*0.17*	*0.017*	**< 0.43**	**0.43 - 3.7**	**> 3.7**
Isopropylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002 J	ND	ND	ND	0.079	ND	ND	0.0062 J	*0.041*	*0.0062*	**< 0.21**	**0.21 - 1.8**	**> 1.8**
Methylcyclohexane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.002 J	0.004 J	ND	ND	0.13	ND	0.0023 J	0.0065 J	*0.045*	*0.0044*	--	--	--
Methylene Chloride	0.021 B	0.022 B	0.043 B	0.027 B	0.02 B	0.022 B	0.0086 B	0.011 B	0.018 B	0.013 B	0.007 B	0.0084 B	0.015 B	0.012 B	0.0019 B	0.0084 B	0.074 B	0.02 B	0.0092 B	0.0087 B	*0.024*	*0.013*	--	--	--
Stryrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	0.02	0.027	0.071	*0.56*	*0.049*	--	--	--
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.009 J	ND	ND	ND	*0.0090*	*ND*	**< 16**	**16 - 57**	**> 57**
Toluene	0.1	ND	ND	ND	ND	ND	0.017	ND	ND	ND	ND	0.0089 J	0.005 J	0.012	ND	ND	1.8 D	0.021	0.019	0.051	*0.39*	*0.024*	**< 0.93**	**0.93 - 4.5**	**> 4.5**
Xylenes, Total	0.013 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0069 J	0.012 J	0.012 J	ND	0.014 J	17 D	0.12	0.19	0.48	*3.4*	*0.17*	**< 0.59**	**0.59 - 5.2**	**> 5.2**
Total VOCs (mg/kg)	*9.17*	*0.124*	*0.043*	*0.027*	*0.172*	*0.142*	*0.0806*	*0.0633*	*0.111*	*0.059*	*0.046*	*0.0781*	*0.077*	*0.130*	*0.0926*	*0.0852*	*21.25*	*0.223*	*0.308*	*0.714*	*3.1*	*0.15*			
TCL SVOCs (Method 8270C) (mg/kg)																									
Acenaphthene	0.64 J		ND		0.1 J		0.22 DJ		0.45 J		0.12 DJ		2.3 J		0.56 DJ		3.6		2.9 D		*1.42*	*0.95*		**9.82**	
Acenaphthylene	0.71 J		ND		0.099 J		0.15 DJ		0.18 J		0.17 DJ		2.5 J		0.95 DJ		12		7.2 D		*3.10*	*2.12*		**9.04**	
Acetophenone	ND		ND		ND		ND		ND		0.11 DJ		ND		ND		ND		ND		*ND*	*0.11*		**--**	
Anthracene	1.1 J		0.41 DJ		0.19 J		0.38 DJ		0.62 J		0.52 DJ		4 J		1.4 DJ		3.3		3.7 D		*1.84*	*1.28*		**11.88**	
Benzo(a)anthracene	2.1		1.4 DJ		0.63 J		0.83 DJ		0.98 J		1.1 DJ		3.5 J		1.4 DJ		1.6		2.3 D		*1.76*	*1.41*		**16.82**	
Benzo(a)pyrene	2.0		1.3 DJ		0.61 J		0.73 DJ		0.79 J		0.91 DJ		1.9 J		1.2 DJ		1.2		1.6 DJ		*1.30*	*1.15*		**19.28**	
Benzo(b)fluoranthene	2.7		1.8 DJ		0.98 J		0.97 DJ		1.3 J		1.1 DJ		3.1 J		1.6 DJ		1.9		2.1 DJ		*2.00*	*1.51*		**19.58**	
Benzo(g,h,i)perylene	0.96 J		0.64 DJ		0.38 J		0.39 DJ		0.42 J		0.4 DJ		1.4 J		0.58 DJ		0.6 J		0.7 DJ		*0.75*	*0.54*		**21.9**	
Benzo(k)fluoranthene	0.95 J		0.46 DJ		0.36 J		0.37 DJ		0.39 J		0.36 DJ		1.5 J		0.52 DJ		0.51 J		0.76 DJ		*0.74*	*0.49*		**19.6**	
Biphenyl	ND		ND		ND		ND		0.1 J		ND		1.3 J		0.38 DJ		3		2.2 D		*1.47*	*1.29*		**--**	
Bis(2-ethylhexyl)phthalate	1.8		ND		1.8		1.2 DJ		1.6		0.71 DJ		ND		0.94 DJ		0.69 J		0.84 DJ		*1.47*	*0.92*		**--**	
Caprolactam	ND		ND		ND		ND		ND		2.1 D		ND		3.9 D		ND		3 D		*ND*	*3.00*		**--**	
Carbazole	0.61 J		0.3 DJ		ND		ND		ND		ND		ND		0.4 DJ		0.93 J		0.74 DJ		*0.77*	*0.48*		**--**	
Chrysene	2.1		1.6 DJ		0.87 J		0.93 DJ		1.3 J		1.1 DJ		3.6 J		1.5 DJ		1.7		2.1 D		*1.91*	*1.45*		**16.86**	
Dibenz(a,h)anthracene	2.7		ND		2.4		0.17 DJ		2.3		0.12 DJ		24		ND		1.9		0.2 DJ		*6.66*	*0.16*		**22.44**	
Dibenzofuran	0.66 J		ND		ND		0.29 DJ		0.38 J		0.14 DJ		4.4 J		1.5 DJ		7.8		6.5 DJ		*3.31*	*2.11*		**--**	
Diethyl phthalate	ND		ND		ND		ND		ND		ND		ND		0.14 DJ		ND		ND		*ND*	*0.14*		**--**	
Fluoranthene	6.1		3.8 DJ		1.7		2.2 D		3.1		1.9 D		8.9 J		4 D		6.3		7.9 D		*5.22*	*3.96*		**14.16**	
Fluorene	0.96 J		ND		ND		0.55 DJ		0.79 J		0.26 DJ		5.5 J		2 DJ		9		8.1 D		*4.06*	*2.73*		**10.78**	
Indeno(1,2,3-cd)pyrene	0.75 J		0.62 DJ		0.3 J		0.36 DJ		0.39 J		0.37 DJ		1.2 J		0.57 DJ		0.5 J		0.58 DJ		*0.63*	*0.50*		**22.3**	
2 - Methylnaphthalene	0.48 J		ND		0.059 J		0.25 DJ		0.42 J		0.16 DJ		4.7 J		2 DJ		22		15 D		*5.53*	*4.35*		**--**	
2 - Methylphenol	0.16 J		ND		ND		ND		ND		ND		ND		ND		ND		ND		*0.16*	*ND*		**--**	
4 - Methylphenol	0.64 J		ND		ND		ND		0.091 J		0.55 DJ		ND		ND		ND		0.21 DJ		*0.37*	*0.38*		**--**	
Naphthalene	4.9		ND		0.061 J		1.2 DJ		1.6		0.5 DJ		26		4.5 D		67 D		31 D		*19.91*	*9.30*		**7.7**	
Phenanthrene	6.4		2.3 DJ		0.96 J		1.5 DJ		2.6		1.2 DJ		15		5.8 D		18		17 D		*8.59*	*5.56*		**11.94**	
Pyrene	4.2 J		2.7 DJ		1.1 J		1.6 DJ		1.9		1.4 DJ		5.8 J		3 D		3		5 D		*3.20*	*2.74*		**13.96**	
Total SVOCs (mg/kg)	*43.6*		*17.3*		*12.6*		*14.3*		*21.7*		*15.3*		*121*		*38.8*		*167*		*122*		*73.0*	*41.5*			

ROUX

TABLE 1
SUMMARY OF PRE- AND POST-ICM DREDGING ANALYTICAL DATA IN SCLR (2007 AND 2009)

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Parameter [1]	Sample Location, Analysis, and Sample Date [3,4]										Pre-ICM Average Concentration [5] (mg/kg)	Post-ICM Average Concentration [5] (mg/kg)	Sediment Guidance Values [7] (mg/kg)		
	SC-SED-01	SC-SED-02	SC-SED-01	SC-SED-02	SC-SED-03	SC-SED-04	SC-SED-03	SC-SED-04	SC-SED-05	SC-SED-06	SC-SED-05	SC-SED-06	SC-SED-07	SC-SED-08	SC-SED-07	SC-SED-08	SC-SED-09	SC-SED-10	SC-SED-09	SC-SED-10					
	pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM		pre-ICM		post-ICM						
	06/27/07		04/01/09		06/27/07		04/23/09		06/27/07		04/24/09		06/27/07		04/24/09		06/27/07		04/24/09				Class A	Class B	Class C
Total PCBs (Method 8082) (mg/kg)																									
Aroclor 1248	0.1		0.094 DJ		0.046 J		0.17		0.27		0.33 D		0.32		0.2		0.14		0.48		*0.18*	*0.25*	--	--	--
Aroclor 1254	0.1		ND		0.087		ND		0.26		ND		0.21		ND		0.081 J		ND		*0.15*	*ND*	--	--	--
Aroclor 1260	ND		ND		ND		ND		ND		ND		0.085 J		ND		ND		ND		*0.09*	*ND*	--	--	--
Total PCBs (mg/kg)	*0.20*		*0.094*		*0.13*		*0.17*		*0.53*		*0.33*		*0.62*		*0.20*		*0.22*		*0.48*		*0.34*	*0.25*	**< 0.1**	**0.1 - 1**	**> 1**
RCRA Metals (Method 6010B/7471A) (mg/kg)																									
Arsenic	ND		4.3		ND		12.4		ND		10.8		50.7		10.9		15		18.6		*32.9*	*11.4*	**< 10**	**10 - 33**	**> 33**
Barium	76.5		47.9		76		84.6		99.8		77.2		104		74.5		93.7		95.2		*90.0*	*75.9*	--	--	--
Cadmium	1.1		ND		1.1		2.16		5.2		2.29		17.2		1.54		5.6		3.77		*6.04*	*2.44*	**< 1**	**1 - 5**	**> 5**
Chromium	57.8		14.5		37.4		51.5		101		48.3		164		47.7		134		76.2		*98.8*	*47.6*	**< 43**	**43 - 110**	**> 110**
Lead	94.9		35.7		85.4		271		369		286		1190		210		180		451		*384*	*251*	**< 36**	**36 - 130**	**> 130**
Mercury	0.25		0.0718		0.253		0.397		0.439		0.354		0.195		0.213		0.151		0.381		*0.258*	*0.283*	**< 0.2**	**0.2 - 1**	**> 1**
Silver	ND		ND		ND		1.18		2		1.3		5.4		0.917		ND		1.8		*3.7*	*1.3*	**< 1**	**1 - 2.2**	**> 2.2**
Wet Chemistry (Method 9012A) (mg/kg)																									
Cyanide	17		ND		ND		2 J		ND		ND		ND		ND		ND		5.8		*17.0*	*3.9*	--	--	--
Total Organic Carbon (Method Lloyd Kahn) (mg/kg)																									
TOC	38,800		19,000		47,800		60,200		43,100		54,500		36,500		59,600		19,200		93,200		*37,080*	*57,300*	--	--	--

Notes:
1. Only those parameters detected at a minimum of one sample location are presented in this table; all other compounds were reported as non-detect.
2. Values per NYSDEC 6NYCRR Part 375 Industrial Soil Cleanup Objectives (December 2006)
3. Discrete samples from each location were collected for VOC analysis; adjacent sediment core locations were composited for SVOC, PCB, metals, cyanide, and TOC analysis.
4. Pre-ICM samples colored **BLUE** were collected June 26-28, 2007; Post-ICM samples colored **BLACK** were collected April 23-24, 2009.
5. Average Concentrations are based on the combined average of detected concentrations.
6. Sample locations are shown on Plate 4-15.
7. NYSDEC Division of Fish, Wildlife and Marine Resources, Bureau of Habitat. Screening and Assessment of Contaminated Sediment (Tables 5 and 7). June 24, 2014.

Definitions:
B = Analyte was detected in the associated Method Blank.
J = Estimated value; result is less than the sample quantitation limit but greater than zero.
D = Indicates value obtained through dilution of sample.
ND = Parameter was analyzed but not detected in sample.

Color Code:

Class A	= Sediments considered to be of low risk to aquatic life.
Class B	= Sediments considered slightly to moderately contaminated; additional testing is required to evaluate the potential risks to aquatic life.
Class C	= Sediments considered to be highly contaminated and likely pose a risk to aquatic life; additional testing is required to evaluate the potential risks to aquatic life.

ROUX

TABLE 2
SUMMARY OF PRE-DREGING ANALYTICAL DATA IN SCUR (2007)

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Parameter [1]	Sample Location, Analysis, and Date [2]											Average Concentrations [3] (mg/Kg)	Sediment Guidance Values [4] (mg/kg)		
	SC-SED-11	SC-SED-12	SC-SED-13	SC-SED-14	SC-SED-15	SC-SED-16	SC-SED-17	SC-SED-18	SC-SED-19	SC-SED-20	SC-SED-22				
	12/04/07	12/04/07	12/04/07	12/04/07	12/04/07	12/04/07	12/05/07	12/05/07	12/05/07	12/05/07	12/05/07		Class A	Class B	Class C
TCL VOCs (Method 8260B) (mg/kg)															
Acetone	0.18	0.14	0.059 J	0.23	0.12 J	0.21 J	0.19	0.044 J	0.067 J	0.29	0.2	*0.16*	--	--	--
Benzene	0.084	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*0.084*	**< 0.53**	**0.53 - 1.9**	**> 1.9**
2-Butanone	0.037 J	0.029 J	ND	0.05 J	ND	ND	ND	ND	ND	0.061 J	0.42 J	*0.12*	--	--	--
Carbon Disulfide	0.014 J	0.008 J	ND	ND	ND	ND	ND	ND	0.036	0.01 J	0.009 J	*0.015*	--	--	--
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	0.01 J	ND	ND	*0.010*	**< 0.2**	**0.20 - 1.7**	**> 1.7**
Cyclohexane	0.03 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.044	*0.037*	--	--	--
Methylcyclohexane	0.013 J	ND	ND	ND	ND	ND	ND	ND	0.005 J	ND	0.016 J	*0.011*	--	--	--
Methylene Chloride	0.092 B	0.047 B	0.024 BJ	0.068 B	0.034 B	0.056 B	0.052 B	0.064 B	0.045 B	0.055 B	0.039 B	*0.052*	--	--	--
Toluene	0.01 J	ND	ND	ND	ND	ND	ND	ND	0.011 J	ND	ND	*0.011*	**< 0.93**	**0.93 - 4.5**	**> 4.5**
Xylenes, Total	0.03 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	*0.030*	**< 0.59**	**0.59 - 5.2**	**> 5.2**
Total VOCs (mg/kg)	*0.49*	*0.22*	*0.083*	*0.35*	*0.15*	*0.27*	*0.24*	*0.11*	*0.17*	*0.42*	*0.73*	*0.29*			
TCL SVOCs (Method 8270C) (mg/kg)															
Acenaphthene	2.5		ND		ND	0.086 J		1.4 J	ND	ND	ND	*1.3*		**9.82**	
Acenaphthylene	1.8 J		ND		ND	ND		ND	ND	ND	ND	*1.8*		**9.04**	
Anthracene	6.2		0.13 J		0.084 J	0.26 J		2.9 J	ND	0.06 J		*1.6*		**11.88**	
Benzo(a)anthracene	5.4		0.44 J		0.18 J	0.47 J		4.4 J	0.16 J	0.21 J		*1.6*		**16.82**	
Benzo(a)pyrene	3.7		0.38 J		ND	0.28 J		ND	0.1 J	0.12 J		*0.92*		**19.28**	
Benzo(b)fluoranthene	4.5		0.47 J		ND	0.45 J		4 J	0.14 J	0.2 J		*1.6*		**19.58**	
Benzo(g,h,i)perylene	2.5		0.31 J		ND	0.22 J		2.2 J	0.069 J	0.12 J		*0.90*		**21.9**	
Benzo(k)fluoranthene	1.8 J		0.24 J		ND	0.18 J		2.2 J	0.066 J	0.091 J		*0.76*		**19.6**	
Biphenyl	0.59 J		ND		ND	ND		ND	ND	ND		*0.59*		**--**	
Bis(2-ethylhexyl) phthalate	ND		0.52 J		ND	ND		ND	ND	ND		*0.52*		**--**	
Carbazole	1.3 J		0.071 J		ND	ND		0.95 J	ND	ND		*0.77*		**--**	
Chrysene	4.6		0.45 J		0.46 J	0.48 J		5.2 J	0.11 J	0.25 J		*1.7*		**16.86**	
Dibenz(a,h)anthracene	0.75 J		0.093 J		ND	0.098 J		ND	ND	ND		*0.31*		**22.44**	
Dibenzofuran	4.4		ND		ND	0.099 J		1.2 J	ND	ND		*1.9*		**--**	
Fluoranthene	15		0.94 J		0.31 J	0.94 J		8.5 J	0.18 J	0.38 J		*3.8*		**14.16**	
Fluorene	3.4		0.058 J		ND	0.17 J		1.8 J	ND	ND		*1.4*		**10.78**	
Indeno(1,2,3-cd)pyrene	2.4		0.28 J		ND	0.22 J		1.2 J	0.056 J	0.09 J		*0.71*		**22.3**	
2 - Methylnaphthalene	1.6 J		ND		0.13 J	0.14 J		1.6 J	ND	ND		*0.87*		**--**	
4 - Methylphenol	ND		ND		1.2 J	ND		ND	ND	ND		*1.2*		**--**	
Naphthalene	3.3		ND		ND	0.17 J		ND	ND	ND		*1.7*		**7.7**	
N-nitrosodiphenylamine	0.24 J		ND		ND	ND		ND	ND	ND		*0.24*		**--**	

ROUX

TABLE 2
SUMMARY OF PRE-DREGING ANALYTICAL DATA IN SCUR (2007)

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Parameter [1]	Sample Location, Analysis, and Date [2]											Average Concentrations [3] (mg/Kg)	Sediment Guidance Values [4] (mg/kg)		
	SC-SED-11	SC-SED-12	SC-SED-13	SC-SED-14	SC-SED-15	SC-SED-16	SC-SED-17	SC-SED-18	SC-SED-19	SC-SED-20	SC-SED-22				
	12/04/07	12/04/07	12/04/07	12/04/07	12/04/07	12/04/07	12/05/07	12/05/07	12/05/07	12/05/07	12/05/07		Class A	Class B	Class C
Phenanthrene	24		0.63 J		0.27 J		0.96 J		14 J	0.13 J	0.3 J	*5.8*		**11.94**	
Pyrene	10		0.8 J		0.36 J		0.81 J		7.4 J	0.17 J	0.32 J	*2.8*		**13.96**	
Total SVOCs (mg/kg)	*100*		*5.8*		*3.0*		*6.0*		*59*	*1.2*	*2.1*	*25*			
Total PCBs (Method 8082) (mg/kg)															
Aroclor 1242	0.034		ND		ND		ND		3.6	0.0055	0.033	*0.92*	--	--	--
Aroclor 1254	0.014 J		ND		ND		ND		ND	ND	ND	*0.014*	--	--	--
Total PCBs (mg/kg)	*0.048*		*ND*		*ND*		*ND*		*3.6*	*0.0055*	*0.033*	*0.92*	**< 0.1**	**0.1 - 1**	**> 1**
RCRA Metals (Method 6010B/7471A) (mg/kg)															
Arsenic	17.1		ND		30.6		22.4		11.3	ND	ND	*20*	**< 10**	**10 - 33**	**> 33**
Barium	72		55.2		59.8		45.3		10.8	80	114	*62*	--	--	--
Cadmium	2.6		ND		3.9		9.4		ND	ND	ND	*5.3*	**< 1**	**1 - 5**	**> 5**
Chromium	84.9		33.2		117		81		44.9	27.4	22.7	*59*	**< 43**	**43 - 110**	**> 110**
Lead	333		134		1370		926		21.6	75.2	113	*425*	**< 36**	**36 - 130**	**> 130**
Mercury	0.205		0.207		0.12		0.188		0.022	0.074	0.1	*0.13*	**< 0.2**	**0.2 - 1**	**> 1**
Silver	ND		ND		5.3		3.4		ND	ND	ND	*4.4*	**< 1**	**1 - 2.2**	**> 2.2**
Wet Chemistry (Method 9012A) (mg/kg)															
Cyanide	ND		ND		ND		4.6		ND	ND	ND	*4.6*	--	--	--
Total Organic Carbon (Method Lloyd Kahn) (mg/kg)															
TOC	38,500		ND		93,400		42,000		66,600	ND	100,000	*68,100*	--	--	--

Notes:
1. Only those parameters detected at a minimum of one sample location are presented in this table; all other compounds were reported as non-detect.
2. Discrete samples from each location were collected for VOC analysis; adjacent sediment core locations for SC-SED-11 thru 18 were composited for SVOC, PCB, metals, cyanide, and TOC analysis. See Plate 4-15.
3. Average concentrations are based on the combined average of detected concentrations.
4. NYSDEC Division of Fish, Wildlife and Marine Resources, Bureau of Habitat. Screening and Assessment of Contaminated Sediment (Tables 5 and 7). June 24, 2014.

Definitions:
J = Estimated value; result is less than the sample quantitation limit but greater than zero.
* = Indicates analysis is not within the quality control limits.
ND = Parameter was analyzed but not detected in sample.

Color Code:

Class A	= Sediments considered to be of low risk to aquatic life.
Class B	= Sediments considered slightly to moderately contaminated; additional testing is required to evaluate the potential risks to aquatic life.
Class C	= Sediments considered to be highly contaminated and likely pose a risk to aquatic life; additional testing is required to evaluate the potential risks to aquatic life.

ROUX

TABLE 3
DATA QUALITY OBJECTIVES PROCESS

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Steps	DQO 1: Determine Quantity of Sediment Above Design Elevation for Dredging	DQO 2: Characterize Chemical/Physical Compostion of Sediment Below Design Elevation to Determine Quantity to be Dredged
1. State the Problem	The thickness of soft sediment above the USACE design elevation is not known	The sediment below the design elevation has not been sampled and analyzed
2. Identify the Goal of the Study	To determine the thickness of soft sediment to be dredged	To determine if the sediment below the design elevation exceeds cleanup objectives
3. Identify the Information Inputs	Depth to soft sediment and depth to hard sediment	Sediment samples collected at two intervals below the design elevation at 5 locations along each transect
4. Define the Boundaries of the Study	Mouth of Smokes Creek to Hamburg Turnpike (NYS Route 5)	Mouth of Smokes Creek to Hamburg Turnpike (NYS Route 5)
5. Develop the Analytical Approach	No analytical required; survey information only	Samples will be analyzed for TCL VOCs, TCL SVOCs, TAL metals (plus mercury), PCBs, cyanide, and TOC per Section 3.6.1
6. Specify Performance or Acceptance Criteria	Not applicable	Results will be compared to Sediment Guidance Values (SGVs) in June 2014 NYSDEC *Screening and Assessment of Contaminated Sediment*
7. Develop the Plan for Obtaining Data	Manual sediment probing as described in Section 3.5.3	Samples collected with Vibracore sampler

ROUX

TABLE 4
SUMMARY OF SAMPLING LOCATIONS AND ANALYSES

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Transect ID	Northing	Easting	1965 Design Centerline Elevation	Analytical and Number of Sample Locations											
				TCL VOCs		TCL SVOCs		TAL Metals+Mercury		PCBs		Cyanide		TOC	
				0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"
Smokes Creek Lower Reach (SCLR)															
SC-SED-1	1024433	1072909	558.00	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-2	1024515	1073167	558.00	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-3	1024663	1073390	558.20	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-4	1024853	1073582	558.49	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-5	1024951	1073832	558.79	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-6	1024975	1074101	559.07	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-7	1024988	1074370	559.37	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-8	1024998	1074640	559.66	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-9	1025024	1074909	559.96	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-10	1025043	1075178	560.45	5	5	5	5	5	5	5	5	5	5	2	2
Subtotal Samples Analyzed in SCLR				*50*	*10*	*50*	*10*	*50*	*10*	*50*	*10*	*50*	*10*	*20*	*4*
Samples Held (80%)				*0*	*40*	*0*	*40*	*0*	*40*	*0*	*40*	*0*	*40*	*0*	*16*
Smokes Creek Upper Reach (SCUR)															
SC-SED-11	1025073	1075381	560.48	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-12	1024887	1075577	560.78	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-13	1024700	1075772	561.08	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-14	1024515	1075968	561.38	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-15	1024312	1076146	561.66	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-16	1024100	1076313	561.96	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-17	1023919	1076512	562.26	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-18	1023960	1076769	562.67	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-19	1024144	1076964	562.85	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-20	1024206	1077226	563.16	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-21	1024384	1077402	563.44	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-22	1024642	1077478	563.71	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-23	1024865	1077572	564.12	5	5	5	5	5	5	5	5	5	5	2	2
SC-SED-24	1024926	1077834	567.63	5	5	5	5	5	5	5	5	5	5	2	2
Subtotal Samples Analyzed in SCUR				*70*	*14*	*70*	*14*	*70*	*14*	*70*	*14*	*70*	*14*	*28*	*7*
Samples Held (80%)				*0*	*56*	*0*	*56*	*0*	*56*	*0*	*56*	*0*	*56*	*0*	*21*
Smokes Creek (SCLR and SCUR)															
Subtotal Samples Analyzed				*120*	*24*	*120*	*24*	*120*	*24*	*120*	*24*	*120*	*24*	*48*	*11*

ROUX

TABLE 4
SUMMARY OF SAMPLING LOCATIONS AND ANALYSES

Pre-Design Investigation Work Plan for Operable Unit OU-09 - Smokes Creek
Tecumseh Redevelopment Inc.
Lackawanna, New York

Transect ID	Northing	Easting	1965 Design Centerline Elevation	Analytical and Number of Sample Locations											
				TCL VOCs		TCL SVOCs		TAL Metals+Mercury		PCBs		Cyanide		TOC	
				0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"	0-12"	12-24"
QA/QC Samples															
Equipment/Rinsate Blanks (1 per day, estimated)				12	--	12	--	12	--	12	--	12	--	12	--
Trip Blanks (1 per 20 VOC samples)				6	2	0	0	0	0	0	0	0	0	0	0
Blind Duplicate (1 per 20 samples)				6	2	6	2	6	2	6	2	6	2	3	2
MS/MSD (1 per 20 samples)				6	2	6	2	6	2	6	2	6	2	3	2
Subtotal QA/QC Samples				*30*	*6*	*24*	*4*	*24*	*4*	*24*	*4*	*24*	*4*	*18*	*4*
Total Number of Samples				**150**	**30**	**144**	**28**	**144**	**28**	**144**	**28**	**144**	**28**	**66**	**15**

Sample Locations and ID Numbers:
Centerline Channel: CC-XX (0-12) & CC-XX (12-24); where XX is sample ID#
South Bank: SB-XXA (0-12) & SB-XXA (12-24) + SB-XXB (0-12) & SB-XXB (12-24)
North Bank: NB-XXA (0-12) & NB-XXA (12-24) + NB-XXB (0-12) & NB-XXB (12-24)

Analytical Methods:
TCL VOCs: Method 8260D
TCL SVOCs: Method 8270E
TAL Metals: Method 6010B / 7471B
PCBs: Method 8082A (Aroclors 1016-1268)
Cyanide, Total: Method 9010C/9012B
Total Organic Carbon (TOC): Method 9060A(M)

FIGURES

1. Site Location and Vicinity Map
2. Site Plan
3. June 2022 Sediment Toxicity Sample Locations
4. Transect Locations for Survey Control
5. Sample Location Profile
6. Sample Location Plan

4,000' 0' 4,000' 8,000'

SCALE: 1 INCH = 4,000 FEET
SCALE IN FEET
(approximate)

N

NOTE:
1. AERIAL IMAGE FROM MICROSOFT BING MAPS USING AUTODESK AUTOCAD GEOLOCATION INTERFACE APRIL 2023. DATE OF IMAGE IS NOT DEFINED.

Title:

SITE LOCATION AND VICINITY MAP

PRE-DESIGN INVESTIGATION WORK PLAN
OU-9 - SMOKES CREEK

FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

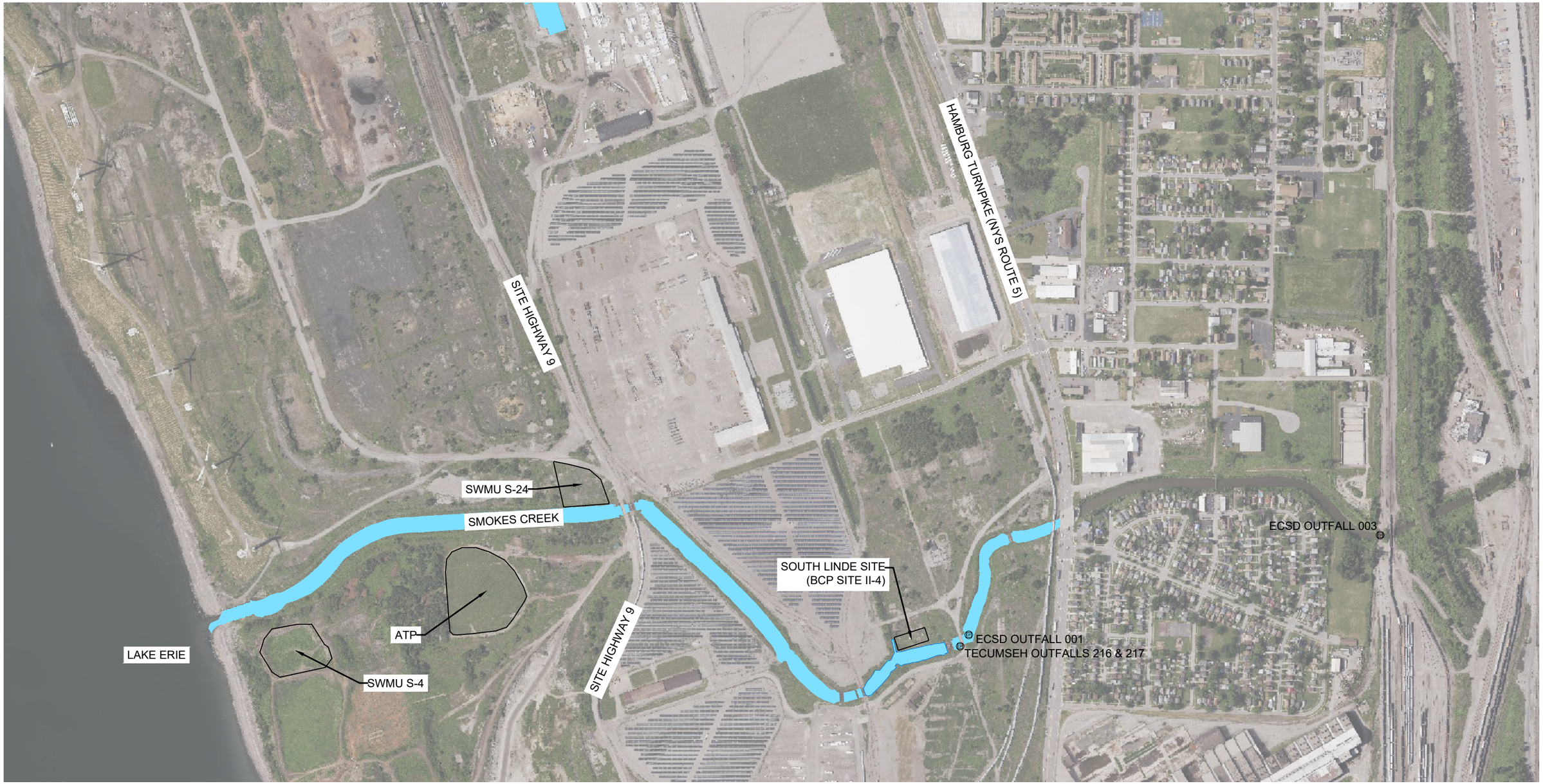
Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: JUNE 2025	FIGURE
Prepared by: RFL	Scale: AS SHOWN	1
Project Mgr: LER	Project: 4395.0005B000	
File: FIGURE 1; SITE LOCATION AND VICINITY MAP - ROUX.DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 1; SITE LOCATION AND VICINITY MAP - ROUX.DWG JYAEGER



N

600' 0' 600' 1,200'

SCALE: 1 INCH = 600 FEET
SCALE IN FEET
(approximate)

LEGEND:

OF — OUTFALL LOCATION

Title:

SITE PLAN

PRE-DESIGN INVESTIGATION WORK PLAN
OU-9 - SMOKES CREEK

FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

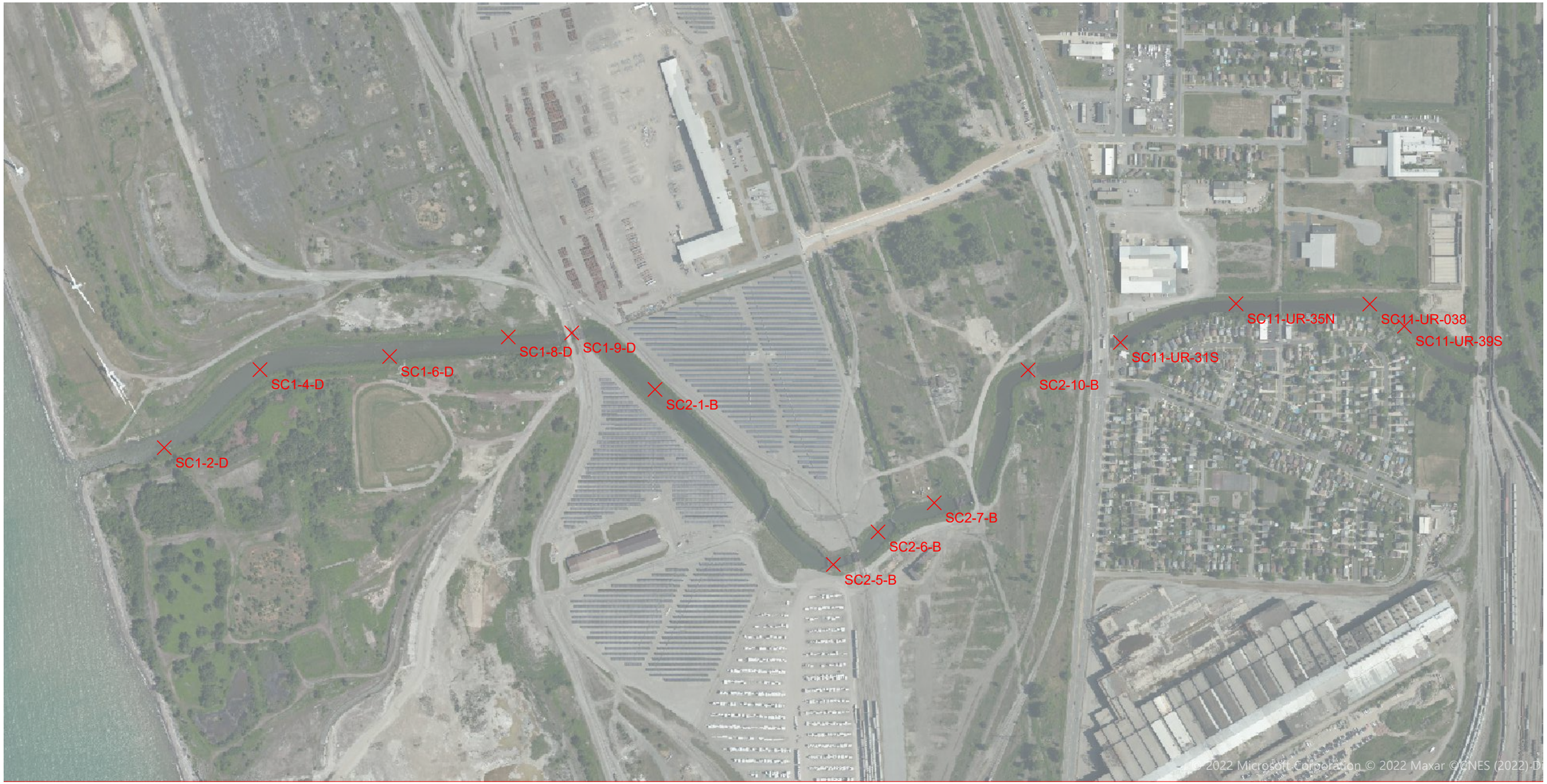
Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: JANUARY 2026	FIGURE
Prepared by: JJY	Scale: AS SHOWN	2
Project Mgr: LER	Project: 4395.0005B000	
File: FIGURE 2; PROJECT AREA - ROUX_R2.DWG		

\\SRVBFNYAFS1\BUFFALOSHARED\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 2; PROJECT AREA - ROUX_R2.DWG JYAEGER



500' 0' 500' 1,000'

SCALE: 1 INCH = 450 FEET
SCALE IN FEET
(approximate)

N

LEGEND:

X
SC11-UR-31S

SAMPLE LOCATIONS TOXICITY TESTING

Title:

JUNE 2022 SEDIMENT TOXICITY SAMPLE LOCATIONS

PRE-DESIGN INVESTIGATION WORK PLAN

OU-9 - SMOKES CREEK

FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

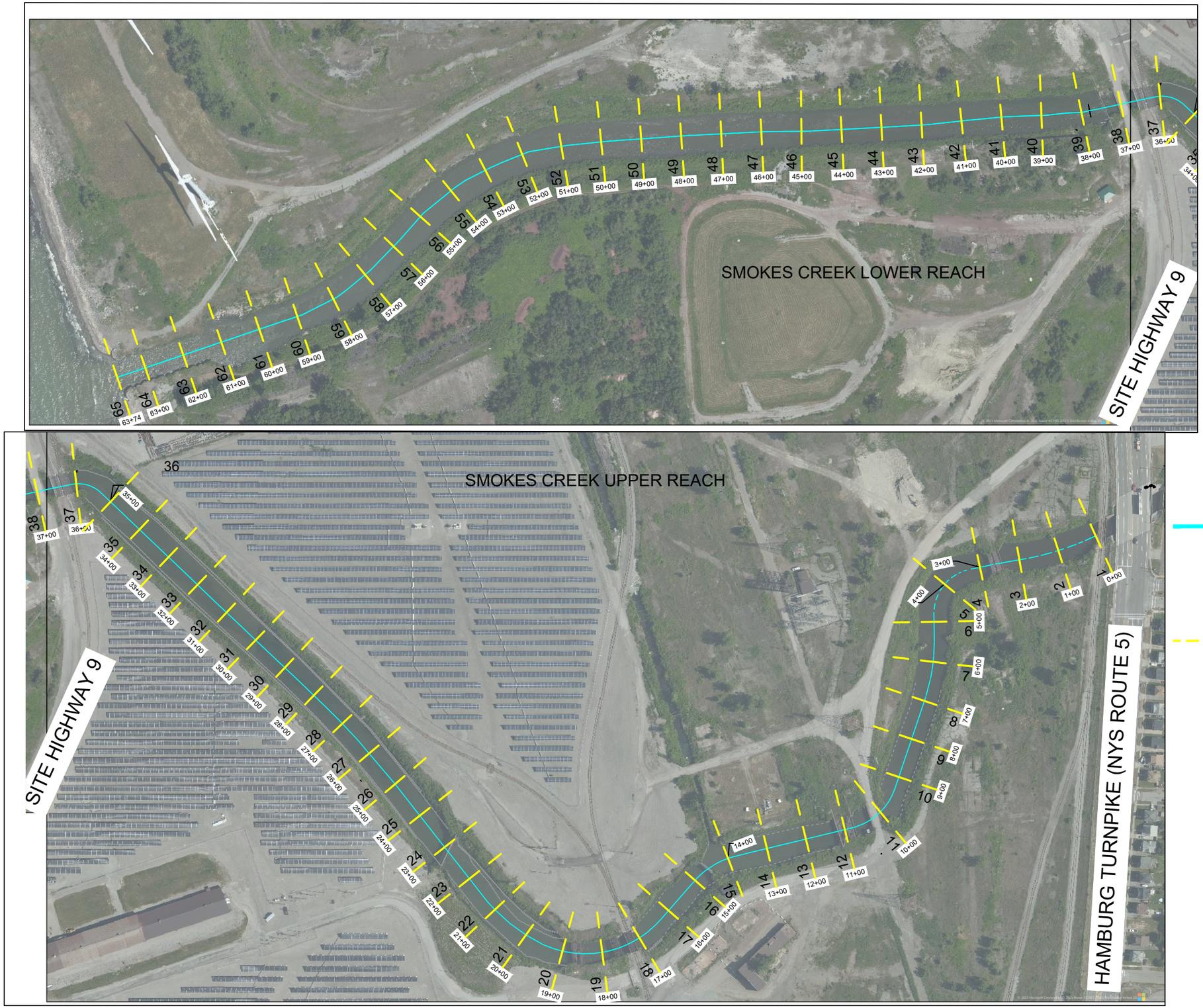
Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: JUNE 2025	FIGURE
Prepared by: RFL	Scale: AS SHOWN	3
Project Mgr: LER	Project: 4395.0005B000	
File: FIGURE 3; USGS SAMPLING LOCATIONS JUNE 2022 - ROUX.DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 3; USGS SAMPLING LOCATIONS JUNE 2022 - ROUX.DWG JYAEGER



LEGEND:

APPROXIMATE ALIGNMENT FOR CENTERLINE (THALWEG) OF CREEK

PLANNED TRANSECT LOCATION (100' INTERVALS)

Title:

TRANSECT LOCATIONS FOR SURVEY CONTROL

PRE-DESIGN INVESTIGATION WORK PLAN
OU-9 - SMOKES CREEK

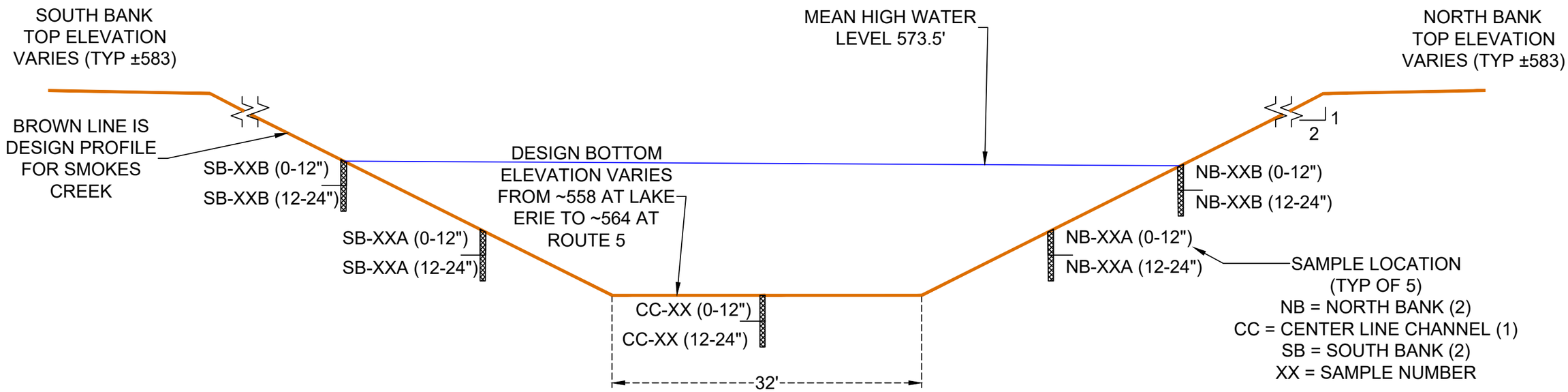
FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX	Compiled by: JJY	Date: JUNE 2025	FIGURE 4
	Prepared by: JJY/CMC	Scale: AS SHOWN	
	Project Mgr: LER	Project: 4395.0005B000	
	File: FIGURE 4; TRANSECT LOCATIONS - ROUX_R2.DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 4; TRANSECT LOCATIONS - ROUX_R2.DWG JYAEGER



NOTES:

1. DESIGN PROFILE VARIES IN VICINITY OF THE MOUTH OF SMOKES CREEK AND PROXIMATE TO BRIDGES DUE TO PRESENCE OF RETAINING WALLS, CAISSONS AND SHEET PILING.
2. THE DATUM USED TO ESTABLISH VERTICAL CONTROL WILL BE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

Title:
SMOKES CREEK DESIGN & SAMPLE LOCATION PROFILE
PRE-DESIGN INVESTIGATION WORK PLAN
OU-9 - SMOKES CREEK

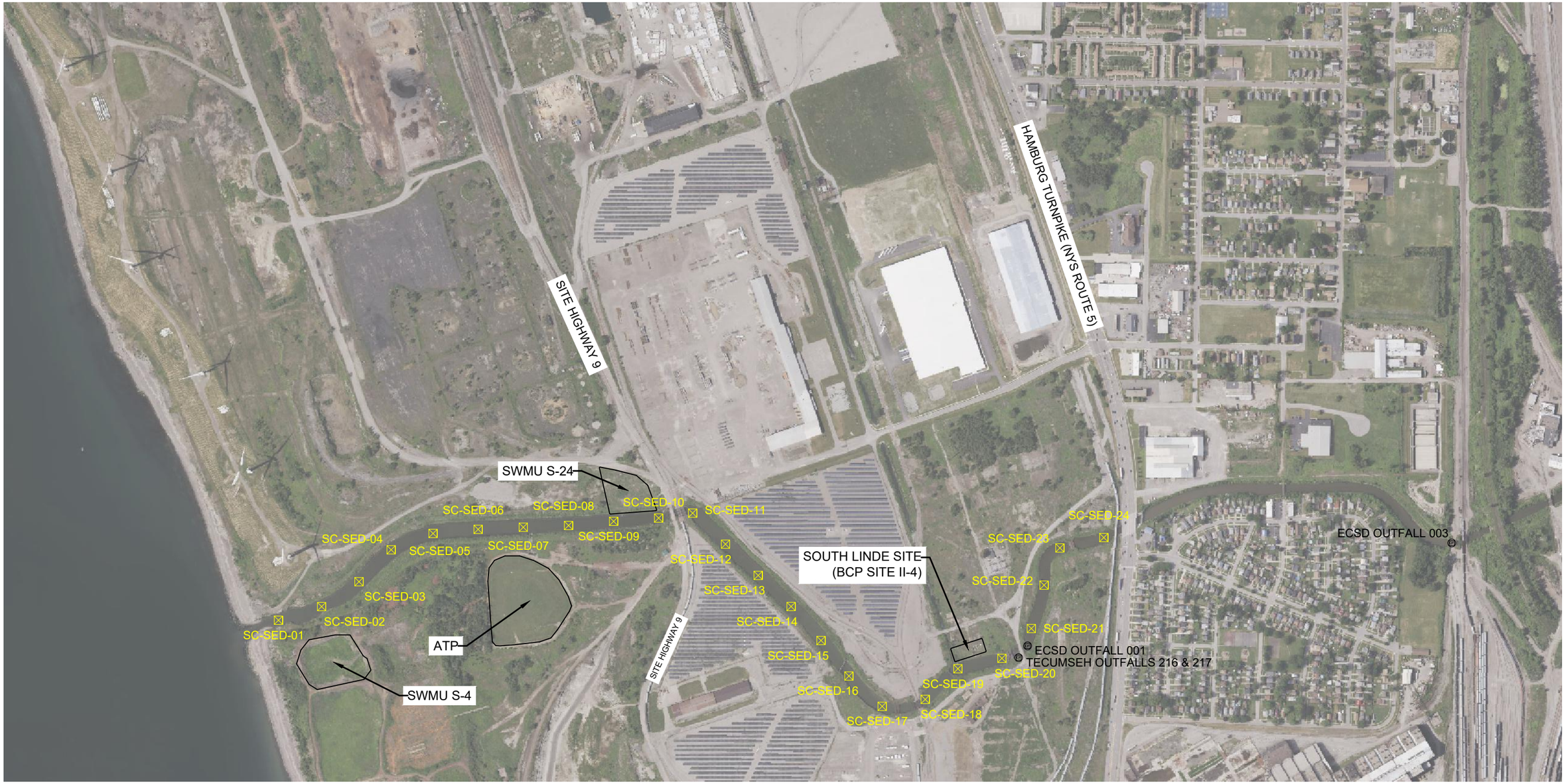
FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

Prepared for:
TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: OCTOBER 2025	FIGURE
Prepared by: JJY	Scale: NOT TO SCALE	5
Project Mgr: LER	Project: 4395.0005B000	
File: FIGURE 5; SAMPLING LOCATIONS PROFILE - ROUX_R1.DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 5; SAMPLING LOCATIONS PROFILE - ROUX_R1.DWG JYAEGER



N

600' 0' 600' 1,200'

SCALE: 1 INCH = 600 FEET
SCALE IN FEET
(approximate)

SC-SED-22

OF

LEGEND:

PLANNED BOTTOM SAMPLE LOCATIONS
SEE FIGURE 5 FOR BANK SAMPLING LOCATIONS

OUTFALL LOCATION

Title:

SAMPLE LOCATION PLAN

PRE-DESIGN INVESTIGATION WORK PLAN
OU-9 - SMOKES CREEK

FORMER BETHLEHEM STEEL SITE
LACKAWANNA, NEW YORK

Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: JANUARY 2026	FIGURE
Prepared by: JJY	Scale: AS SHOWN	6
Project Mgr: LER	Project: 4395.0005B000	
File: FIGURE 6; SAMPLE LOCATION PLAN_R3.DWG		

\\SRVBFNYAFS1\BUFFALOSHARED\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\CORRECTIVE MEASURES\OU-9\SMOKES CREEK\PDI\FIGURE 6; SAMPLE LOCATION PLAN_R3.DWG JYAEGER

APPENDICES

A. Results of Sediment Toxicity Testing
B. Summary of Cleanup Objectives
C. Site-Wide Health and Safety Plan
D. Field Operating Procedures
E. Quality Assurance Project Plan
F. Project Documentation Forms
G. Permits
H. Mean-High Water Level Determination
I. 1965 USACE Plan and Profile Drawings

APPENDIX A

Results of Sediment Toxicity Testing

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Assessing impaired benthic communities using sediment toxicity and contaminant concentrations from reference sites inside the Niagara River Area of Concern

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BUI

ABSTRACT

Anthropogenically degraded benthic-macroinvertebrate communities (benthos) are one of seven beneficial use impairments (BUIs) in the Niagara River Area of Concern (AOC). Over the last 50 years, upgrades to waste-water treatment, industry closures, and sediment remediations reduced contaminant levels throughout the system. Improvements in benthic communities and sediment toxicity, however, were difficult to assess because there are no comparable reference reaches outside the AOC. A multi-phase study was initiated in 2015 to determine if data from inside the AOC could identify reference conditions, if toxicity and benthic-community data from these sites differed from other AOC sites, and if further remediation efforts were warranted in parts of the AOC. Concentrations or quotients of PAHs, PCBs, dioxins and furans, pesticides, and most metals were below their New York Sediment Class A Guidance Values at 10 sites that were subsequently designated as reference sites. Survival and growth data from *Chironomus dilutus* and *Hyalella azteca* bioassays indicated that sediments from only a few individual AOC-impact sites were toxic or significantly different from reference sites, and that mean toxicity at pooled AOC-impact and reference sites did not differ significantly. Similarly, New York Biological Assessment Profile scores and chironomid mentum deformity scores at only a few individual sites differed significantly from corresponding indices at reference sites, but neither metric differed significantly in comparisons between pooled AOC-impact and reference sites. Most analyses indicated that benthic communities were unimpaired and that removal criteria for the benthos BUI were largely met in much of the upper Niagara River AOC.

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Introduction

The governments of Canada and the United States (U.S.) committed to restoring the physical, chemical, and biological integrity of the Laurentian Great Lakes under the 1972 Great Lakes Water Quality Agreement or GLWQA (IJC, 1972). Under this framework, the U.S. and Canada subsequently identified 43 Areas of Concern (AOCs), defined in the most recent update of the Water Quality Agreement (IJC, 2012) as geographic areas where significant impairment of beneficial uses has occurred because of human activities at the local level. Each AOC exhibits 1 or more of 14 potential beneficial use impairments (BUIs) that are defined in the GLWQA and are associated with a reduction in the chemical, physical, or biological integrity of waters in the Great Lakes. For each AOC, a Remedial Action Plan was developed by, or in cooperation with, a local Remedial Advisory Committee to guide remediation efforts and corresponding assessments of restoration effectiveness. Listed BUIs in each AOC are generally evaluated over time, typically before and after remedial efforts, to determine if they are still applicable or if conditions meet AOC-specific BUI-removal criteria, which would permit the BUI designation to be removed. According to the GLWQA, an AOC can only be delisted after all its listed BUIs have been removed.

The entire Niagara River between Lake Erie and Lake Ontario forms the boundary between the U.S. and Canada (Fig. 1) and

Abbreviations: AOC, Area of Concern; GLRI, Great Lakes Restoration Initiative; BUI, Beneficial Use Impairment.

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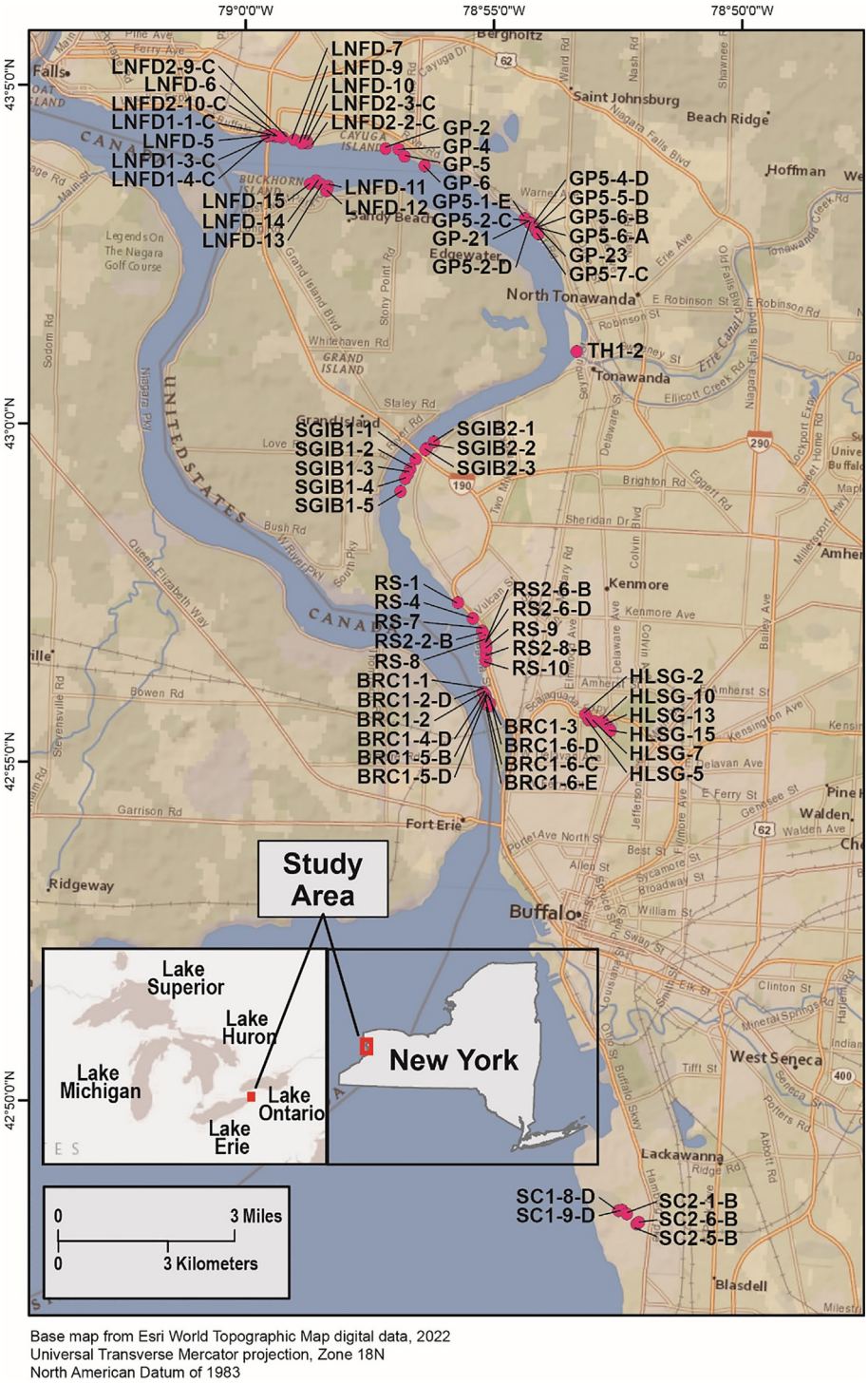

Fig. 1. Study sites in Niagara River where the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers collected sediment samples during 2018 for contaminant analyses and where the U.S. Geological Survey and New York State Department of Environmental Conservation collected sediment samples during 2019 and 2020 for benthic community and invertebrate-toxicity assessments. Only acute and chronic toxicity were assessed from sediments collected at sites in Hoyt Lake and Smoke Creek during 2020. The first 2 to 4 letters of site codes denote general study-area regions as follows: HLSG = Hoyt Lake, SC = Smoke Creek, BRC = Black Rock Canal, RS = Riverside Park, SGIB = South Grand Island Bridge, TH = Tonawanda Harbor, GP = Gratwick Park, and LNFD = downstream of the Little Niagara River.

was designated as a binational AOC in 1987 due to chemical contamination primarily by past industrial discharges and hazardous waste sites, and to extensive degradation of aquatic habitats. In the U.S. (eastern) portion of the AOC, seven BUIs were originally identified, including the degradation of the "benthos," or benthic macroinvertebrate community. Contaminants such as polychlorinated biphenyls (PCBs), dioxins and furans, heavy metals, and hexachlorocyclohexane are probable sources for impairment to the benthos (NYSDEC, 1994, 2012). Over the past 50 years, significant upgrades to industrial and municipal wastewater treatment facilities, closure of many local heavy industries, and extensive shoreline and river-bed remediations have reduced pollutant inputs and removed (or capped) some of the most contaminant-laden sediments in the Niagara River and its tributaries. Subsequent

improvements in water quality are reflected by changes in the New York State Department of Environmental Conservation (NYSDEC) Index of Biotic Integrity for macroinvertebrate communities known as the Biological Assessment Profile (BAP) score (NYSDEC, 2021). The BAP scores in the Niagara River increased from 3.5 to 4.6, to 5.6, and to 6.7 during consecutive surveys conducted by the NYSDEC as part of the Rotating Integrated Basin Studies Program in 2000, 2005, 2010, and 2015, respectively (NYSDEC, 2022). The increase of about 1 BAP unit every 5 years indicates that benthic communities improved from moderately impacted to sightly impacted (and were approaching non-impacted – a score of 7.5) at this site over that period. Recent (2014–15) acute and chronic toxicity tests also showed sediments were moderately toxic at only a few AOC source-area (tributary) sites and that they were generally less toxic in the Niagara River than in other AOCs of New York (George et al., 2016). These findings indicate that the impaired designation of the benthos in the Niagara River AOC may no longer be appropriate and that a contemporary assessment of local benthic macroinvertebrate communities and the degradation of benthos BUI is warranted.

The initial criteria for removing the degradation of benthos BUI were developed by the NYSDEC and the Niagara River AOC Remedial Advisory Committee in 2008 (NYSDEC, 2008). They stipulated that the benthos BUI may be removed after it was shown that: (a) the benthic macroinvertebrate community structure is non-impacted or slightly impacted according to NYSDEC indices (Bode et al., 1996) at selected sediment depositional zones; (b) all known AOC areas of sediment contamination at concentrations exceeding New York State Class A sediment quality thresholds (indicating potential chronic toxicity to aquatic life) have been remediated or scheduled for remediation, and (c) priority contaminants in sediments show no statistically significant bioaccumulation in fish inhabiting selected sediment depositional zones. These criteria, however, were not practical nor attainable in the Niagara River because bed sediments in some areas remained contaminated (NYSDEC, 2006) and exceeded New York State Class A Sediment Guidance Values (SGVs) or Class C SGVs which could be moderately to highly toxic to aquatic life (NYSDEC, 2014). The status of the degradation of benthos BUI may also now be inappropriate because recent data identified no widespread occurrence of highly toxic sediments (George et al., 2016) and showed that benthic communities at several sites inside and outside the Niagara River AOC have improved considerably (NYSDEC, 2022) as compared to the depauperate (or entirely absent) assemblages which existed at some locations during the 1960s (Veal, 1970). The fact that impaired benthic assemblages remain in some parts of the Niagara River with declining contaminant concentrations in sediments indicates that atypical or poor habitat conditions also affect the health of local species populations and their communities.

The impractical benthos BUI-removal criteria for the Niagara River AOC were subsequently modified by NYSDEC and the Remedial Advisory Committee in 2017. The modified BUI-removal criteria state that: "*benthic macroinvertebrate community structure does not significantly diverge from reference sites of comparable physical and chemical characteristics AND the toxicity of sediment-associated contaminants is not significantly higher than reference sites*". In most AOCs within the Great Lakes, data used to evaluate the status of BUIs frequently originate from reference sites located in comparable (and nearby) rivers and harbors or upstream segments of the same river (e.g., Cuyahoga River OH, Waukegan Harbor IL, and Buffalo River NY) which represent regional conditions, and also from AOC sites sampled before-and-after restoration actions (Grapentine, 2009). No upstream reaches or nearby rivers that could be used to determine regional "reference" conditions existed for most BUIs in the Niagara River AOC. Fittingly, the new removal criteria were qualified by the statement: "*In the event that appropriate reference sites cannot be found outside the AOC, reference sites will be identified as the least disturbed sites within the AOC through a sediment chemistry evaluation process that will provide information on the status of sediments within predetermined sampling units*". This provides for the use of a non-standard set of reference sites to assess the condition of benthic communities, sediment toxicity, and ultimately the degradation of benthos BUI. This option is critical because the location and unique physical characteristics of the Niagara River mean that no comparable reference (control) rivers or reaches occur in this region outside the boundaries of the AOC.

Given the lack of nearby reference rivers or sites outside the AOC to assess and gauge regional (background) conditions for BUIs in the Niagara River AOC, staff from five agencies devised and implemented a 4-phase study to test a method to identify reference sites exclusively from inside this AOC. The main objectives of this study were to determine if: (1) sediment-contaminant concentrations could be used to identify sites inside the AOC that represent reference conditions, (2) sediment-toxicity and benthic-community metrics at such reference sites differed significantly from those at other sites in the AOC, and (3) sediment chemistry, toxicity, or benthic community results indicate further remediation efforts are warranted at specific sites or areas within the AOC. The approach of this study was to: (a) identify soft-sediment areas (to target depositional sampling sites), (b) measure contaminant concentrations, (c) classify sediment quality according to New York SGVs, and (d) assess the condition of benthic communities, sediment toxicity, and the revised degradation of benthos BUI-removal criteria in the segment of the Niagara River AOC that is upstream of Niagara Falls (upper Niagara River).

Methods

Study design

Staff from the U.S. Environmental Protection Agency (USEPA), NYSDEC, U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), and U.S. Geological Survey (USGS) completed this 4-phase study between 2016 and 2021 as follows.

Phase 1: The USACE Engineer Research and Development Center assessed roughly 220 linear miles of side scan sonar data and about 51 miles of chirp sub-bottom profiles that USACE and USFWS collected during 2016 and 2017 to determine the location and composition of sediments along shallow shorelines of the U.S. portion of the upper Niagara River. Those results were used to generate maps of the spatial distribution (and depth/volume in selected areas) of fine-grained deposits which were associated primarily with small tributaries, islands/points, or with man-made structures that modified the flow of the system (Wadman and McNinch, 2021). The locations of fine-grained sediments (clay, silt, and muck) were used to inform the collection of sediments for chemistry, toxicity, and benthic community assessments during subsequent phases.

Phase 2: The USEPA and USACE collected sediment samples in 2018 for contaminant analysis from 47 sites using VibraCores and from 438 sites using Ponar dredges across 6 general regions (Black Rock Canal-BRC, Riverside Park-RS, South Grand Island Bridge-SGIB, Tonawanda Harbor-TH, Gratwick Park-GP, and downstream of the Little Niagara River-LNFD) in the AOC-impact area (Fig. 1). Polychlorinated biphenyl (PCB) Aroclors, polycyclic aromatic hydrocarbons (PAHs), metals, and organochlorine pesticides were analyzed from sediments in the uppermost 12 in., and separately in the next lower 24 in. of VibraCore samples from all sites. In addition, dioxins and furans were analyzed in samples from two areas along Gratwick Park and downstream of the Little Niagara River that were downriver from known sources. Equal portions of each Ponar sample from as many as 10 neighboring sites were

composited and analyzed for the same contaminants. An aliquot from each individual Ponar sample was also archived. If elevated contaminants were measured in any composite sample, the archived portions of the individual Ponar samples were analyzed separately for that contaminant group to isolate the responsible site(s).

Phase 3: As sediment-contaminant results became available, the USGS and NYSDEC collected petite Ponar samples from 30 of the 2018 VibraCore-sample sites during 2019, then from 26 Ponar sites (and 4 additional VibraCore sites) during 2020 for biological assessments. Specific sites were targeted to represent a wide range in contaminant concentrations, and the closest alternate site was sampled when sediments at target sites were found to be too rocky. All sediment samples were assessed to determine their acute (survival) and chronic (growth) toxicity to two widely distributed invertebrate species: *Chironomus dilutus* and *Hyalella azteca*, and to characterize the condition of benthic macroinvertebrate communities in the AOC. Additional sediment samples were collected from two AOC source areas: 6 samples were collected from Hoyt Lake (HLSG) and 5 samples were collected from Smoke Creek (SC) during 2020 to assess sediment toxicity (Fig. 1). Hoyt Lake and Smoke Creek represent contaminant source areas to the Niagara River AOC and their 11 sites are referred to as AOC-source or simply "source" sites. All other sites are referred to as AOC-impact or AOC-reference sites, or more simply as "impact" or "reference" sites, respectively. The extent of source and impact area types are delineated in USEPA (2022).

Phase 4: The relations among contaminant concentrations and NYSDEC SGVs for non-toxic Class A sediments (NYSDEC, 2014), measured toxicity, and benthic-community metrics were evaluated and interpreted during 2020 and 2021 to directly address primary study objectives and goals.

Sediment chemistry field surveys

Bed sediments were collected at study sites in the Niagara River using 1 of 2 methods: a Standard Ponar or a VibraCore sampler, deployed from the USEPA research vessel *Mudpuppy II* during summer 2018. In the field, each VibraCore sample was divided into 2 subsamples – a shallow portion from the 0-to-1-foot (0-to-30 cm) depth section and a deep portion from the 1-to-3-foot (30-to-91 cm) depth section. After being homogenized separately, a subsample from each section was placed into sample bottles. Each Ponar sample was homogenized, then two separate aliquots were collected. One aliquot was placed into a sample bottle and later submitted to the U.S. Army Engineer Research and Development Center (USAERDC) Environmental Laboratory (Vicksburg, VA) where it was frozen at −20 °C until further analyses - if needed. One 250 g portion was added to 250 g portions from as many as 9 other sites (in a stainless-steel bowl), homogenized to create a group-composite sample, then a subsample was placed into a glass bottle. All samples were labeled, placed into coolers (with enough ice to maintain samples at $\leq$ 6 °C for 24 h), sealed, and transferred to processing laboratories or cold storage using proper Chain-of-Custody procedures. Both VibraCore samples from each site, and composited Ponar samples from a group of sites were shipped via overnight delivery to SGS North America Inc., in Dayton NJ, where all constituent groups were analyzed. Additional petite Ponar samples were collected from several sites in Smoke Creek during Sept. 2017 and in Hoyt Lake during 2013 by the USACE to produce pooled composite (up to 10 grabs) and (or) discrete sediment samples following the same procedures used in the 2018 Niagara River survey. Only metals were assessed from individual Smoke Creek samples, and they were analyzed by RTI Laboratories in Livonia, MI. Only chemistry data from shallow VibraCore and discrete Ponar samples were assessed herein.

Sediment chemistry laboratory analyses

All composite and discrete sediment samples were analyzed for target analyte list (TAL) metals, mercury, total organic carbon (TOC), 16 priority pollutant PAHs (plus benzo[*j*,*k*]fluoranthene), PCBs as Aroclors, pesticides, and grain size. Samples from sites located downstream from known sources were also analyzed for dioxins and furans. All analytical procedures followed standard methods approved by the USEPA or the American Society for Testing and Materials (ASTM). Target analyte list (23) metals analysis followed USEPA method 6010D (Revision 4) utilizing inductively coupled plasma-atomic emission spectrometry (Campisano et al., 2017; USEPA, 2014a) and mercury analysis followed USEPA method 7471B utilizing the manual cold-vapor atomic absorption procedure (Campisano et al., 2017; USEPA, 2007a). Concentrations of 16 PAHs were quantitated through USEPA method 8270D using gas chromatography/mass spectrometry (GC/MS) (USEPA, 2014b). Concentrations of PCBs Aroclors and pesticides were determined through USEPA methods 8082A (USEPA, 2007c) and 8081B (USEPA, 2007b), respectively, using gas chromatography. Total organic carbon content was quantitated through USEPA method 9060A via carbonaceous analyzer (USEPA, 2004). Sediment grain size was determined by sieve and hydrometer using ASTM methods D421-85 and D422-63 (ASTM, 2007). Concentrations of dioxins and furans were determined through USEPA method 8290A utilizing high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) (USEPA, 2007d).

Estimated toxicity

The raw data from analysis of individual dioxins and furans, PCBs, PAHs, metals, and pesticides in 71 sediment samples collected in the upper Niagara River, Hoyt Lake, and Smoke Creek are available from the USACE (A. Lenox, unpublished USACE data, April 2021) and, except for summed totals and (or) toxicity quotients, most are not presented herein. The classification of each AOC-impact site as a potential reference site or impaired site was determined through an analysis of the potential toxicity of each constituent group (summed totals) and/or the toxicity of individual constituents based on their measured concentrations in sediment samples collected at all sites and their corresponding Class A SGVs established by New York State (NYSDEC, 2014). The Class A SGV for listed contaminants is essentially a threshold concentration, below which contaminants have been shown to "present little or no potential risk to aquatic life". The NYSDEC (2014) presents Class A SGVs for (a) the total (sum) of all PAHs, (b) sum of 16 organic-carbon normalized PAHs represented as Toxic Units (TUs), (c) dioxin and furan toxic equivalent quotients (TEQs) determined as the sums of individual constituent concentrations multiplied by their toxic equivalency factors and also by their bioaccumulation equivalency factors to standardize toxicity relative to that of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD), (d) nine metals, (e) total PCBs, and (f) 9 of the 21 pesticides (or pesticide degradates) that were measured in sediment samples from many study sites in the Niagara River AOC as described herein. Pesticide (dichlorodiphenyltrichloroethane; DDT) and PCB results at each site are not normalized for organic carbon but rely on the 2 % mean TOC (range 0.3 to 7.4 %) levels estimated at sites with PCB or DDT data.

Sediment guidance values

Sixteen PAHs were analyzed from sediment samples collected at 32 Niagara River impact sites and six source sites in Hoyt Lake. The empirical Class A SGV for total (summed) concentrations of the 16 priority pollutant PAHs is 4.0 mg/kg (NYSDEC, 2014). The USEPA

identified 34 individual PAHs (18 specific non-alkylated compounds and 16 generic alkylated forms), which taken together represent "total" PAHs (USEPA, 2003). Because only 16 priority pollutant PAHs were analyzed and any unmeasured PAHs present in a sample can contribute to toxicity, toxicity of sediment samples using quantitative structure activity relationships (QSAR) for individual PAHs was also estimated (NYSDEC, 2014). In brief, this method normalizes the concentration of each of 34 PAHs (PAH_{34}) to the percent of TOC in a sample, divides those concentrations by their corresponding SGVs (derived from the narcosis model and equilibrium partitioning, based on the *n*-octanol–water partition coefficient (log K_{ow})) for individual PAHs to estimate Toxic Unit (TU) quotients, then sums all individual PAH TUs to calculate a total TU for each sample. Because this procedure relies on data from 34 PAHs, and we only have data for 16 PAHs, we multiplied each TU_{34} by a correction factor of 9.3 to interpolate a total TU_{16} for each sample following NYSDEC, (2014) and USEPA, (2003) guidelines. The Class A SGV for PAHs is 1.0 TU, thus, sediments with a total corrected TU_{16} greater than 1.0 are potentially toxic to aquatic life while those with TUs less than 1.0 should not be toxic (NYSDEC, 2014).

Seven polychlorinated dibenzo-*p*-dioxins (PCDDs) and 10 polychlorinated dibenzo-*p*-furans (PCDFs) or simply "dioxins and furans" were quantified from sediment samples collected at 26 study sites located near Gratwick Park and downstream of the Little Niagara River. Toxic equivalency factors, which equate toxicity of each detected dioxin and furan to an equivalent concentration of the most toxic compound: 2,3,7,8 tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) following Van den Berg et al. (2006) were multiplied by each compound's concentration to estimate individual toxic equivalencies (TEQs), then summed to estimate the total TEQ of each sample (mixture of dioxins and furans) compared to 2,3,7,8-TCDD following NYSDEC, 2014 guidelines. The New York dioxin-furan Class A SGV is 0.5 2,3,7,8-TCDD TEQ in ng/kg at 2 % TOC (which was the mean TOC percentage for all samples). Macroinvertebrates are relatively insensitive to dioxins and furans (Eisler, 1986; Sany et al., 2015; West et al., 1997), thus, sediments with total TEQs less than 0.5 ng/kg should not be toxic to aquatic biota, while sediments with TEQs greater than 0.5 ng/kg could potentially be toxic, especially to species at higher trophic levels.

As many as nine PCB Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268) were assessed in sediment samples collected from 37 impact sites and from six source sites in Hoyt Lake. Total PCB concentrations were calculated as the sum of individual Aroclors (primarily 1242, 1248, 1254, and 1260) where results below detection limits were treated as "0" and results outside calibration limits were used as reported. While the summed totals could be biased high because some congeners are measured in more than one Aroclor (ATSDR, 2000), the method is commonplace and provides for a conservative selection of likely reference sites. The New York total PCBs Class A SGV is 0.1 mg/kg (NYSDEC, 2014), thus, sediments with total PCB concentrations less than 0.1 mg/kg should not be toxic to aquatic life and those with total PCBs greater than 0.1 mg/kg may need further evaluation.

Twenty-one pesticides or their degradates were analyzed from sediment samples collected at 33 impact sites in the Niagara River and at six source sites in Hoyt Lake. Of all the pesticides with New York SGVs (DDT, dichlorodiphenyldichloroethane or DDD, dichlorodiphenyldichloroethylene or DDE, Chlordane, Dieldrin, Endrin, Lindane, Heptachlor, Heptachlor Epoxide, Methoxychlor, and Toxaphene), only the sum concentrations of DDT, DDE, and DDD (termed DDX hereafter) at several sites reached a significant fraction of its Class A SGV of 44 µg/kg at 2 % TOC (NYSDEC, 2014). Accordingly, sediments with DDX concentrations less than roughly 44 µg/kg should not be toxic, and samples with DDX concentrations greater than 44 µg/kg could be toxic to aquatic biota.

Twenty-three metals were analyzed from sediment samples collected at 38 impact sites in the AOC, at six source sites in Hoyt Lake, and at five source sites in Smoke Creek. The New York State Class A SGVs for nine metals: arsenic (10 mg/kg), cadmium (1 mg/kg), total chromium (43 mg/kg), copper (32 mg/kg), lead (36 mg/kg), mercury (0.2 mg/kg), nickel (23 mg/kg), silver (1 mg/kg), and zinc (120 mg/kg) (NYSDEC, 2014) were surpassed in about half of the samples. However, sediments from 16 sites had no metals-SGV exceedances and five sites had only one (usually negligible) metals-SGV exceedance (Table 2). Consequently, sediments with no, or only one metals-SGV exceedance were presumed not to be toxic to aquatic life.

Sediment toxicity assessments

Bed sediments for toxicity testing were collected from 60 VibraCore and Ponar impact sites in the Niagara River and from six source sites in Hoyt Lake and five source sites in Smoke Creek (Fig. 1, Table 1) during 2019 and 2020. Samples were collected in depositional areas with fine-grained sediments using a petite Ponar (0.03 square meter) dredge. At each site, 6 Ponar "grabs" were composited into a bucket, mixed well, and a 4-liter subsample was transferred to a polyethylene container for toxicity analysis. Toxicity samples were kept on ice and shipped to Great Lakes Environmental Center, Inc. (GLEC), where tests were conducted to quantify toxicity to the dipteran *C. dilutus*, and the amphipod *H. azteca*, during 10-day survival and growth bioassays following USEPA test methods 100.2 and 100.1, respectively (USEPA, 2000). *Chironomus dilutus* and *H. azteca* are used as indicator species because they each inhabit broad geographic ranges, are either epibenthic (amphipod) or burrow in sediments (chironomid), and have known sensitivities to common nutrients and toxins (ASTM, 2010; USEPA, 2000).

In brief, toxicity tests for both species were conducted with eight replicates from each sediment sample. Each replicate was composed of 100 mL of sediment and 175 mL of overlying water into which 10 test organisms were added. At the conclusion of the 10-day exposure, the percentage of organisms surviving (hereafter survival), and average ash-free dry weight of all surviving organisms (hereafter growth) were assessed for each replicate. The quality of the data generated by the toxicity tests was assured by (a) testing laboratory-control sediment samples (three in 2019 and five in 2020) to verify that test conditions and the responses of both species met test acceptability criteria, (b) collecting and testing duplicate sediment samples from 3 or 4 sites each year to determine the precision of test endpoints, and (c) daily monitoring of temperature and dissolved oxygen in overlying water as indicated in USEPA (2000). In addition, porewater testing for ammonia (total ammonia as N) was conducted on all samples collected in 2020 upon receipt at the testing facility. All samples had porewater ammonia concentrations below the 20 mg/L threshold except for one site (SC2-1-B) which was mitigated with aeration and twice-daily renewals of overlying water for a period of seven days prior to test initiation following standard procedures (USACE and USEPA, 1998a). Tests were started after ammonia porewater concentrations in all mitigated and unmitigated samples were less than 20 mg/L. Raw toxicity data are available in George et al. (2021).

Benthic community assessments

Bed sediments for benthic macroinvertebrate community assessments were collected from the 60 VibraCore and Ponar impact sites in the Niagara River (Fig. 1, Table 1) at the same time that toxicity samples were obtained. At each site, 6 petite Ponar grabs were collected for each of 3 macroinvertebrate community

Table 1
The reach name, site identification (ID) code, U.S. Geological Survey (USGS) station number, latitude and longitude (in decimal degrees); site depth (in meters), percent fines and total organic carbon (TOC) percentages in sediment; and water temperature (°C) and dissolved oxygen (D.O. in mg/L) concentrations from 1-meter above the bottom at the time of sediment-sample collection at all study sites in the Niagara River Area of Concern, Hoyt Lake, and Smoke Creek where sediment chemistry, toxicity, and benthic communities were assessed in 2018, 2019, and 2020. Most data from George et al. (2021).

Reach name	Site ID	USGS Station Number	Latitude (decimal degrees)	Longitude (decimal degrees)	Depth (m)	Temp (°C)	D.O. (mg/L)	Fines (%)	TOC (%)
Black Rock Canal	BRC1-1	425621078543601	42.93918	−78.90993	8.0	17.4	9.0	3[a]	4.1
	BRC1-2	425617078543301	42.93792	−78.90915	7.8	17.3	7.9	48[a]	2.9
	BRC1-2-D	425619078543301	42.93854	−78.90924	8.0	21.1	7.4	48	2.1
	BRC1-3	425612078543001	42.93674	−78.90846	7.4	21.1	7.5	81	2.8
	BRC1-4-D	425614078543101	42.93749	−78.90885	7.4	21.1	7.7	86	2.4
	BRC1-5-B	425613078543001	42.93706	−78.90846	7.5	21.2	7.5	94	2.7
	BRC1-5-D	425612078543301	42.93670	−78.90917	8.2	20.9	7.1	82	2.3
	BRC1-6-C	425610078542601	42.93629	−78.90748	5.2	21.2	7.7	65	2.8
	BRC1-6-D	425610078543001	42.93616	−78.90855	7.7	21.2	7.6	79	2.8
	BRC1-6-E	425609078542701	42.93584	−78.90763	7.4	21.2	7.5	56	2.1
Gratwick Park	GP-2	430418078570401	43.07178	−78.95123	1.1	18.8	10.0	13[a]	0.9
	GP-21	430319078540801	43.05517	−78.90151	3.0	17.8	11.5	19[a]	2.2
	GP-23	430311078535601	43.05308	−78.89916	1.0	17.7	11.0	53[a]	3.1
	GP-4	430417078565101	43.07182	−78.94683	0.9	19.5	10.3	30[a]	0.3
	GP-5	430412078564101	43.07015	−78.94477	1.0	20.7	8.5	5	0.1
	GP5-1-E	430322078541201	43.05622	−78.90329	2.3	21.1	8.0	48	2.1
	GP5-2-C	430318078540501	43.05530	−78.90158	2.5	21.3	8.1	53	2.4
	GP5-2-D	430318078540401	43.05510	−78.90133	2.5	21.4	8.8	42	2.3
	GP5-4-D	430315078540001	43.05415	−78.90001	2.0	21.2	8.6	59	2.4
	GP5-5-D	430313078535801	43.05345	−78.89954	1.5	21.3	8.7	52	2.4
	GP5-6-A	430312078535701	43.05352	−78.89919	1.5	21.4	8.5	50	2.5
	GP5-6-B	430312078535702	43.05353	−78.89935	2.0	21.2	8.1	53	2.8
	GP5-7-C	430309078535501	43.05259	−78.89871	2.1	21.0	7.9	37	2.5
	GP-6	430403078561801	43.06808	−78.93779	1.0	20.7	12.1	30[a]	0.3
Hoyt Lake	HLSG-10	425559078520901	42.93326	−78.86948	2.0	25.7	6.6	68	7.4
	HLSG-13	425555078520401	42.93215	−78.86794	1.5	25.9	6.9	69	7.3
	HLSG-15	425551078520001	42.93111	−78.86664	1.5	26.3	7.7	65	7.1
	HLSG-2	425605078523101	42.93488	−78.87536	2.7	25.2	6.7	60	8.9
	HLSG-5	425600078522601	42.93345	−78.87411	2.0	25.4	5.5	59	11.0
	HLSG-7	425559078522001	42.93325	−78.87234	2.0	25.7	6.6	64	6.7
Downstream of the Little Niagara River	LNFD-10	430419078584001	43.07229	−78.97749	1.5	19.4	10.1	28[a]	1.0
	LNFD-11	430342078581101	43.06200	−78.96982	2.0	18.3	11.8	53[a]	0.9
	LNFD1-1-C	430424078591801	43.07357	−78.98849	1.2	21.9	10.2	30	0.9
	LNFD-12	430339078581301	43.06071	−78.97020	1.8	18.7	12.5	6[a]	0.9
	LNFD-13	430344078581901	43.06243	−78.97257	1.0	17.8	10.8	17[a]	1.0
	LNFD1-3-C	430425078592501	43.07366	−78.99039	1.5	20.8	8.5	10	0.3
	LNFD-14	430346078582801	43.06317	−78.97408	2.0	17.9	11.4	11[a]	1.0
	LNFD1-4-C	430424078592801	43.07355	−78.99129	2.5	21.6	10.5	11.4	0.5
	LNFD-15	430344078583301	43.06232	−78.97600	1.0	17.8	11.8	19[a]	0.4
	LNFD2-10-C	430424078591301	43.07353	−78.98721	2.0	22.1	10.1	49.4	1.3
	LNFD2-2-C	430422078584001	43.07280	−78.97785	2.0	21.5	8.8	25.5	0.6
	LNFD2-3-C	430421078584301	43.07271	−78.97884	1.0	21.3	8.7	34.2	1.0
	LNFD2-9-C	430423078590801	43.07345	−78.98587	1.6	20.9	7.7	29.8	3.4
	LNFD-5	430426078592101	43.07401	−78.98913	1.2	18.2	9.2	40[a]	5.1
	LNFD-6	430424078591201	43.07350	−78.98697	2.0	20.1	11.8	65[a]	2.0
	LNFD-7	430422078585701	43.07291	−78.98202	1.2	18.7	9.4	52[a]	0.9
	LNFD-9	430419078584701	43.07226	−78.97943	1.4	18.8	10.0	37[a]	0.7
Riverside Park	RS-1	425739078551101	42.96086	−78.91977	1.7	18.8	9.5	49[a]	1.4
	RS-10	425648078543401	42.94680	−78.90956	3.0	17.7	8.8	65[a]	2.2
	RS2-2-B	425714078544001	42.95418	−78.91130	3.7	20.8	9.9	68.0	1.5
	RS2-6-B	425703078543401	42.95121	−78.90982	3.3	21.0	9.0	43.7	2.8
	RS2-6-D	425702078543501	42.95079	−78.90988	4.0	21.2	8.8	28.1	1.9
	RS2-8-B	425655078543401	42.94867	−78.90967	4.8	21.4	9.5	49.0	2.6
	RS-4	425725078545201	42.95719	−78.91457	3.5	17.9	9.1	9[a]	1.6
	RS-7	425712078543801	42.95334	−78.91061	3.5	20.9	8.8	68.1	2.6
	RS-8	425705078543601	42.95163	−78.91014	4.0	21.2	9.4	56.5	1.8
	RS-9	425700078543401	42.95016	−78.90964	3.4	17.8	9.3	31[a]	1.2
Smoke Creek	SC1-8-D	424846078512301	42.81305	−78.85667	3.0	21.0	6.2	65.1	3.6
	SC1-9-D	424847078511901	42.81311	−78.85546	4.0	20.7	6.2	37.0	9.5
	SC2-1-B	424844078511301	42.81232	−78.85387	2.9	20.7	6.3	75.2	3.8
	SC2-5-B	424835078510101	42.80987	−78.85046	2.5	20.9	6.7	54.0	9.3
	SC2-6-B	424837078505801	42.81033	−78.84961	4.0	20.6	5.8	52.3	15.0
South Grand Bridge Island	SGIB1-1	425944078561001	42.99575	−78.93624	2.5	18.9	9.2	40[a]	3.6
	SGIB1-2	425935078561601	42.99322	−78.93783	1.8	18.4	9.2	53[a]	2.0
	SGIB1-3	425931078561901	42.99203	−78.93865	1.2	19.4	9.3	34[a]	1.2
	SGIB1-4	425926078562101	42.99078	−78.93938	1.5	18.3	9.2	83[a]	1.5
	SGIB1-5	425915078562601	42.98761	−78.94073	3.5	18.3	8.9	53[a]	4.1
	SGIB2-1	430000078554901	43.00015	−78.93042	4.8	18.9	9.1	9[a]	2.2
	SGIB2-2	425955078555701	42.99857	−78.93264	3.5	19.3	9.4	55[a]	1.9
	SGIB2-3	425954078555901	42.99815	−78.93307	2.7	19.4	9.4	21[a]	2.8
Tonawanda Harbor	TH1-2	430126078530101	43.02410	−78.88388	2.3	19.1	9.0	29[a]	2.9

[a] Data from 2019 grain size samples were lost due to laboratory error and substituted with percent fines data from VibraCore 0–12″ depth samples collected by the USEPA and USACE in 2018.

replicate samples. The 6 "grabs" forming each replicate sample were composited into a single bucket, then fine sands and organics, silts, and clays were removed by rinsing all material through a 500 μm mesh screen bottom bucket. The remaining debris and invertebrates were preserved in 95 % ethyl alcohol, and shipped to Watershed Assessment Associates, Schenectady, NY, for specimen sorting, identification, and enumeration. Raw community data (and metrics) are available in George et al. (2021).

A 100-organism subsample, or an exhaustive pick (when less than 100 organisms were present), was sorted from each replicate using a gridded tray and identified to the lowest practical taxonomic resolution (usually genus or species). The NYSDEC BAP score for Ponar samples (NYSDEC, 2021) was then calculated for each replicate to assess the condition of macroinvertebrate assemblages at each site. The index calculates five component metrics: species richness, Hilsenhoff Biotic Index (Hilsenhoff, 1987), Dominant-3, Percent Model Affinity (Novak and Bode, 1992), and Shannon-Weiner diversity. The five-component metrics are normalized on a 10-scale and averaged to produce each BAP score, which categorizes water-quality impact using a four tiered scale (severe: 0.0–2.5; moderate: 2.5–5.0; slight: 5.0–7.5; or non-impacted: 7.5–10.0) according to NYSDEC (2021) guidelines. Impact tiers of moderate and severe are usually indicative of impaired biological conditions. The BAP values presented herein are the averages of the scores from the three replicates collected from each Niagara River study site. No benthic community samples were collected at either Hoyt Lake or Smoke Creek.

Mentum deformities

A morphological deformity analysis of midge larvae was performed on all sediment samples as an additional line of evidence for assessing toxicity. Chironomids often dominate benthic communities at sites where sediments consist primarily of clay and silt-sized particles and fine organic material (NYSDEC, 2021). Morphological deformities in organisms, especially mentum (mouthparts) of midge larvae in the genus *Chironomus*, have been associated with toxic levels of contaminants in aquatic environments (Lenat, 1993a; Warwick, 1988). As a result, the frequency and severity of mentum deformities in midge larvae were designated a reliable metric for identifying toxicity in bed sediments from waterbodies of New York State (NYSDEC, 2021). For this analysis, all specimens identified as *Chironomus* sp. were slide mounted and individually examined to determine, if deformities were present, which severity class (I-III) each organism fell into. Class I indicates slight deformities that may resemble chipped teeth. Class II indicates more obvious deformities such as extra or missing teeth, large gaps, or distinct asymmetry. Class III contains the most severe deformities with at least two Class II characteristics present. Indices of deformity frequency and severity were then calculated by (1) calculating the percent of *Chironomus* sp. falling into any severity category (frequency) and (2) multiplying the Class number by the number of deformities in each category, summing, and calculating an average severity score. The frequency and severity indices were then categorized using a four-tiered rating system that ranged from non-toxic to severely toxic as described in NYSDEC (2021). Raw mentum deformity data are available in George et al. (2021).

Habitat characterization

A standard suite of physical and water quality parameters was measured at the time of sediment toxicity and macroinvertebrate community sample collection to evaluate comparability of habitat among sites and any potential effects on benthic community and toxicity results. At each site, water-quality parameters (specific conductance, dissolved oxygen, pH, and temperature) were measured at 1 m above the river bottom using a YSI Professional Plus Multiparameter Water Quality Meter. The grain-size distribution and TOC concentration in sediments collected at each site in 2019 and 2020 were determined from 0.24-L and 0.12-L subsamples of the homogenized toxicity-sample composite, and shipped to RTI Laboratories, Livonia, MI. Grain size was characterized using the ASTM D422–63 method for determining the distribution of particle sizes (ASTM, 2007). The percentage of each sample that was composed of fine sediments (the silt and clay fractions), was calculated as percent by mass able to pass through a No. 200 (75 μm) sieve. Grain size results for all 2019 samples were flawed and replaced with data from the USACE 2018 survey. TOC was measured using method 9060A (USEPA, 2004), reported in mg/kg, and summarized herein as a percentage of total sample weight. Raw habitat characterization data are available in George et al. (2021).

Data analyses

Ten Niagara River impact sites located entirely within the boundaries of the AOC, where measured concentrations or toxicity quotients of PAHs (TUs), PCBs, dioxins and furans (TEQs), pesticides (or pesticide degradates), and most metals were lower than corresponding Class A SGVs, were classified as "reference" sites as described in the results section. Toxicity results from these 10 reference sites (Table 2) were then used to gauge the level and significance of sediment toxicity in the other 61 study sites (50 impact and 11 source sites). Mean survival and growth of *C. dilutus* and survival of *H. azteca* in sediments from the 10 reference sites were compared to the same endpoints from each of the other 50 Niagara River, 6 Hoyt Lake, and 5 Smoke Creek sites using a one-way ANOVA and Welch's *t*-test (Welch's ANOVA) with the Games-Howell multiple comparisons procedure to determine if the metrics differed significantly. The Welch *t-test* is robust as it does not assume homogeneous data; thus, it is a suitable substitute for the *F-test* when assessing means from multiple populations where sample sizes and variability differ. For AOC-wide analyses, the same Welch's ANOVA (without the Games-Howell procedure) was used to evaluate the significance of differences in mean toxicity endpoints or biological metrics from all 10 reference sites and the same mean endpoint or metric from all 50 (pooled) impact sites. All tests considered a type I error rate of 5 % or less to be acceptable, thus, *P*-values less than or equal to 0.05 were treated as statistically significant. Sediments were considered to be toxic, i.e., "*have unacceptable adverse impacts on benthos*", according to USACE and USEPA (1998a) and USACE and USEPA (1998b) if any of the following criteria were met:

(a) mean mortality of *C. dilutus* in sediments from a site was more than 20 % greater (or survival was more than 20 % lower) than mean mortality in sediments from the reference sites ***and*** the difference was statistically significant, ***or***
(b) mean mortality of *H. azteca* in sediments from a site was more than 10 % higher (or survival was more than 10 % lower) than mean mortality in sediments from the reference sites ***and*** the difference was statistically significant, ***or***
(c) mean weight (growth) of *C. dilutus* was less than 0.6 mg per organism ***and*** the mean weight was more than 10 % lower than the mean weight of *C. dilutus* in sediments from the reference sites ***and*** the difference was statistically significant.

Sites with results that met one or more of these criteria were potentially impaired by toxic contaminants or inhospitable habitat. Sites that did not meet these criteria were subsequently categorized as likely unimpaired by contaminants and (or) poor habitat in situ.

Table 2
Individual or summed (total) concentrations of DDX (sum of dichlorodiphenyltrichloroethane, dichlorodiphenyldichloroethylene, and dichlorodiphenyldichloroethane), polychlorinated biphenyls (PCBs), and 16 polycyclic aromatic hydrocarbons (PAH_{16}); Toxic Units corrected for 16 PAHs (TU_{16}); concentrations of cadmium, mercury, and lead; the number of metals that did not exceed their New York State Department of Environmental Conservation (NYSDEC) Class A Sediment Guidance Values (SGVs); Toxic Equivalent Quotients (TEQs) for dioxins and furans; and the percentage total organic carbon in sediment samples collected from study sites in the Niagara River Area of Concern by the U.S. Army Corps of Engineers (USACE) primarily during 2018. Green-shaded cells indicate the measurement or derived metric was generally less than their corresponding Class A SGV and pink-shaded cells indicate the measurement or metric was greater than their Class A SGV as listed in notes below; red site IDs denote reference sites; ND = not detected. Data from A. Lenox, unpublished USACE data (April 2021).

Site ID	Total DDX[1] (µg/kg)	Total[2] PCB (mg/kg)	Total[3] PAH_{16} (mg/kg)	Corrected[4] PAH TU_{16}	Cadmium[5] (mg/kg)	Lead[6] (mg/kg)	Mercury[7] (mg/kg)	No. of 9 metals w/SGV < Class A value[8]	Total dioxin-furan TEQ[9] (ng/kg)	Total organic carbon (%)
BRC1-1	ND		1.55	1.44	0.096	6.2	0.018	9		0.3
BRC1-2	4.1	0.6	4.18	3.88	3.7	147	0.61	0		2.4
BRC1-2-D		1.1								3.4
BRC1-3	6.1		2.42	2.25	4.8	164	0.44	0		2.6
BRC1-4-D		0.32								4.0
BRC1-5-B		0.99								4.2
BRC1-5-D		0.29								3.8
BRC1-6-C					2.6	183	0.25	2		
BRC1-6-D		0.45								5.3
BRC1-6-E		0.47								4.4
GP-2	ND	0.05	1.60	1.49	0.097	9	0.039	9	37.1	0.3
GP-21	ND	ND	38.70	35.99	0.21	44.2	0.18	8	1.2	2.3
GP-23	ND	0.16	0.41	0.38	4.6	143	1.1	2	4541.9	3.4
GP-4	ND	ND	0.05	0.05	ND	4.4	0.037	9	0.6	0.5
GP-5	ND	ND	0.14	0.13	0.12	4.1	ND	9	1.0	0.3
GP5-1-E									113.5	3.2
GP5-2-C									132.5	4.1
GP5-2-D									12624.4	3.7
GP5-4-D									294.3	3.0
GP5-5-D									363.7	3.6
GP5-6-A									295.7	3.6
GP5-6-B									56.8	3.5
GP5-7-C									131.1	3.8
GP-6	ND	ND	0.003	0.003	ND	6.2	ND	9	0.5	0.4
HLSG-10	18	0.26	14.55	13.54	6.4	130	0.24	2		5.4
HLSG-13	21	0.41	20.97	19.50	6.4	150	0.27	2		6.2
HLSG-15	19	0.38	41.97	39.04	5	150	0.18	4		5.7
HLSG-2	ND	0.22	1.25	1.16	7	140	0.18	2		7.4
HLSG-5	21	0.31	1.53	1.42	6.7	140	0.17	3		6.3
HLSG-7	18	0.30	0.82	0.76	5.9	110	0.23	2		4.9
LNFD-10	2.2	0.01	0.45	0.41	0.12	6.1	0.042	9	2.1	0.5
LNFD-11	ND	ND	1.41	1.32	0.1	19.3	0.056	9		1.0
LNFD1-1-C									23.4	1.7
LNFD-12					ND	3.6		9		
LNFD-13	7.7	0.04	4.31	4.01	0.51	26.2	0.14	7		2.0
LNFD1-3-C									33.3	0.9
LNFD-14	0.2	0.01	0.07	0.07	0.14	4.6	ND	9		0.9
LNFD1-4-C									70.1	2.1
LNFD-15	ND	ND	0.16	0.15	ND	3.3	0.04	9		0.3
LNFD2-10-C									46.4	2.7
LNFD2-2-C									53.0	1.6
LNFD2-3-C									74.2	1.6
LNFD2-9-C									26.9	8.6
LNFD-5	ND	0.43	1.25	1.16	0.68	33.8	0.54	7	501.6	0.9
LNFD-6	1.9	0.12	1.53	1.42	1.1	47.6	0.48	3	179.1	3.0
LNFD-7	2.1	0.23	0.82	0.76	0.51	58.6	0.46	5	173.1	2.0
LNFD-9	ND	ND	0.01	0.01	ND	6.2	ND	9	0.3	0.6
RS-1	ND	ND	0.58	0.54	0.1	8.3	ND	9		0.7
RS-10	12.6	ND	0.65	0.60	1.4	299	1.2	2		2.9
RS2-2-B					11.7	30.2	0.12	5		
RS2-6-B					0.62	210	ND	8		
RS2-6-D			6.63	6.16						6.0
RS2-8-B					4.4	193	1.5	0		
RS-4	ND	ND	0.01	0.01	ND	3.8	ND	9		0.5
RS-7	ND	0.10	1.59	1.48	1.3	59.4	0.42	2		2.4
RS-8	ND	0.09	4.73	4.40	4.1	166	1.3	2		3.3
RS-9	5.3	0.07	39.36	36.61	1.8	174	0.79	1		2.9
SC1-8-D					1.5	189	0.17	1		
SC1-9-D					7.6	541	0.36	1		
SC2-1-B					2.2	278	0.25	0		
SC2-5-B					4.3	711	0.21	1		
SC2-6-B					5.1	753	0.12	2		
SGIB1-1	0.92	0.22	7.93	7.37	0.44	35.3	0.12	7		1.1
SGIB1-2	ND	ND	0.04	0.03	0.1	6.5	ND	9		2.1
SGIB1-3	ND	0.01	0.06	0.05	ND	11.5	0.021	9		3.1
SGIB1-4	ND	ND	0.53	0.49	0.26	60.4	0.56	4		0.6
SGIB1-5	2.4	0.86			0.62	62.5	0.26	2		0.9
SGIB2-1	2.4	0.43	8.67	8.06	0.91	72.6	0.31	3		2.2
SGIB2-2	ND	0.004	0.27	0.25	ND	9.7	0.024	8		0.8
SGIB2-3	0.14	0.02	2.10	1.95	0.083	10.2	0.028	9		0.5
TH1-2	9.7	0.52			0.26	86	0.14	8		0.4

[1]NYSDEC Class A SGV for Total DDX < 44 µg/kg, Class C SGV > 48,000 µg/kg.
[2]NYSDEC Class A SGV for Total PCB < 0.1 mg/kg, Class C SGV > 1.0 mg/kg.
[3]NYSDEC Class A SGV for Total of 16 PAHs < 4.0 mg/kg, Class C SGV > 35.0 mg/kg.
[4]NYSDEC Class A SGV corrected for 16 PAHs, TU < 1.0.
[5]NYSDEC Class A SGV for cadmium < 1.0 mg/kg, Class C SGV > 5 mg/kg.
[6]NYSDEC Class A SGV for lead < 36 mg/kg, Class C SGV > 130.0 mg/kg.
[7]NYSDEC Class A SGV for mercury < 0.2 mg/kg, Class C SGV > 1.0 mg/kg.
[8]NYSDEC Class A SGVs available for 9 of 23 analyzed metals.
[9]NYSDEC Class A SGV for total dioxin/furans TEQ < 0.5 ng/kg, Class B SGV > 0.5 ng/kg at 2 % TOC.

Similarly, the three biological metrics (the macroinvertebrate-community BAP scores, frequency of mentum deformities, and severity of mentum deformities) at the 10 reference sites were used to assess the health of benthic communities and potential effects of toxicants on chironomids at all other 50 impact sites. Mean metrics from all 10 pooled reference sites were compared to the same metrics from each of the other 50 impact sites using Welch's ANOVA and the Games-Howell multiple comparisons procedure to determine if any metric differed significantly. For the AOC-wide assessments, the same Welch's ANOVA was used to evaluate the significance of differences in mean biological metrics from all 10 pooled reference and the corresponding mean metrics from the 50 pooled impact sites.

Results

Sediment contaminants and SGVs

Each of the concentrations or quotients that characterize: (a) total or sum of 16 PAHs, (b) total estimated PAH TU_{16}, (c) total dioxin and furan TEQs, (d) nine heavy metals, (e) total PCBs, and (f) 9 pesticides (or their degradates) measured in sediment samples from selected sites in the AOC were compared to their respective Class A SGVs listed in NYSDEC (2014) to determine the potential for, or the lack of, toxicity and impairment of local benthic macroinvertebrate communities. All comparisons are summarized in Table 2, and taken together, identify which sites may be classified as a reference and which sites may be classified as potentially toxic. The sum (total) of 16 PAHs (PAH_{16}) were less than the Class A SGV of 4.0 mg/kg in sediments at 27 of 38 sites where they were assessed. Total TU estimates corrected for 16 PAHs were less than the Class A SGV of 1.0 in sediments at 17 of the 38 sites. Total dioxin and furan TEQs were equal to, or less than, the Class A SGV of 0.5 ng/kg in sediments from 2 of 26 sites where dioxins and furans were assessed, and slightly above 0.5 (0.6) at 1 other site (Table 2). Total PCBs were less than their Class A SGV of 0.1 mg/kg in sediments from 21 of 43 sites where nine Aroclors were analyzed. Except for detections of DDT or its byproducts (DDE and DDD) at as many as 19 sites and *beta*-chlordane at all six Hoyt Lake sites (averaging 0.024 mg/kg), almost all other pesticides (or pesticide degradates) were below instrument detection limits. The New York Class A SGV for total DDX of 44 µg/kg was not exceeded in sediments from any site where DDT, DDE, or DDD were detected (Table 2). The individual Class A SGVs for 8 or 9 of the metals with NYSDEC SGVs were not exceeded in sediments from 20 of the 49 sites where metals were assessed (Table 2). The concentration of nickel at SGIB2-2 (23.3 mg/kg) was only slightly above its Class A SGV of 23.0 mg/kg. Consequently, sediments with one or no metal Class A SGV exceedances and total PAHs, total PAH TU_{16}, dioxin and furan TEQs, PCBs, and DDX levels below their corresponding Class A SGVs were presumed to be non-toxic to aquatic life. Reference-site criteria for all constituent groups were met at 10 upper Niagara River impact sites (GP-4, GP-6, LNFD-14, LNFD-15, LNFD-9, RS-1, RS-4, SGIB1-2, SGIB1-3, and SGIB2-2) and were classified as such in Table 2.

Toxicity test quality assurance

Due to the large number of sediment samples collected over 2 years, 10-d *C. dilutus* toxicity tests were conducted in 5 separate batches, and 10-d *H. azteca* toxicity tests were conducted in 3 separate batches, each with their own laboratory controls. Toxicity data are available in George et al. (2021). The mean survival (96.3 %) and growth (1.27 mg) of *C. dilutus* exceeded minimum test acceptability criteria of 70 % and 0.48 mg (USEPA, 2000), respectively, in all sediment and water laboratory controls during the five sets of toxicity tests. Similarly, the mean survival (96.7 %) of *H. azteca* in controls exceeded the minimum laboratory-control acceptability criteria of 80 % and exhibited measurable growth in sediment and water laboratory controls during the three sets of toxicity tests. Toxicity test results from the seven pairs of duplicate sediment samples (three pairs from 2019 and four pairs from 2020) found that the relative percent difference between duplicates was generally small and acceptable; it averaged 11.7 % for survival of *C. dilutus*, 11.8 % for growth of *C. dilutus*, 7.1 % for survival of *H. azteca*, and 12.9 % for growth of *H. azteca*. These quality-assurance data indicate that test-acceptability criteria were met and that results can be treated as valid measures of sediment toxicity.

Toxicity test results

The raw survival and growth data for *C. dilutus* and *H. azteca* exposed to sediments collected from 71 Niagara River, Hoyt Lake, and Smoke Creek sites during 2019 and 2020 are organized and presented by year, site, date, species, and replicate in George et al. (2021). The mean survival of *C. dilutus* in sediments from 7 of the 61 study sites was significantly less than the mean survival at the 10 reference sites (84.6 %) and also fell below a toxicity threshold of 64.6 % (84.6 % minus 20 %) (Fig. 2A) as defined in the methods section. Six of those 7 sites were in source areas (Hoyt Lake and Smoke Creek) while only 1 site (RS2-6-B) was within the AOC-impact area. Thus, *C. dilutus* mortality only met conditions for toxicity in 1 (2 %) of the 50 impact sites (excluding the 10 reference sites) in the Niagara River. The mean growth of *C. dilutus* in sediments from 11 of 61 study sites was significantly less than the mean growth at the 10 reference sites (1.64 mg) but only 7 of these sites were in the AOC-impact area (Fig. 2B). In contrast, growth of *C. dilutus* only fell below the minimum growth criterion of 0.6 mg (as defined in the methods section) at 1 impact site (SGIB1-5). Thus, all *C. dilutus* mortality and growth results indicate that sediments were potentially toxic at only 2 (3 %) of the 60 individual impact sites (including the 10 reference sites) in the upper Niagara River. In the comprehensive AOC-wide analysis, mean survival and growth of *C. dilutus* at all 10 reference sites did not differ significantly from mean survival (83.9 %) and growth (1.35 mg) at the other 50 impact sites (*Welch t-statistic* = 0.017, *Df1* = 1, *Df2* = 11.5, *P* = 0.899 and *Welch t-statistic* = 3.657, *Df1* = 1, *Df2* = 12.1, *P* = 0.080, respectively).

Mean survival of *H. azteca* in sediments from 9 of the 61 study sites fell below the toxicity threshold of 85.2 % and was significantly less than mean survival at the 10 reference sites (95.2 %)

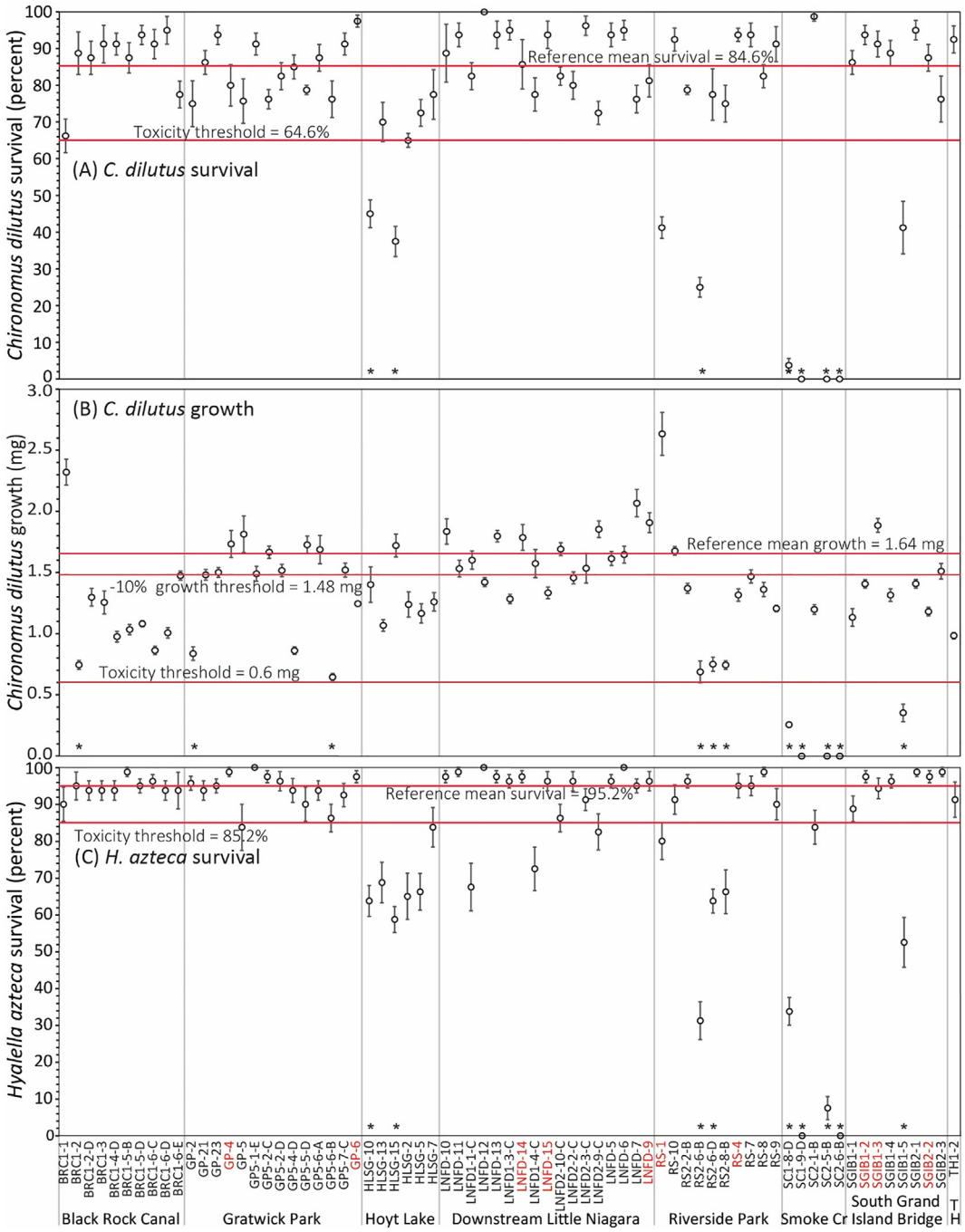

Fig. 2. Mean (symbols) and standard errors (whiskers) for (A) survival and (B) growth of *Chironomus dilutus* and (C) survival of *Hyalella azteca* in eight replicate, 10-d toxicity tests with sediments collected from 60 sites in the Niagara River Area of Concern, six source sites in Hoyt Lake, and five source sites in Smoke Creek during June 24–26, 2019 and June 22–25, 2020. Mean survival and growth at reference sites (IDs highlighted in red), and criteria for toxicity are denoted by labeled red threshold lines; TH = Tonawanda Harbor; and sites with metrics that are significantly lower ($P \leq 0.05$) than those at pooled reference sites are denoted by an asterisk on the x-axis.

(Fig. 2C). Six of these sites were in AOC-source areas and 3 sites (SGIB1-5, RS2-6-B, and RS2-6-D) were within the AOC-impact area, thus, the toxicity criteria for *H. azteca* were only met in 3 (5.0 %) of the 60 individual impact sites (including the 10 reference sites) in the upper Niagara River. In the AOC-wide analyses, mean survival of *H. azteca* at the 10 reference sites (95.2 %) was slightly higher but not significantly different from mean survival at the other 50 impact sites (90.0 %) (*Welch t-statistic* = 4.031, *Df1* = 1, *Df2* = 33.67, *P* = 0.053).

Macroinvertebrate communities and habitat

On average, 98 % of specimens at all study sites were chironomids and oligochaetes, with an average of 77 % Diptera-family Chironomidae (56 % were *Chironomus* sp. but also 1-to-5 % *Cricotopus*, *Polypedilum*, and *Procladius* spp. or groups) and 21 % Tubificidae-family Naididae (primarily *Aulodrilus limnobius* and *Limnodrilus hoffmeisteri*) collected at each site (George et al., 2021). The depths, fines, and TOC averaged 3.1 m (min 0.9 m, max 8.2 m), 43 % (min

3 %, max 94 %), and 1.9 % (min 0.1 %, max 5.1 %), respectively, at the 60 Niagara River sites sampled in 2019 and 2020 (George et al., 2021). The integrity of macroinvertebrate communities, as represented by mean BAP scores, ranged from 0.15 (at GP5-2-D) to 5.12 (at RS2-8-B) and varied moderately among the 60 impact sites (Fig. 3A). Benthic communities were not surveyed at the 11 sites in Hoyt Lake and Smoke Creek; therefore, corresponding community metrics and mentum-deformity data are not available. According to NYSDEC classifications in Fig. 3A, almost all benthic communities appear to be moderately-to-severely impacted. The lowest BAP scores were generally found at sites in the Black Rock Canal and Gratwick Park study areas, while the highest BAP scores were commonly noted at sites in the Riverside Park (RP) and South Grand Island Bridge study areas. Contaminant concentrations in sediments from all 10 reference and most impact sites, however, were below the NYSDEC Class C SGVs "*considered to be highly contaminated and likely to pose a risk to aquatic life*" (NYSDEC, 2014). This indicates that contaminated sediments were not the main rea-

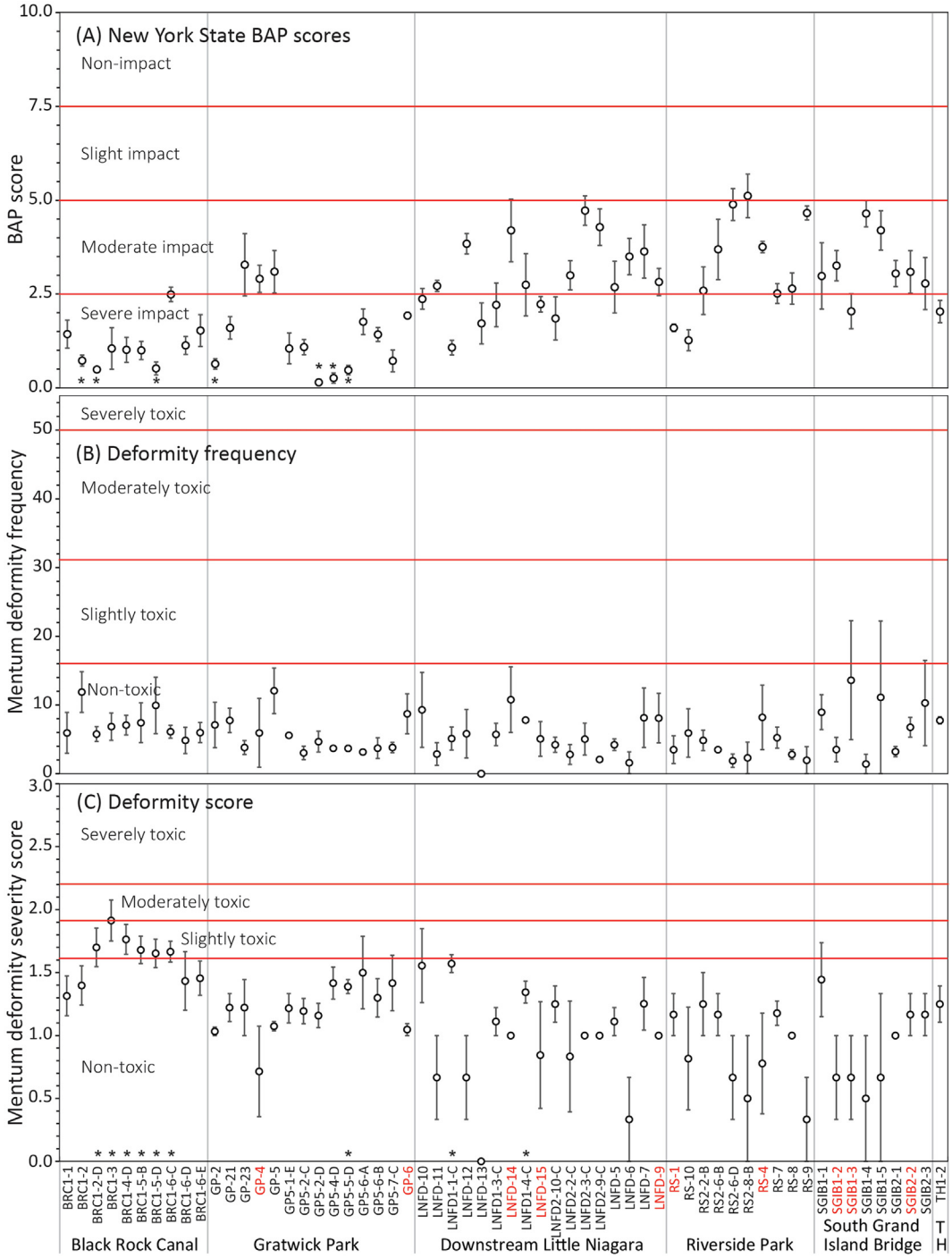

Fig. 3. Mean (symbols) and standard errors (whiskers) for (A) New York State Biological Assessment Profile (BAP) scores, (B) frequency of mentum deformities, and (C) deformity severity score for *Chironomus* sp. collected from 60 sites in the Niagara River Area of Concern during June 24–26, 2019 and June 22–25, 2020. The BAP impact categories and thresholds for no, slight, moderate, and severe impact are denoted by labeled red lines; TH = Tonawanda Harbor; and sites with metrics that are significantly lower (BAP scores) or higher (deformity frequency and severity index) ($P \leq 0.05$) than those at pooled reference sites (IDs highlighted in red) are denoted by an asterisk on the x-axis.

son for low BAP scores at most sites. Results from Welch's ANOVA and Games-Howell multiple range tests indicate that the BAP scores at 7 (15 %) of the other 50 impact sites (GP-2, GP5-2-D, GP5-4-D, GP5-5-D, BRC1-2, BRC1-2-D, and BRC1-5-D) were significantly lower than the mean BAP score for the 10 reference sites (2.78) (Fig. 3A). However, an AOC-wide analysis indicates that the mean BAP score for the 10 reference sites and all 50 impact sites (2.29) did not differ significantly (Welch *t-statistic* = 2.296, *Df1* = 1, *Df2* = 20.36, *P* = 0.145).

Mentum deformities

The frequency and severity of mentum-deformities for *Chironomus* sp. are available in George et al. (2021) and provide additional evidence that sediments throughout the Niagara River AOC are generally not toxic to benthic macroinvertebrates. The frequency of mentum deformities at all sites averaged 5.7 % (range 0 % to 13.6 %) and fell below the 16 % frequency threshold for slight toxicity (NYSDEC, 2021) in all samples from the 50 impact and 10 reference sites (Fig. 3B). Results from Welch's ANOVA and multiple range tests indicate that the mean frequency of deformities at none of the impact sites were significantly higher than the mean frequency of deformities at the 10 reference sites (7.4 %) (Fig. 3B). A broad AOC-wide analysis also indicates that there is no significant difference in mean frequency of deformities observed at the 10 reference and at the remaining 50 impact sites (5.4 %) (Welch *t-statistic* = 3.503, *Df1* = 1, *Df2* = 12.0, *P* = 0.086) in the Niagara River. Excluding class I deformity counts (Burt et al., 2003), produces more conservative frequencies that were on average 70 % lower (mean = 1.7 %; range 0 % to 11.1 %) than those using all 3 deformity classes. The lower 95 % confidence intervals for these frequencies (not shown) at all but 1 Niagara site (BRC1-4-D) were below the upper 95 % confidence interval (2.66 %) for *Chironomus* deformity frequencies from reference sites identified in 8 waterbodies across the Great Lakes (Burt et al., 2003) which adds support to the assertion that sediment toxicity does not adversely affect benthic communities at most AOC-impact sites in the upper Niagara River.

The mean mentum-deformity severity scores ranged from 0 to 1.91 and 54 of the 60 impact sites fell into the non-toxic class (0 to 1.6) (Fig. 3C). Five sites fell into the slightly toxic class of 1.6 to 1.9 (BRC1-2-D, BRC1-4-D, BRC1-5-B, BRC1-5-D, and BRC1-6-C) and BRC1-3 barely reached the moderately toxic class (Fig. 3C). Results from the Welch's ANOVA and multiple range tests indicate that the mean severity score at the 10 reference sites (0.91) was significantly lower than mean scores at 9 impact sites (6 Black Rock Canal sites and GP5-5-D, LNFD1-1-C, and LNFD1-4-C) (Fig. 3C). The AOC-wide analysis indicates the mean severity score was significantly higher at the 50 impact sites (1.16) than the mean score at the 10 reference sites (0.91) (Welch *t-statistic* = 8.801, *Df1* = 1, *Df2* = 27.43, *P* = 0.006). This relatively small difference, however, does not infer widespread toxicity because the severity score for all but 6 sites fell into the non-toxic class.

Discussion

The ability to gauge the condition of benthic communities and the benthos BUI in the Niagara River AOC is limited for some obvious reasons. The Niagara River essentially functions as a strait between Lake Erie and Lake Ontario, draining four of the five Great Lakes, thus, its AOC encompasses the entire system and has no nearby and comparable reference reaches or rivers. The status of the benthic macroinvertebrate community (benthos) BUI in most (not all) AOCs of the Great Lakes has typically been evaluated using direct comparisons to assemblages from physically similar sites in nearby (primarily upstream or adjacent) systems that are outside the AOC boundaries and represent regional conditions. For example, the condition of the benthos at sites within the St. Lawrence River at Massena/Akwesasne AOC was evaluated by comparing benthic communities at AOC sites to those at reference sites located outside the AOC boundaries in the St. Lawrence River itself and in upstream segments of several tributaries (Duffy et al., 2016). Similar comparisons were made between benthic communities sampled at sites in the Eighteenmile Creek AOC and in the nearby reference Oak Orchard Creek (George et al., 2017). Just as important, extensive channel alterations (e.g., hardened, deepened, canalized), dreissenid mussel dominance in some reaches, and organic-rich (fine) deposits often create hypoxic sediments in the Niagara River which deters typical riverine benthic communities. George et al. (2022), for example attributed differences in the condition of benthic communities at upstream-reference and downstream-AOC sites in the Buffalo River, not to contaminated sediment and toxicity, but to high TOC content of sediments and dense dreissenid mussel populations in the AOC reach. Our effort to identify and classify reference sites inside this Niagara River AOC eliminates one barrier to assessing BUIs in this AOC and, like the weight-of-evidence approach of Chapman et al. (2002), can serve as a model for other multinational connecting-channel AOCs (e.g., Detroit River and St. Marys River), where appropriate reference rivers and sites may be lacking. The use of sediment chemistry, toxicity, and habitat data also helps to explain the condition of benthic communities and to interpret their differences among contaminated and uncontaminated sites in the AOC.

Our novel study design and data analyses indicate that the lack of a comparable reference system, needed to assess conditions in the Niagara River AOC, is not an insurmountable problem. The undetectable or low concentrations of pervasive contaminants in sediments from at least 10 impact sites indicate that these locations can represent reference conditions in the upper Niagara River. While contaminant levels at these locales may not indicate pristine environments, they reflect the best attainable (background) settings that likely exist in this river and across the region. In fact, the concentrations or levels of total PCBs and PAHs, most individual metals, PAH TU_{16}, and dioxin and furan TEQs in sediments from those 10 sites did not exceed their NYSDEC Class A SGVs. The absence of significant effects on mortality and growth of *C. dilutus* and *H. azteca* in sediments from these sites, according to the USACE and USEPA (1998a) criteria, confirms that contaminant levels are largely tolerable to some (maybe most) invertebrate species, and supports their designation as reference sites. Thus, the toxicity endpoints and macroinvertebrate-community and mentum-deformity metrics from these 10 reference sites are undoubtedly the most suitable benchmarks against which to judge the condition (impairment) of benthic communities at other sites in the Niagara River AOC.

The multiple comparisons between toxicity endpoints, community BAP scores, and chironomid mentum deformity (severity) scores at the 10 reference sites and each of the impact sites identified no broad or AOC-wide impacts but several potential localized impairments. In general, mean survival and growth *of C. dilutus*, survival of *H. azteca*, benthic-community BAP scores, and frequency of chironomid mentum deformities at all 50 impact sites did not differ significantly from corresponding means at all 10 reference sites and indicate that sediment contaminants are currently not a widespread or AOC-specific issue. High levels of toxicity, however, were evident in sediments from many source sites, as well as a few impact sites. For examples, mean survival and growth of *C. dilutus* and survival of *H. azteca* at several Smoke Creek and Hoyt Lake sites exceeded toxicity thresholds and were significantly lower than that at the reference sites. While mean growth of *C. dilutus* also fell below the toxicity threshold of 0.6 mg at SGIB1-5, mean mortality of both species exceeded toxicity thresholds (and

differed significantly from reference sites) at impact sites SGIB1-5, RS2-6-B, and RS2-6-D. In addition, mean BAP scores were significantly lower than those at reference sites and mentum deformity severity indices indicated slight to moderate toxicity at 5 to 6 Black Rock Canal sites. Thus, the toxicity endpoints indicate that sediments at 6 source sites and at least 3 impact sites may be toxic to benthic communities and the deformity severity and BAP scores indicate that sediments from 6 or 7 Black Rock Canal and Gratwick Park impact sites could be marginally harmful to local biota. While comparisons between the 10 reference sites and individual impact sites indicate some contaminant hotspots persist in the Niagara River, AOC-wide analyses (pooled sites) indicate that no significant sediment contamination issues remain within the impact area.

The high levels of mortality and toxicity observed in sediments at six source sites was anticipated, but high and significant mortality at impact sites SGIB1-5, RS2-6-B, RS2-6-D, and possibly others, indicate that some contaminants still surpass toxic concentrations in parts of the upper Niagara River. Comparing SGV Class C thresholds to concentration of selected contaminants at sites with significant toxicity provides insight into the probable source(s) of toxicity, potential threats they pose to local benthic communities, and possible need for remediation. Sediments with contaminant levels that surpass their SGV Class C thresholds are considered to be "*highly contaminated and likely to pose a risk to aquatic life*" according to NYSDEC, (2014) and identify them as likely sources of any acute or chronic toxicity observed in toxicity tests. In the Smoke Creek source area, concentrations of silver, nickel, and zinc (not shown) and cadmium and lead exceeded their SGV Class C thresholds at 1 to 5 sites (Table 2). In another source area, Hoyt Lake, concentrations of zinc (not shown) and cadmium, lead, total PCBs, and total of 16 PAHs also surpassed their SGV Class C thresholds at 5 to 6 sites (Table 2). Significant toxicity was not evident at sites in the Black Rock Canal AOC-impact reach, but chironomid mentum-severity indices indicated sediments were slightly to moderately toxic. Concentrations of zinc and copper (not shown), lead, and total PCBs were near or above their SGV Class C thresholds at 2–3 Black Rock Canal sites, including BRC1-2-D (Table 2). In the Riverside Park impact reach, concentrations of total PAHs exceeded its SGV Class C threshold at RS-9 and approached it at RS2-6-D, while concentrations of lead surpassed its SGV Class C threshold at 5 Riverside Park sites, including RS2-6-B (Table 2). Concentrations of mercury and cadmium (Table 2) and zinc, copper, and chromium (not shown) were also close to, or surpassed, their respective SGV Class C thresholds at 3, 1, 4, 4, and 2 Riverside Park sites, respectively. In the South Grand Island Bridge AOC-impact reach, concentrations of total PCBs fell into its SGV Class B range (NYSDEC, 2014) at one site, SGIB1-5 (Table 2). While concentrations of PCBs, PAHs, metals, and pesticides (or pesticide degradates) were not an issue at impact sites in Gratwick Park and downstream of the Little Niagara reaches, total dioxin and furan TEQs far exceeded their SGV Class B threshold of 0.5 ng/kg at nearly all sites in both reaches (Table 2). Benthic invertebrates, however, are relatively insensitive to dioxins and furans (Eisler, 1986; Sany et al., 2015; West et al., 1997), so their concentrations should not drive toxic responses nor be correlated with the health of benthic communities in situ. Because sediments at study sites (and reaches) typically contain a mix of contaminants, the specific agents responsible for toxicity, and which could impair benthic communities, may require further investigation to confirm the exact source(s) of observed effects and (or) to help devise effective strategies for any remedial actions.

At first glance, the very low BAP scores which indicate moderate to severe impact at all study sites, indicate the benthos are highly impaired by contaminated water or sediments throughout the Niagara River AOC. This inference, however, may be refuted by several arguments. First, while the BAP scores at 7 impact sites were significantly different from the mean score at the 10 reference sites and classified as severely impacted, the AOC-wide assessment found no significant difference in the mean BAP scores from the 10 reference and the 50 impact sites. Second, contaminant concentrations were less than all Class A SGVs in sediments at four reference sites (GP-6, LNFD-15, RS-1, and SGIB1-3) which were also classified by their BAP scores as severely impacted. Third, the BAP scores classified all reference sites as moderately to severely impacted, but all sites were consistently classified as non-toxic based on toxicity-test results and the frequency and severity of mentum deformities. Since chironomid mentum deformities have been related to toxic contaminants (Warwick, 1988) and they are not reactive to severe organic loading (Lenat, 1993b), they would have presented evidence of contaminants at reference sites if any exceeded toxic levels. Such conditions would assuredly affect local benthic communities because chironomids were one of the most abundant taxa at our study sites. Fourth, and maybe most important, the BAP metrics and summary scores derived from macroinvertebrates collected at impact sites may not be properly calibrated to conditions in the upper Niagara River. The BAP metrics for Ponar samples from soft sediments were originally calibrated to detect water-quality degradation in large rivers with moderate velocities and a mix of fine to coarse bed sediments. Waters in most reaches of the Niagara River flow at relatively high velocities. However, to obtain sediments for toxicity testing and invertebrate identification and enumeration, our sampling efforts had to be located where coarse substrates were rare or absent (to ensure Ponar closure) and fines (e.g., clay, silt, and particulate organic matter that can adsorb pollutants) were plentiful. In the Niagara, these conditions were most prevalent in backwaters where flows were stagnant and very fine sediments and decomposing organic matter accumulated. And, because all sites were only a short distance downstream from Lake Erie, they naturally acquired depositional materials from that lake. As such, the thermal, chemical, and physical conditions at most of our slack-water study reaches were more representative of lacustrine bays or harbors in Lake Erie than they were characteristic of a large fast-flowing river. The macroinvertebrate species and their assemblages at most Niagara River sites would certainly not reflect assemblages typically found at uncontaminated riverine sites which were used to calibrate the NYSDEC Ponar BAP (NYSDEC, 2021). Taken together, these points support the thesis that local benthic communities and low BAP scores at all impact sites in the upper Niagara River do not truly reflect high contaminant levels, toxicity, or biological impairment.

The notion that sampled benthic communities in the upper Niagara River are more characteristic of lentic rather than lotic habitats, and that Ponar BAP categories do not correctly characterize the levels of impairment in similar lentic environments, may be justified by the similarities between Niagara River assemblages and those encountered at non-AOC sites in adjacent lakes and bays as well as in some moderately-sized and slack-water rivers. In the upper Niagara River, community richness averaged 10 species (min 5, max 18) and the BAP scores averaged 2.4 (min 0.2, max 5.1) which classified 59 of 60 sites as moderately or severely impacted. In addition, during 2019 and 2020 surveys nearly all benthic invertebrates collected in the Niagara River were chironomids and oligochaetes, site depths averaged about 3 m, and percent fines and TOC in sediments averaged around 43 % and 2 %, respectively. While relatively few macroinvertebrate datasets are available from the upper Niagara River, results from several studies indicate that benthic communities at some nearshore or embayment sites in Lakes Erie or Ontario (and some rivers) were comparable to those found in this system. For example, on average, chironomid and tubificid worm taxa totaled 88 % of all specimens and Ponar BAP scores averaged 2.7 at three sites surveyed in Irondequoit Bay

(near Rochester NY), where depths ranged from 1 to 10 m, fines averaged 76 %, and TOC averaged 1.9 % during July 2002 (NYSDEC, 2007). In nearby Lake Ontario, Duffy et al. (2017) used a modified "embayment" BAP (eBAP) to characterize the status of benthic communities at sites sampled in and near the Rochester Embayment AOC because the standard Ponar BAP generated low scores (due mostly to dense dreissenid populations) and was considered inappropriate at relatively deep (10 – 30 m) nearshore lake sites. The Ponar BAP scores for this study were not published but, excluding *Dreissena polymorpha*, means ranged from 1.3 to 2.7 and richness averaged 5 species at four reference sites (B. Duffy, unpublished NYSDEC data, January 28, 2022) just east and west of the AOC (mean depth = 24 m, percent fines = 50 %, and precent TOC = 0.8 %). Just as notable, the mean Ponar BAP scores at three reference sites in the Genesee River, with depths averaging 2.4 m, ranged from 1.8 to 3.3 and richness averaged 9 species (Duffy et al., 2017). Because the 3 reference sites were in a reach intersected by the New York Barge Canal (and upstream of a stage-control dam), river waters were nearly still and percent fines and percent TOC averaged 75 % and 1.1 %, respectively (Duffy et al., 2017). An average of 92 and 97 % of all specimens collected at reference sites in the embayment and the Genesee River, respectively, were chironomids and oligochaetes. Likewise, the BAP scores and richness for benthic communities from Ponar samples collected at 4 non-AOC sites in Tonawanda Creek (essentially the western end of New York's Barge Canal which terminates at the Niagara River) ranged from 1.1 to 3.6 and 5 to 11 species, respectively, during 2014–15 (B. Duffy, unpublished NYSDEC data, January 28, 2022). The depths, percent fines, and percent TOC at these 4 sites averaged 3.5 m, 75.6 %, and 3.8 %, respectively. Because the Ponar BAP is not calibrated to benthic communities in lake environments (NYSDEC, 2021), it may not correctly assign the condition of lentic macroinvertebrate assemblages to specific impact classes. Since the physical habitat and benthic communities at upper Niagara River impact sites are mostly analogous to those in nearby lakes (and low-velocity rivers or reaches) that are not in an AOC, the Ponar BAP does not appear to be suitable for classifying the level of biological impairment in this system. In the connected Buffalo River AOC, George et al. (2022) also concluded that the condition of benthic communities in remediated reaches was chiefly shaped by legacy habitat alterations rather than AOC-specific sediment contamination and toxicity. Thus, it is understandable why low BAP scores at most sites in the upper Niagara River do not accurately reflect the condition of, or degree of impairment in, benthic communities across this AOC.

While our 2019–20 BAP scores were consistently low (mean = 2.4) and indicative of lentic conditions, we can arguably infer that benthic communities have improved noticeably over the past 50(+) years and are now relatively unimpaired throughout much of the upper Niagara River AOC where fine sediments predominate. This thesis is supported by our contemporary findings, comparing these results to those from an extensive survey done prior to enactment of the 1972 Clean Water Act, and by the results from other studies in the Niagara River. Our 2019–20 toxicity-test and chironomid mentum-deformity results indicate sediments were toxic at only 1 to 3 impact sites. More noteworthy, between 6 and 27 invertebrate taxa (not all individual species) were collected from all upper Niagara River sites and Tubificidae on average only accounted for 21 % of specimens at each site in 2019–20 (George et al., 2021), whereas, sediment samples at most upper Niagara River sites on the U.S. side of the international border were entirely "void of macroinvertebrate taxa" or dominated by one or two pollution-tolerant taxa (primarily the sludgeworm *Tubifex tubifex*) in 1968 (Veal, 1970). These results imply that the abundance and diversity of benthic macroinvertebrate species increased greatly over the past 5 to 6 decades. Though only one Rotating Integrated Basin Studies site in the upper Niagara River has long-term records (01-NIAG-33.4), a steady increase in BAP scores (from 3.5 to 6.7) at this mid-channel location between 2000 and 2015 (NYSDEC, 2022) supports the thesis that benthic communities are improving. Additionally, the USEPA successfully sampled 59 sites in the upper and lower Niagara River during a 2018 stratified-random survey and found that a sediment-quality index (based on combined probable effect concentration quotients or PECqs for metals, PAHs, and PCBs) classified most sites in both segments as either fair, good, or unassessed and about 7 % (4) of sites as poor (Pawlowski et al., 2019). Control-corrected survival during *H. azteca* toxicity tests was less than 75 %, and also classified sediment toxicity as poor at only 2 sites in each segment. While BAP scores were not calculated for benthos data, the fact that only 2 sites in the upper river were classified as poor based on sediment-quality and toxicity is noteworthy. Another 2014–15 study found that survival and growth of *C. dilutus* and *H. azteca* in sediments at 5 Niagara River impact sites did not differ significantly from laboratory controls nor did they indicate toxicity (George et al., 2016) and the benthic community BAP scores averaged 3.7 and ranged from 1.8 to 6.6 (B. Duffy, unpublished NYSDEC data, January 28, 2022). While an unrelated survey of 106 sites in the lower Niagara River did not calculate indices of community condition, it reported that many of the same Chironomidae and Tubificidae taxa (which were most abundant at upper Niagara sites) also dominated assemblages at most lower Niagara sites where substrates were very fine, depths were less than 10 m, and near-bottom velocities were low (Mehler et al., 2017). Maybe most telling, the benthic communities in the Niagara River on the Canadian side of the AOC were recognized as being either relatively sparse (due to lack of suitable substrate related to the high-velocity water flow) or unimpaired in backwater areas in its first remedial action plan (NRRAP, 1993). Thus, at a minimum, the comparable benthic communities found at our reference and most impact sites in the upper Niagara River (and on the Canadian side of the river); at some sites in the lower Niagara; and at sites outside this and other AOCs, indicate that the benthos in this AOC are not markedly impaired. These findings also indicate that the observed communities are archetypical of soft-bottom, low velocity, organic rich, and shallow habitats that exist in mostly nearshore, and slack-water areas along the river. At the most, large declines in pollutant-tolerant taxa, increases in species richness and diversity in benthic communities, low frequency, and severity of mentum deformities in chironomids, and the small number of sites with sediments exhibiting toxicity to *C. dilutus* and *H. azteca* indicate that sediment (and water) quality and benthic communities have improved significantly throughout much of the upper Niagara River AOC over the past five or six decades.

Enhanced treatment of municipal waste waters, closure of some large heavy industries, reduced contaminant loads from enduring industries, and numerous sediment-remediation efforts clearly reduced contaminated sediments and toxicity in parts of the upper Niagara River since the 1970s. These changes have some important implications for the health of benthic communities and for assessing the status of BUIs in AOCs under the Great Lakes Restoration Initiative. First, the condition of benthic communities in the upper Niagara River, as noted above, has improved in direct response to numerous waste-cleanup, habitat-restoration, and water-quality (regulatory) actions. Eight municipal waste-water treatment plants were constructed on the upper Niagara River and its tributaries between 1938 and 1978, and most were upgraded to secondary or tertiary treatment between 1978 and 2003. In addition, dozens of heavy industries ceased operations in the surrounding watershed and new water-quality regulations linked to the National Pollutant Discharge Elimination System program reduced the number and the total loads of industrial pollutants entering the waterway from waste-water treatment plants. Just as important, between

1989 and 2015, at least 15 remedial actions were undertaken to remove and (or) cap contaminated sediments in the upper Niagara River and its tributaries. Apart from extensive capping, about 83,000, 160,000, and 1,000,000 cubic yards of sediments that were highly contaminated with PCBs, dioxins, PAHs, mercury, other metals, or volatile and semi-volatile organic compounds were removed from the upper Niagara River, its small tributaries, and the Buffalo River (including the City Ship Canal), respectively. While our results indicate sediments remain slightly or moderately toxic at a few impact sites, the overall condition of benthic communities at all reference sites does not significantly differ from that at all other impact sites in the upper Niagara River. Second, the lack of nearby rivers or reaches with similar but uncontaminated physical environments was not an impediment to evaluating the status of benthos in parts of this AOC. With the availability of sediment-contaminant data from the same sites where toxicity and the health of benthic communities were assessed, we were able to identify sites within the AOC that had little potential to harm aquatic biota and, thus, could represent reference conditions. Similar procedures could be used in other AOCs to identify suitable reference conditions where reference rivers or sites are unavailable and then used to assess the status of existing BUIs. Third, while the NYSDEC Ponar BAP scores should have been applicable to large rivers, they imply that benthic communities were moderately to severely impaired by poor water quality in the upper Niagara River. Since the source of the Niagara River is Lake Erie, the low (or zero) flows and very fine sediments from our sites, located in near-shore depositional areas, were more typical of lentic (lake) environments. This is important because this metric is not calibrated for assessing water-quality impairment in lake environments (NYSDEC, 2021). The lake-like conditions in some parts of the upper Niagara River mean that local benthic communities may be more characteristic of lake harbors or bays rather than riverine environments. The similarly low BAP scores for macroinvertebrate assemblages encountered at reference sites near the Rochester Embayment AOC and in the Genesee River and Tonawanda Creek support the view that the metric is not applicable, and low scores are not indicative of impairment in the upper Niagara River. Lastly, while contaminant concentrations surpassed SGV Class C limits at many source sites and at a few impact sites (which may warrant additional investigation and remediation efforts), most biological data indicate that benthic macroinvertebrate communities are not adversely affected by sediment contamination and that, excluding source areas, criteria for removing the Benthos BUI appear to be met in much of the upper segment of the Niagara River AOC. While only the Remedial Advisory Committee for the Niagara River AOC and staff from the associated state and federal agencies can make final recommendations about removing any BUI, the findings presented herein are important contributions to that action and for continuing the process to assess the degradation of benthos BUI in this AOC and in other AOCs across the Great Lakes.

CRediT authorship contribution statement

Barry P. Baldigo: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Scott D. George:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – review & editing. **Andrew Lenox:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Mark D. Filipski:** Conceptualization, Writing – review & editing, Project administration, Funding acquisition. **Brian T. Duffy:** Conceptualization, Methodology, Writing – review & editing, Project Administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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RESULTS OF TOXICITY TESTING WITH *Hyalella azteca* AND *Chironomus dilutus* ON SEDIMENT SAMPLES FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

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Results relate only to the items tested or to the samples as received by the laboratory.

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This report contains 15 pages plus 4 attachments.

30 September 2022

Michael K. Chanov II
Laboratory Director

Date

EA Project Number 70022.TOX

ACCREDITED IN ACCORDANCE WITH nelac ID# E87550

EA Report Number 8946

1. INTRODUCTION

At the request of the Benchmark Civil/Environmental Engineering & Geology, PLLC and TurnKey Environmental Restoration, LLC, EA Engineering, Science, and Technology performed sediment toxicity tests on five sediment samples. The sediment samples were evaluated using 10-day survival and growth toxicity tests with the freshwater amphipod *Hyalella azteca,* and the midge *Chironomus dilutus* (formerly *tentans*). The objective of the toxicity testing was to evaluate the toxicity of each of the site sediment samples based on the survival and growth of the test organisms, as compared to the control.

2. METHODS AND MATERIALS

2.1 SAMPLE DESCRIPTIONS

Five sediment samples were collected and shipped via overnight courier to EA's Ecotoxicology Laboratory in Hunt Valley, Maryland. Upon receipt at EA, the samples were visually inspected, compared against the chain-of-custody record, and assigned EA laboratory accession numbers. A copy of the chain-of-custody record is included in Attachment I. Table 1 summarizes the collection and receipt data for the five site sediments. When not being processed for testing, the samples were stored in the dark at 4°C.

2.2 CONTROL SEDIMENT

A control sediment was initiated with the site sediments. The control sediment was a natural sediment from Pretty Boy Reservoir, Maryland which has been utilized previously in amphipod and midge sediment toxicity testing.

2.3 LABORATORY WATER

Dechlorinated tap water was used as the overlying water for the sediment exposures. The source of the water was the City of Baltimore municipal water system. Upon entering the laboratory, the water passed through a high-capacity, activated-carbon filtration system to remove any possible contaminants such as chlorine and trace organic compounds. This water source has proven safe for aquatic organism toxicity testing at EA as evidenced by maintenance of the multigeneration *Hyalella azteca*, and fathead minnow cultures with no evident loss of fecundity.

2.4 TEST ORGANISMS

The midges (*Chironomus dilutus*) lot CH-100 were obtained from Aquatic Research Organisms (Hampton, New Hampshire). Upon receipt at EA on 21 July 2022, the organisms were gradually acclimated to laboratory water at 23°C. Second to third instar larvae were used in the toxicity

testing. The amphipods (*Hyalella azteca*) lot HA-058 were obtained from Aquatic Research Organisms (Hampton, New Hampshire). Upon receipt at EA on 21 July 2022, organisms were 12 days old for testing and were acclimated to the testing temperature of 23°C during the holding period.

2.5 TOXICITY TEST OPERATIONS AND PERFORMANCE

Toxicity testing was conducted in accordance with US EPA guidance (US EPA 2000), and test methodologies followed EA's standard toxicity testing protocols (EA 2022). The sediment samples were evaluated for toxicity with *C. dilutus* and *H. azteca,* and the test results comply with current NELAC standards where applicable.

The test chambers used in the *C. dilutus* 10-day survival and growth toxicity test, and the *H. azteca* 10-day survival and growth toxicity test were 300-ml lipless glass beakers, each containing 100 ml of sediment and 175 ml of overlying water. The tests were performed with eight replicates per sediment. The sediments and overlying water were added to the chambers at least 24 hours prior to introduction of the test organisms. The beakers were left undisturbed overnight to allow any suspended sediment particles in the water column to settle. The introduction of the test organisms to the test chambers marked the initiation of the toxicity tests. Ten organisms were randomly introduced into each replicate beaker for a total of 80 organisms per sediment. The test chambers were placed in a water bath to maintain temperatures at a target range of 23±1°C, with a 16-hour light/8-hour dark photoperiod.

The *C. dilutus* were fed 1.5 ml per replicate of a 4 g/L slurry of Tetramin flake food daily, while the *H. azteca* were fed 1.0 ml per replicate of YCT (a suspension of yeast, ground cereal leaves, and trout chow) daily.

The overlying water in the exposure chambers was renewed a minimum of twice daily using a water delivery system (Zumwalt et al. 1994). Fresh overlying water was slowly added to each replicate, displacing the water already in the beaker to flow out through a notch cut into the top

of the beaker. The notch was sealed with fine mesh screen to prevent loss of organisms during the renewal process.

For the amphipod and midge toxicity testing, water quality parameters of temperature, pH, dissolved oxygen, and conductivity were recorded daily on the overlying water in one replicate of each sediment. Composite samples of the overlying water of each sediment were also analyzed for alkalinity, hardness, and ammonia at test initiation and termination.

At the end of the 10-day (*C. dilutus*) or 10-day (*H. azteca*) exposure period, the surviving organisms from each replicate were retrieved from the sediment. The number of surviving organisms from each replicate was recorded. The surviving *H. azteca* and *C. dilutus* from each replicate were then placed in a dried, pre-weighed aluminum pan (*H. azteca*) or ceramic crucible (*C. dilutus*), and placed in a drying oven at 100°C for at least 24 hours. The pans (or crucibles) were then removed from the oven, placed in a desiccator to cool, and weighed. The dry weight of the surviving organisms in each replicate was determined by subtracting the weight of the empty pan (or crucible) from the weight of the pan (or crucible) plus dried organisms. The mean dry weight per organism was obtained by dividing the total organism dry weight per replicate by the number of surviving organisms per replicate.

The ash-free dry weight was determined for the *C. dilutus* by placing the crucibles with oven-dried organisms in a muffle furnace at 550°C for at least two hours, then weighing the crucibles with organisms following an appropriate cooling period. For each replicate, the weight of the crucible with furnace-dried organisms was subtracted from the weight of the crucible with oven-dried organisms, yielding a total organism ash-free dry weight. A mean ash-free dry weight per organism was obtained by dividing the total organism ash-free dry weight per replicate by the number of surviving organisms per replicate.

The survival and growth results of the *C. dilutus* and *H. azteca* toxicity tests were statistically analyzed according to US EPA guidance (US EPA 2000) to determine if any of the five site sediments were significantly different ($p=0.05$) from the control sediment. If the data were normally distributed, then a t-Test was performed to detect statistically significant differences

between test sediments and the control sediment. If the data distribution was non-normal, then a Wilcoxon Two-Sample Test was used to compare the group means. Shapiro-Wilk's Test was used to determine if the data were normally distributed, and the F-Test was used to test for homogeneity of variance.

Table 2 presents a summary of the water quality measurements recorded during the *C. dilutus* toxicity testing, and table 3 summarizes the results of the *C. dilutus* test. Tables, 4 and 5 present the water quality and test results, respectively, for the *H. azteca* toxicity testing. Copies of the original data sheets and statistical analyses from the sediment toxicity testing are included in Attachment II for *C. dilutus* and Attachment III for *H. azteca*.

2.6 REFERENCE TOXICANT TESTS

In conformance with EA's quality assurance/quality control program, reference toxicant tests were performed on *C. dilutus* and *H. azteca*. The midges were exposed to sodium dodecyl sulfate (SDS) to determine the 48-hour LC50. The amphipods were exposed to the reference toxicant copper sulfate ($CuSO_4$) in a graded concentration series to determine the 96-hour median lethal concentration (LC50). The results of the reference toxicant tests were compared to EA's established control chart limits according to US EPA methodology (US EPA 2002). Reference toxicant test data are presented in Table 6.

2.7 ARCHIVES

Original data sheets, records, memoranda, notes, and computer printouts are archived at EA's Office in Hunt Valley, Maryland. These data will be retained for a period of 5 years unless a longer period of time is requested.

3. RESULTS AND DISCUSSION

3.1 *Chironomus dilutus* SEDIMENT TOXICITY TESTS

The results of the *C. dilutus* sediment toxicity tests comply with current NELAC standards. A summary of water quality measurements recorded during the test is included in Table 2, and test results are presented in Table 3. After 10 days of exposure, mean survival in all site sediments (6 to 44 percent survival) except SC2-1-B (95 percent) were statistically different (p=0.05) from the control site which had 100 percent survival.

Mean ash-free dry weight, after 10 days exposure in the sediments ranged from 0.270 to 0.650 mg per organism. The control site had mean ash-free dry weights of 0.998 mg per organism. The mean ash-free dry weight for the site sediment samples were all statistically different (p=0.05) from the control site.

3.2 *Hyalella azteca* SEDIMENT TOXICITY TESTS

The results of the *H. azteca* sediment toxicity tests comply with current NELAC standards. Water quality measurements taken during the test are presented in Table 4, and test results are summarized in Table 5. After 10 days of exposure, mean survival in the sediments ranged from 6 to 88 percent, and were statistically different (p=0.05) from the control site which had 95 percent survival.

Mean dry weight in the sediments ranged from 0.090 to 0.127 mg per organism. The control sediment had a mean dry weight of 0.121 mg per organism. The mean dry weight in three sediment samples were statistically different (p=0.05) from the control site.

3.3 REFERENCE TOXICANT TESTS

The results of the reference toxicant testing (Table 6) indicated that the *H. azteca* and the *C. dilutus* were of acceptable quality, and the test results were within acceptable control chart limits.

4. REFERENCES

EA. 2022. EA Ecotoxicology Laboratory Quality Assurance and Standard Operating Procedures Manual. EA Manual ATS-102. Internal document prepared by EA's Ecotoxicology Laboratory, EA Engineering, Science, and Technology, Inc., Hunt Valley, Maryland.

US EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates. Second Edition. EPA/600/R-99/064. U.S. Environmental Protection Agency, Office of Research and Development, Duluth, Minnesota.

US EPA. 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. EPA-821-R-02-012. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Zumwalt, D.C., F.J. Dwyer, I.E. Greer, and C.G. Ingersoll. 1994. A water-renewal system that accurately delivers small volumes of water to exposure chamber. Environmental Toxicology and Chemistry. 13:1311-1314.

TABLE 1 COLLECTION AND RECEIPT INFORMATION FOR SEDIMENT SAMPLES FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

Sediment Sample Identification	EA Accession Number	Collection Time and Date	Receipt Time and Date	Receipt Temperature (ºC)	Initial Ammonia (mg/L)
SCI-4-D	AT2-420	1030-1130, 29 June 2022	1035, 1 July 2022	3.7	13.2
SCI-8-D	AT2-421	1230-1330, 29 June 2022	1035, 1 July 2022	5.9	32.9
SC2-1-B	AT2-422	1400-1500, 29 June 2022	1035, 1 July 2022	8.9[(a)]	47.2
SC2-6-B	AT2-423	1530-1630, 29 June 2022	1035, 1 July 2022	6.4[(a)]	23.8
SC2-10-B	AT2-424	1215-1315, 30 June 2022	1035, 1 July 2022	5.4	10.8

(a) Sample upon receipt was greater than 6°C. Sample was received without ice.

TABLE 2 WATER QUALITY PARAMETERS MEASURED DURING *Chironomus dilutus* TOXICITY TESTING WITH SEDIMENTS FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

EA Test Number: TN-22-610
Test Initiation: 22 July 2022
Test Termination: 1 August 2022

Sample Identification	EA Accession Number	Temperature (°C)		pH (su)		Dissolved Oxygen (mg/L)		Conductivity (µs/cm)	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Laboratory Control	AT1-697	22.0	23.4	7.3	8.2	6.7	7.8	341	388
SCI-4-D	AT2-420	22.1	23.6	7.3	8.1	6.6	8.2	349	562
SCI-8-D	AT2-421	22.2	23.5	7.2	8.1	6.2	7.4	360	523
SC2-1-B	AT2-422	22.2	23.5	7.3	8.0	6.3	7.8	355	419
SC2-6-B	AT2-423	22.2	23.5	7.4	8.0	5.0	7.4	374	420
SC2-10-B	AT2-424	22.0	23.6	7.3	8.0	6.0	7.6	364	418

Sample Identification	EA Accession Number	Alkalinity (mg/L)		Hardness (mg/L)		Conductivity (µs/cm)		Ammonia (mg/L)	
		Day 0	Day 10	Day 0	Day 10	Day 0	Day 10	Day 0	Day 10
Laboratory Control	AT1-697	46	60	80	108	312	348	2.6	0.5
SCI-4-D	AT2-420	122	70	108	100	389	379	2.7	0.4
SCI-8-D	AT2-421	120	80	200	116	590	379	4.9	0.9
SC2-1-B	AT2-422	142	80	144	120	532	385	11.8	1.0
SC2-6-B	AT2-423	130	84	140	120	502	385	5.0	1.4
SC2-10-B	AT2-424	100	86	136	116	474	390	2.4	0.9

TABLE 3 RESULTS OF *Chironomus dilutus* TOXICITY TESTING WITH SEDIMENTS FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

EA Test Number: TN-22-610
Test Initiation: 22 July 2022
Test Termination: 1 August 2022

Sample Identification	**EA Accession Number**	**10-Day Survival (percent)**	**Ash-Free Dry Weight as mg/Organism (±SD)**
Laboratory Control	AT1-697	100	0.998 (±0.099)
SCI-4-D	AT2-420	44[(a)]	0.343 (±0.177)[(a)]
SCI-8-D	AT2-421	35[(a)]	0.395 (±0.180)[(a)]
SC2-1-B	AT2-422	95	0.650 (±0.146)[(a)]
SC2-6-B	AT2-423	6[(a)]	0.406 (±0.331)[(a)]
SC2-10-B	AT2-424	10[(a)]	0.270 (±0.403)[(a)]

(a) Significantly different (p=0.05) from laboratory control.

TABLE 4 WATER QUALITY PARAMETERS MEASURED DURING *Hyalella azteca* TOXICITY TESTING WITH SEDIMENTS FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

EA Test Number: TN-22-611
Test Initiation: 22 July 2022
Test Termination: 1 August 2022

Sample Identification	EA Accession Number	Temperature (°C)		pH (su)		Dissolved Oxygen (mg/L)		Conductivity (µs/cm)	
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Laboratory Control	AT1-697	22.0	23.4	7.5	8.0	6.7	8.1	331	376
SCI-4-D	AT2-420	22.0	23.4	7.4	8.0	6.6	8.1	337	419
SCI-8-D	AT2-421	22.1	23.4	7.1	8.0	4.6	7.7	354	580
SC2-1-B	AT2-422	22.1	23.6	7.2	7.9	4.3	7.5	370	475
SC2-6-B	AT2-423	22.1	23.5	7.3	7.9	4.2	7.6	360	438
SC2-10-B	AT2-424	22.1	23.4	7.1	7.9	4.1	7.8	362	430

Sample Identification	EA Accession Number	Alkalinity (mg/L)		Hardness (mg/L)		Conductivity (µs/cm)		Ammonia (mg/L)	
		Day 0	Day 10	Day 0	Day 10	Day 0	Day 10	Day 0	Day 10
Laboratory Control	AT1-697	46	70	80	108	312	351	2.6	0.1
SCI-4-D	AT2-420	122	66	108	116	389	368	2.7	0.2
SCI-8-D	AT2-421	120	84	200	100	590	385	4.9	0.5
SC2-1-B	AT2-422	142	78	144	120	532	380	11.8	0.4
SC2-6-B	AT2-423	130	68	140	108	502	374	5.0	0.2
SC2-10-B	AT2-424	100	90	136	116	474	384	2.4	0.6

TABLE 5 RESULTS OF *Hyalella azteca* TOXICITY TESTING WITH SEDIMENTS FROM BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC AND TURNKEY ENVIRONMENTAL RESTORATION, LLC

EA Test Number: TN-22-610
Test Initiation: 22 July 2022
Test Termination: 1 August 2022

Sample Identification	EA Accession Number	10-Day Survival (percent)	Mean Dry Weight as mg/Organism (±SD)
Laboratory Control	AT1-697	95	0.121 (±0.005)
SCI-4-D	AT2-420	70[(a)]	0.127 (±0.011)
SCI-8-D	AT2-421	46[(a)]	0.090 (±0.019)[(a)]
SC2-1-B	AT2-422	79[(a)]	0.108 (±0.012)[(a)]
SC2-6-B	AT2-423	6[(a)]	0.110 (±0.057)
SC2-10-B	AT2-424	88[(a)]	0.109 (±0.009)[(a)]

(a) Significantly different (p=0.05) from laboratory control.

TABLE 6 RESULTS OF REFERENCE TOXICANT TESTING

Test Species	Reference Toxicant	Test Result	Acceptable Control Chart Limits
Hyalella azteca (amphipod)	Copper sulfate ($CuSO_4$)	96-Hour LC50: 177 µg/L Cu	0 – 278 µg/L Cu
Chironomus dilutus (midge)	Sodium dodecyl sulfate (SDS)	48-Hour LC50: 70.6 mg/L SDS	17.6 – 76.8 mg/L SDS

ATTACHMENT I

Chain-of-Custody Record
(2 pages)

Chain-of-Custody Record

EA Engineering, Science, and Technology

EA Ecotoxicology Laboratory
231 Schilling Circle
Hunt Valley, Maryland 21031
Telephone: 410-584-7000
Fax: 410-584-1057

Client: Benchmark C.E. Eng. + Geology, PLLC Project No.:

NPDES Number: Client Purchase Order Number:

City/State Collected: Buffalo, NY

Sample Shipped By: (circle)
Fed. Ex. UPS Other:
Tracking #: 274994847473

PLEASE READ SAMPLING INSTRUCTIONS ON BACK OF FORM

Accession Number (office use only)	Grab	Composite	Collection Start Date/Time	Collection End Date/Time	Sample Description (including Site, Station Number, and Outfall Number)	Temp (°C)	Number/Volume of Container
ATJ-420		X	6/29/22 1030	6/29/22 1130	SC1-4-D	3.7°C	1=1gal 2=1L
ATJ-421		X	1230	13:30	SC1-8-D	5.9	↓
ATJ-422		X	1400	15:00	SC2-1-B	8.9	
ATJ-423		X	1530	16:30	SC2-6-B	6.4	
ATJ-424		X	6/30/22 1215	6/30/22 1315	SC2-10-B	5.4	↓

Sampled By:	Date/Time	Received By:	Date/Time
B. Hann	6/30/2022 14:00		
Sampler's Printed Name:	Title:	Relinquished By:	Date/Time
Bryan Hann	Sr. PM		
Relinquished By:	Date/Time	Received By Laboratory	Date/Time
	6/30/2022 1400	[signature]	7/1/22 1035

Was Sample Chilled During Collection? (Yes) / No

Comments:
see Benchmark Quote EA781 for analysis

Sample Collection Parameters
Visual Description: black sediment
Temperature (°C):
pH:
TRC (mg/L):
Other:

ATTACHMENT II

Data Sheets and Statistical Analyses
from *Chironomus dilutus* Sediment Toxicity Test
(27 pages)

SEDIMENT TOXICITY TEST SET-UP BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

TEST ORGANISM INFORMATION

Common Name: Midge

Scientific Name: *C. dilutus*

Lot Number: CH-100

Source: EA ARO

Adults Isolated (Time, Date): _____

Neonates Pulled (Time, Date): _____

Acclimation: 24hrs

Age: 13 days

Culture Water (T/S): 24.3 °C Ø ppt

(6) To Trivia

TEST INITIATION

Date	Time	Initials	Activity
7/20/22 ↓	1350 ↓	JB/GL ↓	Sediment Added to Chambers
7/22/22	1200	MKC	Overlying Water Added to Chambers
			Organisms Transferred

TEST SET-UP

Sample Number(s): AT1-697, AT2-420 → AT2-424

Overlying Water Number: Dechlor

Treatment	Volume Test Sediment	Volume Overlying Water
Pretty Boy Control (AT1-697)	100 ml	175 ml
AT2-420 ↓	↓	↓
AT2-424		

TOXICOLOGY LABORATORY BENCH SHEET - ORGANISM RECOVERY RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

TEST ORGANISM

Common Name: Midge

Scientific Name: *C. dilutus*

Organisms Recovered (date, time, initials): 8/1/22, 0950, MKC

Treatment	Replicate	Number of Organisms Loaded	Number of Organisms Recovered
AT1-697	A	10	10
(Lab Control)	B	10	10
	C	10	10
	D	10	10
	E	10	10
	F	10	10
	G	10	10
	H	10	10
AT2-420	A	10	4
	B	10	4
	C	10	8
	D	10	5
	E	10	5
	F	10	6
	G	10	2
	H	10	1
AT2-421	A	10	5
	B	10	5
	C	10	3
	D	10	3
	E	10	3
	F	10	3
	G	10	3
	H	10	3

TOXICOLOGY LABORATORY BENCH SHEET - ORGANISM RECOVERY RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Organisms Recovered (date, time, initials): 8/1/22, 0950

TEST ORGANISM

Common Name: Midge

Scientific Name: *C. dilutus*

Treatment	Replicate	Number of Organisms Loaded	Number of Organisms Recovered
AT2-422	A	10	10
	B	10	9
	C	10	9
	D	10	10
	E	10	10
	F	10	9
	G	10	9
	H	10	10
AT2-423	A	10	1
	B	10	1
	C	10	1
	D	10	1
	E	10	0
	F	10	01
	G	10	0
	H	10	0
AT2-424	A	10	1
	B	10	1
	C	10	1
	D	10	1
	E	10	1
	F	10	1
	G	10	1
	H	10	1

ASH-FREE DRY WEIGHT DATA (Test Species: *C. dilutus*)

Project Number: EA.TOX Client: Benchmark QC Test Number: TN-22-610

	Date	Time	Initials		Date	Time	Initials
Loaded pans in oven:	8/1/22	1000		Loaded pans in furnace:	9/28/22	1100	
Loaded pans out oven:	8/19/22	0750	RSB	Loaded pans out furnace:	9/29/22	1500	
Loaded pans weighed:	8/19/22	0820	RSB	Loaded pans weighed:	9/29/2022	0954	SR
Oven Temp (°C):	100			Furnace Temp (°C):	550		

Test Concentration	Rep	Pan #	A Weight of Pan (mg)	B Weight of Pan and Oven-Dried Organisms (mg)	C Weight of Pan and Furnace-Dried Organisms (mg)	B-C Total Ash-Free Dry Weight (mg)	D Number of Organisms Weighed	(B-C)/D Mean Ash-Free Dry Organism Weight (mg)
Control	A	98	5563	5577.59	5568.30	9.29	10	0.929
	B	271	5137	5149.93	5139.84	10.09	10	1.009
	C	120	5702	5715.37	5706.43	8.94	10	0.894
	D	29	4919	4932.02	4923.01	9.01	10	0.901
	E	226	5389	5405.33	5394.46	10.87	10	1.087
	F	133	4689	4707.69	4695.90	11.79	10	1.179
	G	245	4618	4631.61	4622.07	9.54	10	0.954
	H	220	4470	4485.38	4475.14	10.24	10	1.024
AT2-420	A	16	4989	4992.42	4989.99	2.43	4	0.608
	B	184	5119	5122.08	5120.38	~~1.70~~ 1.70	4	~~0.350~~ 0.425
	C	9	5072	5078.68	5074.62	~~4.06~~ 4.06	8	~~0.507~~ 0.508
	D	48	4879	4881.86	4880.21	1.65	5	0.330
	E	36	5332	5334.79	5332.97	1.82	5	0.364
	F	160	5210	5211.67	5210.34	1.33	6	0.222
	G	87	5159	5160.33	5159.83	0.50	2	0.250
	H	114	4721	4721.44	4721.40	0.04	1	0.040

Dry wt. calculations checked (date, initials): 9/24/2022, SR

Ash-Free calculations checked (date, initials): 9/24/2022, SR

@ 9/24/2022 SR

ASH-FREE DRY WEIGHT DATA (Test Species: *C. dilutus*)

Project Number: EA.TOX Client: Benchmark QC Test Number: TN-22-610

	Date	Time	Initials		Date	Time	Initials
Loaded pans in oven:	8/1/22	1000		Loaded pans in furnace:	9/2/22	1100	
Loaded pans out oven:	8/19/22	0750	LS	Loaded pans out furnace:	9/2/22	1500	
Loaded pans weighed:	8/19/22	0920	NB	Loaded pans weighed:	9/29/2022	0954	JR

Oven Temp (°C): 100 Furnace Temp (°C): 550

Test Concentration	Rep	Pan #	A Weight of Pan (mg)	B Weight of Pan and Oven-Dried Organisms (mg)	C Weight of Pan and Furnace-Dried Organisms (mg)	B-C Total Ash-Free Dry Weight (mg)	D Number of Organisms Weighed	(B-C)/D Mean Ash-Free Dry Organism Weight (mg)
AT2-421	A	100	4927	4931.98	4930.44	1.54	5	0.308
	B	110	4631	4633.85	4632.72	1.13	5	0.226
	C	197	4775	4778.26	4777.42	0.84	3	0.280
	D	232	4704	4712.73	4710.74	1.99	3	0.663
	E	143	5480	5483.23	5482.41	0.82	3	0.273
	F	159	4821	4826.82	4825.51	1.31	3	0.437
	G	62	4398	4402.60	4400.57	2.03	3	0.677
	H	150	4907	4908.87	4907.98	0.89	3	0.297
AT2-422	A	233	4525	4532.50	4527.44	5.14	10	0.514
	B	319	4852	4862.68	4855.18	7.50	9	0.833
	C	103	5145	5155.11	5148.61	6.50	9	0.722
	D	95	5290	5297.42	5293.32	4.10	10	0.410
	E	134	4532	4541.95	4534.90	7.05	10	0.705
	F	112	4810	4820.79	4813.87	6.92	9	0.769
	G	145	4413	4419.96	4415.15	4.81	9	0.534
	H	93	4574	4586.69	4579.57	7.12	10	0.712

Dry wt. calculations checked (date, initials): 9/29/2022, JR Ash-Free calculations checked (date, initials): 9/29/2022, JR

ASH-FREE DRY WEIGHT DATA (Test Species: *C. dilutus*)

Project Number: EA.TOX Client: Benchmark QC Test Number: TN-22-610

	Date	Time	Initials		Date	Time	Initials
Loaded pans in oven:	8/1/22	1000	[illegible]	Loaded pans in furnace:	9/29/22	1100	[illegible]
Loaded pans out oven:	8/19/22	0750	MB	Loaded pans out furnace:	9/29/22	1520	[illegible]
Loaded pans weighed:	8/19/22	0820	MB	Loaded pans weighed:	9/29/2022	0954	JR

Oven Temp (°C): 100 Furnace Temp (°C): 550

Test Concentration	Rep	Pan #	A Weight of Pan (mg)	B Weight of Pan and Oven-Dried Organisms (mg)	C Weight of Pan and Furnace-Dried Organisms (mg)	B-C Total Ash-Free Dry Weight (mg)	D Number of Organisms Weighed	(B-C)/D Mean Ash-Free Dry Organism Weight (mg)
AT2-423	A	234	4404	4406.03	4405.08	~~1.03~~ 0.95	1	~~1.03~~ 0.950
	B	121	5763.96	5766.590	5766.39	0.19	1	0.190
	C	20	5263	5265.97	5265.54	0.43	1	0.430
	D	262	4879.70	4881.69	4881.33	0.36	1	0.360
	E	217	~~5250.79~~ 19	~~5250.79~~	—	—	X0	—
	F	322	5662	~~5667.15~~ —	5667.05	0.10	~~0~~ 1	0.100
	G	19	5095.57	—	—	—	0	—
	H	96	4874	—	—	—	0	—
AT2-424	A	317	4570	4570.24	4570.13	0.11	1	0.110
	B	72	5095	5094.74	5094.60	0.14	1	0.140
	C	82	5046	5046.19	5046.00	0.19	1	0.190
	D	108	5283.~~84~~34	5604.04	5284.01	0.03	1	0.030
	E	1	5724.93	5727.64	5726.38	1.26	1	1.260
	F	295	5324	5324.73	5324.56	0.17	1	0.170
	G	44	4516.65	4517.14	4517.~~84~~	0.13	1	0.130
	H	92	4924	4925.03	4924.90	0.13	1	0.130

Dry wt. calculations checked (date, initials): 9/29/2022, JR (9/29/2022 JR)

Ash-Free calculations checked (date, initials): 9/29/2022, JR (9/29/2022 JR) (6) 9/11/22

(5) RB 9/19/22

TOXICITY TEST WATER QUALITY DATA SHEET - NEW SOLUTIONS

Project Number: EA.TOX
Client: Benchmark
QC Test Number: TN-22-610

TEST ORGANISM
Common Name: Midge
Scientific Name: *C. dilutus*

Beginning Date: 7/22/22 Time: 1200
Ending Date: 8/1/22 Time: 0950

TARGET VALUES: Temp: 23±1 °C pH: 6.0 - 9.0 DO: >4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Control (AT1-697)		23.4							7.3							7.9							340						
AT2-420		23.6							7.3							8.2							560						
AT2-421		23.5							7.2							7.4							523						
AT2-422		23.5							7.3							7.8							419						
AT2-423		23.5							7.5							7.4							414						
AT2-424		23.6							7.4							7.5							418						
Meter Number		682							682							682							682						
Time		1030							1030							1030							1030						
Initials		JM							JM							JM							JM						

JM 7/28/22

TOXICITY TEST WATER QUALITY DATA SHEET - OLD SOLUTIONS

Project Number: EA.TOX | TEST ORGANISM | Beginning Date: 7/22/22 Time: 1205

Client: Benchmark | Common Name: Midge | Ending Date: 8/1/22 Time: 0950

QC Test Number: TN-22-610 | Scientific Name: *C. dilutus*

TARGET VALUES Temp: 23±1 °C pH: 6.0 - 9.0 DO: ≥4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control (AT1-697)		23.3	22.4	22.8	22.2	22.2	22.7	22.4	7.8	8.2	7.9	7.7	7.8	8.2	7.8	6.9	7.7	7.2	7.8	6.7	7.6	7.3	355	354	375	388	365	362	353
AT2-420		23.4	22.7	22.9	22.3	22.2	22.8	22.7	7.7	8.1	7.9	7.5	7.8	8.0	7.6	7.1	7.6	7.1	7.2	7.2	7.3	6.8	386	372	390	401	376	407	386
AT2-421		23.4	23.0	23.0	22.4	22.2	22.8	22.6	7.7	8.0	7.8	7.5	7.7	7.9	7.4	6.3	7.2	6.7	7.2	7.1	6.8	6.5	517	428	430	422	404	410	394
AT2-422		23.4	23.0	23.0	22.7	22.3	22.7	22.7	7.7	7.9	7.8	7.4	7.7	7.9	7.4	6.7	6.7	6.7	6.9	6.4	6.7	7.2	418	390	403	407	381	390	378
AT2-423		23.4	23.0	23.1	22.8	22.3	22.7	22.6	7.7	7.9	7.5	7.4	7.7	7.8	7.4	7.2	7.4	6.8	6.9	5.0	6.8	7.4	405	392	407	420	406	384	404
AT2-424		23.4	23.0	23.1	22.7	22.3	22.7	22.5	7.8	7.9	7.6	7.3	7.7	7.8	7.5	7.4	7.0	6.5	6.9	6.0	6.9	7.6	392	382	395	406	386	385	378
Meter Number		681	682	682	681	681	682	682	681	682	682	681	681	682	682	681	682	682	681	681	682	682	681	682	682	681	681	682	682
Time		0901	0846	0839	0807	0827	0826	0818	0901	0846	0839	0807	0827	0826	0818	0901	0846	0839	0807	0827	0826	0818	0901	0846	0839	0807	0827	0826	0818
Initials		GL	AH	AH	TP	TP	AH	JB	GL	AH	AH	TP	TP	AH	JB	GL	AH	AH	TP	TP	AH	JB	GL	AH	AH	TP	TP	AH	JB

TOXICITY TEST WATER QUALITY DATA SHEET - OLD SOLUTIONS

Project Number: EA.TOX
Client: Benchmark
QC Test Number: TN-22-610

TEST ORGANISM
Common Name: Midge
Scientific Name: *C. dilutus*

Beginning Date: 7/22/22 Time: 1200
Ending Date: 8/1/22 Time: 0950

TARGET VALUES Temp: 23±1 °C pH: 6.0 - 9.0 DO: ≥4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14
Control (AT1-697)		22.1	22.0	22.1					7.7	7.7	8.1					6.9	7.7	7.2					352	354	341				
AT2-420		22.2	22.1	22.1					7.7	7.7	8.1					6.6	7.1	7.2					374	358	349				
AT2-421		22.2	22.3	22.2					7.7	7.7	8.1					6.2	7.3	7.3					382	370	360				
AT2-422		22.2	22.4	22.2					7.7	7.8	8.0					6.3	7.3	7.2					368	364	355				
AT2-423		22.2	22.4	22.2					7.7	7.7	8.0					6.7	7.4	7.3					406	388	374				
AT2-424		22.0	22.4	22.2					7.7	7.7	8.0					6.4	7.0	6.8					382	374	364				
Meter Number		681	650	681					681	650	681					681	650	681					681	650	681				
Time		0947	0840	0839					0947	0840	0839					0947	0840	0839					0947	0840	0839				
Initials		AY	SL	AY					AY	SL	AY					AY	SL	AY					AY	SL	AY				

TOXICOLOGY LABORATORY BENCH SHEET - RENEWAL RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Day	Date	Time		Initials
0	7/22/22	AM	1160	OW
		PM		
1	7/23/22	AM	0840	GC
		PM	1515	[illegible]
2	7/24/22	AM	0830	AG
		PM	1347	SL
3	7/25/22	AM	0803	AG
		PM	1317	AG
4	7/26/22	AM	0802	TP
		PM	1302	AG
5	7/27/22	AM	0811	JL
		PM	1310	SL
6	7/28/22	AM	0814	AG
		PM	1258	SL
7	7/29/22	AM	0808	JB
		PM	1350	NS
8	7/30/22	AM	0828	GC
		PM	1334	AG
9	7/31/22	AM	0820	SL
		PM	1256	SL
10	8/1/22	AM	0820	AG
		PM		

TOXICOLOGY LABORATORY BENCH SHEET - FEEDING RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Food: 1.5 ml Tetramin Slurry

Day	Date	Time	Initials
0	7/22/22	1610	TP
1	7/23/22	1528	TP
2	7/24/22	1348	SL
3	7/25/22	1330	AG
4	7/26/22	1018	AG
5	7/27/22	1310	SL
6	7/28/22	1334	SL
7	7/29/22	1527	LMO
8	7/30/22	1344	AG
9	7/31/22	1256	SL
10			
11			
12			
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23			
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27			
28			

TOXICOLOGY LABORATORY BENCH SHEET - TESTING LOCATION

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Day	Testing Location	Date	Time	Initials
0	51	7/22/22	1600	TO
1	51	7/23/22	0907	GL
2	51	7/24/22	0836	AG
3	51	7/25/22	0803	AG
4	51	7/26/22	0804	TO
5	51	7/27/22	0830	TO
6	51	7/28/22	0814	AG
7	51	7/29/22	0841	GL
8	51	7/30/22	0826	GL
9	51	7/31/22	1256	JL
10	51	8/1/22	0820	AG
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

TOXICOLOGY LABORATORY BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Date/Time/Initials	Comments/Activity

TOXICOLOGY LABORATORY CORRECTION BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-610

Correction Explanations

(a) Technician Error-Mathematical

(b) Technician Error-Manual Data Recording

(c) Technician Error-Head Count Observation

(d) Technician Error-Overwrite

(e) Technician Error-Missing Data

(f) Technician Error-Lost Organism

(g) Technician Error-Transcription Error

(h) Technician Error-Other:

(i) Meter Malfunction

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8		
*AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8	36.00	46.00
*AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8	36.00	46.00
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8	52.00	46.00
*AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8	36.00	46.00
*AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8	36.00	46.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.88975	0.929	-0.0984	5.45964
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)

Steel's Many-One Rank Test indicates significant differences

Reviewed by: JR

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8		
*AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8	36.00	51.00
AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8		
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8		
AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8		
AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.81804	0.844	-0.1764	3.19827
Equality of variance cannot be confirmed				
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Two-Sample Test indicates significant differences				

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8		
AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8		
*AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8	36.00	51.00
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8		
AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8		
AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.67657	0.844	1.80702	2.82967
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates significant differences

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8		
AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8		
AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8		
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8	52.00	51.00
AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8		
AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.81997	0.844	0	-0.9066
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates no significant differences

Reviewed by: JR

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8		
AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8		
AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8		
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8		
*AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8	36.00	51.00
AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.7856	0.844	-0.8081	-0.1593
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates significant differences

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
AT2-420	0.4000	0.4000	0.8000	0.5000	0.5000	0.6000	0.2000	0.1000
AT2-421	0.5000	0.5000	0.3000	0.3000	0.3000	0.3000	0.3000	0.3000
AT2-422	1.0000	0.9000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
AT2-423	0.1000	0.1000	0.1000	0.1000	0.0000	0.1000	0.0000	0.0000
AT2-424	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

			Transform: Arcsin Square Root				
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N
Control	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8
AT2-420	0.4375	0.4375	0.7149	0.3218	1.1071	33.963	8
AT2-421	0.3500	0.3500	0.6311	0.5796	0.7854	15.093	8
AT2-422	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8
AT2-423	0.0625	0.0625	0.2606	0.1588	0.3218	32.361	8
*AT2-424	0.1000	0.1000	0.3218	0.3218	0.3218	0.000	8

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	1	0.844	0	-2.3077
Equality of variance cannot be confirmed				

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8	S.D.
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240	0.09855
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400	0.17709
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967	0.18004
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120	0.14603
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000				0.33126
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300	0.40281

			Transform: Untransformed					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8		
*AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8	36.00	45.00
*AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8	36.00	45.00
*AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8	36.00	45.00
*AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5	18.00	19.00
*AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8	44.00	45.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.82562	0.926	2.24956	7.83674
Bartlett's Test indicates unequal variances (p = 5.14E-03)	16.6856	15.0863		
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Rank Sum Test indicates significant differences				

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000			
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8			
*AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8	9.135	1.761	0.1262
AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8			
AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8			
AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5			
AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97353		0.844		-0.079	0.56758
F-Test indicates equal variances (p = 0.14)	3.22913		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.1262	0.12649	1.7137	0.02054	2.8E-07	1, 14

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000			
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8			
AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8			
*AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8	8.305	1.761	0.1278
AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8			
AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5			
AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.87283		0.844		1.00071	-0.0474
F-Test indicates equal variances (p = 0.13)	3.33751		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.12781	0.1281	1.45283	0.02106	8.8E-07	1, 14

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000			
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8			
AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8			
AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8			
*AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8	5.583	1.761	0.1097
AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5			
AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96709		0.844		-0.2174	-0.5794
F-Test indicates equal variances (p = 0.32)	2.19576		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.10971	0.10996	0.48376	0.01552	6.7E-05	1, 14

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000			
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8			
AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8			
AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8			
AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8			
*AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5	3.888	2.132	0.3244
AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.88142		0.814		1.43445	3.79181
F-Test indicates unequal variances (p = 7.12E-03)	11.2981		10.0505			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic t Test indicates significant differences	0.32443	0.32516	1.07744	0.04608	5.2E-04	1, 11

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-610	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediments
Sample Date:		Protocol:		Test Species:	CT-Chironomus dilutus
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.9290	1.0090	0.8940	0.9010	1.0870	1.1790	0.9590	1.0240
AT2-420	0.6075	0.4250	0.5075	0.3300	0.3640	0.2217	0.2500	0.0400
AT2-421	0.3080	0.2260	0.2800	0.6633	0.2733	0.4367	0.6767	0.2967
AT2-422	0.5140	0.8333	0.7222	0.4100	0.7050	0.7689	0.5344	0.7120
AT2-423	0.9500	0.1900	0.4300	0.3600	0.1000			
AT2-424	0.1100	0.1400	0.1900	0.0300	1.2600	0.1700	0.1300	0.1300

			Transform: Untransformed					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	0.9978	1.0000	0.9978	0.8940	1.1790	9.877	8		
AT2-420	0.3432	0.3440	0.3432	0.0400	0.6075	51.599	8		
AT2-421	0.3951	0.3960	0.3951	0.2260	0.6767	45.570	8		
AT2-422	0.6500	0.6515	0.6500	0.4100	0.8333	22.467	8		
AT2-423	0.4060	0.4069	0.4060	0.1000	0.9500	81.590	5		
*AT2-424	0.2700	0.2706	0.2700	0.0300	1.2600	149.189	8	44.00	51.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.60492	0.844	3.17523	11.2528
F-Test indicates unequal variances (p = 1.43E-03)	16.7065	8.88539		
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Two-Sample Test indicates significant differences				

ATTACHMENT III

Data Sheets and Statistical Analyses
from *Hyalella azteca* Sediment Toxicity Test
(27 pages)

SEDIMENT TOXICITY TEST SET-UP BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

TEST ORGANISM INFORMATION

Common Name: Amphipod

Scientific Name: *H. azteca*

Lot Number: HA-058

Source: ARO

Adults Isolated (Time, Date): _____

Neonates Pulled (Time, Date): _____

Acclimation: 1 day Age: 12 days

Culture Water (T/S): 23.0 °C Ø ppt

TEST INITIATION

Date	Time	Initials	Activity
7/20/22	1350	JG/GL	Sediment Added to Chambers
↓	↓	↓	Overlying Water Added to Chambers
7/21/22	1310	[signature]	Organisms Transferred

TEST SET-UP

Sample Number(s): AT1-697, AT2-420 → AT2-424

Overlying Water Number: Dechlor

Treatment	Volume Test Sediment	Volume Overlying Water
Pretty Boy Control (AT1-697)	100 ml	175 ml
↓ AT2-420	↓	↓
↓ AT2-224		

TOXICOLOGY LABORATORY BENCH SHEET - ORGANISM RECOVERY RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Organisms Recovered (date, time, initials): 8/12/22, 1230, JR, MKC

TEST ORGANISM

Common Name: Amphipod

Scientific Name: *H. azteca*

Treatment	Replicate	Number of Organisms Loaded	Number of Organisms Recovered
AT1-697	A	10	10
(Lab Control)	B	10	10
	C	10	9
	D	10	9
	E	10	10
	F	10	9
	G	10	10
	H	10	9
AT2-420	A	10	8
	B	10	7
	C	10	9
	D	10	7
	E	10	6
	F	10	5
	G	10	7
	H	10	7
AT2-421	A	10	5
	B	10	5
	C	10	6
	D	10	5
	E	10	4
	F	10	3
	G	10	4
	H	10	5

TOXICOLOGY LABORATORY BENCH SHEET - ORGANISM RECOVERY RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Organisms Recovered (date, time, initials): 8/1/22, 1330, JR, MKL

TEST ORGANISM

Common Name: Amphipod

Scientific Name: *H. azteca*

Treatment	Replicate	Number of Organisms Loaded	Number of Organisms Recovered
AT2-422	A	10	7
	B	10	9
	C	10	8
	D	10	8
	E	10	8
	F	10	7
	G	10	8
	H	10	8
AT2-423	A	10	2
	B	10	0
	C	10	0
	D	10	0
	E	10	0
	F	10	0
	G	10	0
	H	10	3
AT2-424	A	10	9
	B	10	8
	C	10	9
	D	10	9
	E	10	8
	F	10	9
	G	10	9
	H	10	9

WEIGHT DATA (Test Species: *H. azteca*)

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Tin Lot: Feb 290

Oven Temp (°C): Start: 100 End: 103

	Date	Time	Initials
Loaded tins placed in oven:	8/1/22	1335	MKL
Loaded tins removed from oven:	9/4/22	1000	
Loaded tins weighed:	9/4/22	1300	

Oven Number: BLM-01 / G4-009646 Balance Number: TS-L-225.C / P0115825

Test Concentration	Rep	Tin #	A Weight of Tin (mg)	B Weight of Tin and Dried Organisms (mg)	B-A Total Dry Organism Weight (mg)	C Number of Organisms Weighed	(B-A)/C Mean Dry Organism Weight (mg)	(if applicable) Mean Biomass (mg/exposed org.)
Pretty Boy Res.	A	11	27.57	28.86	1.29	10	0.129	
(AT1-697)	B	17	28.38	29.61	1.23	10	0.123	
	C	31	29.00	~~30.27~~ 30.01	1.01	9	0.112	
	D	38	29.16	~~30.56~~ 30.27	1.11	9	0.123	
	E	27	29.35	~~30.39~~ 30.58	1.23	10	0.123	
	F	35	29.33	~~30.67~~ 30.39	1.06	9	0.118	
	G	13	29.50	30.67	1.17	10	0.117	
	H	25	27.48	28.58	1.10	9	0.122	
AT2-420	A	33	30.27	31.29	1.02	8	0.128	
	B	16	27.41	28.41	1.00	7	0.143	
	C	23	27.09	28.21	1.17	9	0.130	
	D	26	29.05	29.94	0.89	7	0.127	
	E	45	29.57	30.29	0.72	6	0.120	
	F	43	28.45	29.15	0.70	5	0.140	
	G	4	28.70	29.52	0.82	7	0.117	
	H	40	29.18	29.97	0.79	7	0.113	

(b) mm 9/6/22

Dry wt. calculations checked (date, initials): 9/29/2022, SR

Biomass calculations checked (date, initials): —

WEIGHT DATA (Test Species: *H. azteca*)

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

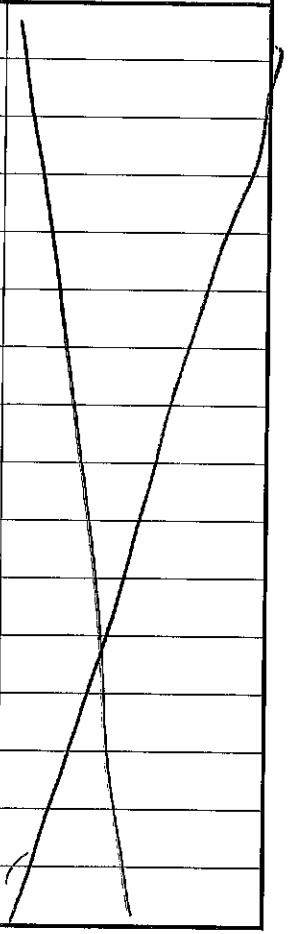
Tin Lot: Red 390

Oven Temp (°C): Start: 100 End: 103

	Date	Time	Initials
Loaded tins placed in oven:	8/1/22	1235	MKL
Loaded tins removed from oven:	9/6/22	1000	
Loaded tins weighed:	9/6/22	1300	

Oven Number: BLM-01 / G4-009646 Balance Number: TS-L-225.C / P0115825

Test Concentration	Rep	Tin #	A Weight of Tin (mg)	B Weight of Tin and Dried Organisms (mg)	B-A Total Dry Organism Weight (mg)	C Number of Organisms Weighed	(B-A)/C Mean Dry Organism Weight (mg)	(if applicable) Mean Biomass (mg/exposed org.)
AT2-421	A	18	27.01	27.44	0.43	5	0.086	
	B	31	29.06	29.72	0.66	5	0.132	
	C	29	27.57	28.08	0.51	6	0.085	
	D	2	29.12	29.54	0.42	5	0.084	
	E	50	29.51	29.83	0.32	4	0.080	
	F	6	28.87	29.08	0.21	3	0.070	
	G	47	28.14	28.54	0.40	4	0.100	
	H	51	28.87	29.30	0.43	5	0.086	
AT2-422	A	8	30.03	30.91	0.88	7	0.126	
	B	7	28.96	29.79	0.81	9	0.090	
	C	34	28.45	29.35	0.90	8	0.113	
	D	21	27.93	28.69	0.76	8	0.095	
	E	49	28.87	29.74	0.87	8	0.109	
	F	19	28.23	29.05	0.82	7	0.117	
	G	42	28.28	29.19	0.91	8	0.114	
	H	29	27.74	28.54	0.80	8	0.100	



Dry wt. calculations checked (date, initials): 9/29/2022, JR

Biomass calculations checked (date, initials): —

WEIGHT DATA (Test Species: *H. azteca*)

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Tin Lot: Red 990

Oven Temp (°C): Start: 100 End: 103

	Date	Time	Initials
Loaded tins placed in oven:	8/1/22	1235	MKL
Loaded tins removed from oven:	9/1/22	1000	—
Loaded tins weighed:	9/6/22	1300	—

Oven Number: BLM-01 / G4-009646 Balance Number: TS-L-225.C / P0115825

Test Concentration	Rep	Tin #	A Weight of Tin (mg)	B Weight of Tin and Dried Organisms (mg)	B-A Total Dry Organism Weight (mg)	C Number of Organisms Weighed	(B-A)/C Mean Dry Organism Weight (mg)	(if applicable) Mean Biomass (mg/exposed org.)
AT2-423	A	81	28.19	28.49	0.30	2	0.150	
	B	15	28.76	—	—	0	—	—
	C	77	29.70	—	—	0	—	—
	D	41	29.63	—	—	0	—	—
	E	20	28.34	—	—	0	—	—
	F	48	29.56	—	—	0	—	—
	G	9	28.69	—	—	0	—	—
	H	44	29.06	29.27	0.21	3	0.070	
AT2-424	A	10	29.92	30.99	1.07	9	0.119	
	B	30	28.86	29.84	0.98	8	0.123	
	C	24	28.26	29.22	0.96	9	0.107	
	D	3	29.11	30.14	1.03	9	0.114	
	E	22	27.22	28.04	0.82	8	0.103	
	F	28	29.69	30.65	0.96	9	0.107	
	G	5	29.32	30.31	0.99	9	0.110	
	H	32	29.73	30.57	0.84	9	0.093	

Dry wt. calculations checked (date, initials): 9/29/2022, OR

Biomass calculations checked (date, initials): —

TOXICITY TEST WATER QUALITY DATA SHEET - NEW SOLUTIONS

Project Number: EA.TOX
Client: Benchmark
QC Test Number: TN-22-611

TEST ORGANISM
Common Name: Amphipod
Scientific Name: *H. azteca*

Beginning Date: 7/22/22 Time: 1310
Ending Date: 8/1/22 Time: 1230

TARGET VALUES: Temp: 23±1 °C pH: 6.0 - 9.0 DO: >4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6	0	1	2	3	4	5	6
Control (AT1-697)		23.4							7.5							~~8.7~~ 7.9							2931						
AT2-420		23.3							7.5							7.7							408						
AT2-421		23.2							7.1							7.0							580						
AT2-422		23.6							7.0							5.1							475						
AT2-423		23.5							7.5							7.4							438						
AT2-424		23.4							7.5							7.7							430						
Meter Number		680							680							680							680						
Time		1045							1045							1045							1045						
Initials		DM							DM							DM							DM						

DM 7/22/22

TOXICITY TEST WATER QUALITY DATA SHEET - OLD SOLUTIONS

Project Number: EA.TOX
Client: Benchmark
QC Test Number: TN-22-611

TEST ORGANISM
Common Name: Amphipod
Scientific Name: *H. azteca*

Beginning Date: 7/22/22 Time: 1312
Ending Date: 8/1/22 Time: 1230

TARGET VALUES Temp: 23±1 °C pH: 6.0 - 9.0 DO: ≥4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Control (AT1-697)		23.3	22.8	22.9	22.7	22.0	22.7	22.5	7.9	7.9	7.6	7.6	8.0	7.8	7.5	7.1	7.3	7.5	7.8	8.1	6.8	7.4	336	343	361	376	368	357	351
AT2-420		23.4	22.8	23.1	22.7	22.0	22.7	22.5	7.8	7.9	7.5	7.4	8.0	7.7	7.5	6.9	7.2	7.2	7.2	8.1	6.6	7.0	401	337	393	419	387	380	377
AT2-421		23.4	22.9	23.2	22.8	22.2	22.7	22.4	7.8	7.7	7.5	7.4	8.0	7.6	7.4	7.0	7.0	6.7	7.0	7.7	6.3	7.6	473	440	445	435	459	384	388
AT2-422		23.4	22.9	23.2	22.8	22.2	22.7	22.5	7.8	7.7	7.5	7.4	7.9	7.4	7.4	7.4	6.9	6.6	7.0	7.5	6.0	7.3	408	407	422	414	389	387	379
AT2-423		23.4	22.9	23.1	22.8	22.2	22.7	22.5	7.8	7.8	7.5	7.3	7.9	7.3	7.5	7.6	7.0	6.5	6.9	7.5	6.0	7.4	396	380	397	402	380	401	379
AT2-424		23.3	22.9	23.2	22.9	22.2	22.6	22.4	7.8	7.8	7.6	7.3	7.8	7.4	7.5	7.5	4.6	5.6	6.9	7.8	6.1	7.5	394	383	393	401	381	382	383
Meter Number		681	682	682	681	681	682	682	681	682	682	681	681	682	682	681	682	682	681	681	682	682	681	682	682	681	681	682	682
Time		0855	0849	0841	0810	0830	0823	0823	0855	0849	0841	0810	0830	0823	0823	0855	0849	0841	0816	0830	0823	0823	0855	0849	0841	0810	0830	0823	0823
Initials		GL	AJ	AJ	TP	TP	AJ	JB	GL	AJ	AJ	TP	TP	AJ	JB	GL	AJ	AJ	TP	TP	AJ	JB	GL	AJ	AJ	TP	TP	AJ	JB

TOXICITY TEST WATER QUALITY DATA SHEET - OLD SOLUTIONS

Project Number: EA.TOX | TEST ORGANISM | Beginning Date: 7/22/22 Time: 1310

Client: Benchmark | Common Name: Amphipod | Ending Date: 8/1/22 Time: 1230

QC Test Number: TN-22-611 | Scientific Name: *H. azteca*

(DO) 7/28/1/22

TARGET VALUES Temp: 23±1 °C pH: 6.0 - 9.0 DO: ≥4.0 mg/L Salinity: 0 ppt Photoperiod: 16 *l*, 8 *d* Light Intensity: 50 - 100 fc

Test Conc	Rep	Temperature (°C)							pH							Dissolved Oxygen (mg/L)							Conductivity (µS/cm)						
		8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14	8	9	10	11	12	13	14
Control (AT1-697)		22.1	22.0	22.2					7.7	7.6	8.0					6.7	6.9	6.9					349	350	341				
AT2-420		22.1	22.2	22.2					7.6	7.6	8.0					6.6	6.9	6.9					368	365	359				
AT2-421		22.1	22.1	22.2					7.5	7.5	7.9					4.6	6.7	6.8					398	386	354				
AT2-422		22.1	22.3	22.2					7.5	7.5	7.9					4.3	6.5	6.7					424	370	371				
AT2-423		22.1	22.3	22.2					7.5	7.5	7.9					4.2	6.8	6.6					373	390	360				
AT2-424		22.1	22.4	22.2					7.6	7.1	7.9					4.1	6.0	5.1					372	365	362				
				6281																									
Meter Number		6281	680	680					6281	680	6281					6281	680	6281					6281	680	6281				
Time		0949	0840	0841					0949	0840	0841					0949	0840	0841					0949	0840	0841				
Initials		AJ	SL	AJ					AJ	SL	AJ					AJ	SL	AJ					AJ	SL	AJ				

TOXICOLOGY LABORATORY BENCH SHEET - RENEWAL RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Day	Date	Time	Initials
0	7/22/22	AM 1000	[illegible]
		PM —	—
1	7/23/22	AM 0840	GL
		PM 1515	[illegible]
2	7/24/22	AM 0836	[illegible]
		PM 1347	SL
3	7/25/22	AM 0803	[illegible]
		PM 1317	[illegible]
4	7/26/22	AM 0805	[illegible]
		PM 1302	[illegible]
5	7/27/22	AM 0810	JL
		PM 1310	SL
6	7/28/22	AM 0814	[illegible]
		PM 1258	SL
7	7/29/22	AM 0808	[illegible]
		PM 1350	[illegible]
8	7/30/22	AM 0823	GL
		PM 1334	[illegible]
9	7/31/22	AM 0820	SL
		PM 1250	SL
10	8/1/22	AM 0820	[illegible]
		PM	

TOXICOLOGY LABORATORY BENCH SHEET - FEEDING RECORD

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Food: 1 ml YCT per beaker daily

Day	Date	Time	Initials
0	7/22/22	1615	TP
1	7/23/22	~~0845~~ 1528	~~GL~~ TP
2	7/24/22	1347	SL
3	7/25/22	1330	AG
4	7/26/22	1317	AG
5	7/27/22	1310	SL
6	7/28/22	1311	SL
7	7/29/22 ~~7/29/22~~	1524 ~~0810~~	JL ~~GL~~
8	7/30/22	1346	AG
9	7/31/22	1246	SL
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			

(b) GL 7/23/22

(b) JL 7/29/22

TOXICOLOGY LABORATORY BENCH SHEET - TESTING LOCATION

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Day	Testing Location	Date	Time	Initials
0	51	7/22/22	1310	
1	51	7/23/22	1515	TP
2	51	7/24/22	0836	AG
3	51	7/25/22	0803	AG
4	51	7/26/22	0805	TP
5	51	7/27/22	0830	TP
6	51	7/28/22	0814	AG
7	51	7/29/22	0840	JL
8	51	7/30/22	0827	GL
9	51	7/31/22	1250	JL
10	51	8/1/22	0820	AG
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

TOXICOLOGY LABORATORY BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Date/Time/Initials	Comments/Activity

TOXICOLOGY LABORATORY CORRECTION BENCH SHEET

Project Number: EA.TOX

Client: Benchmark

QC Test Number: TN-22-611

Correction Explanations

(a) Technician Error-Mathematical

(b) Technician Error-Manual Data Recording

(c) Technician Error-Head Count Observation

(d) Technician Error-Overwrite

(e) Technician Error-Missing Data

(f) Technician Error-Lost Organism

(g) Technician Error-Transcription Error

(h) Technician Error-Other:

(i) Meter Malfunction

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root						1-Tailed	
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8			
*AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8	5.916	2.306	0.1292
*AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8	10.413	2.306	0.1292
*AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8	4.188	2.306	0.1292
*AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8	19.294	2.306	0.1292
AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8	2.087	2.306	0.1292

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93718		0.929		0.82007	1.26892
Bartlett's Test indicates equal variances (p = 0.12)	8.80961		15.0863			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates significant differences	0.07377	0.0782	1.23064	0.01256	4.9E-22	5, 42

Reviewed by: JK

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8			
*AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8	5.753	1.761	0.1015
AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8			
AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8			
AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8			
AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.94767		0.844		0.3144	0.59697
F-Test indicates equal variances (p = 0.25)	2.50086		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.0557	0.05904	0.43955	0.01328	5.0E-05	1, 14

Reviewed by: JR

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root						1-Tailed	
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8			
AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8			
*AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8	12.924	1.761	0.0795
AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8			
AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8			
AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.90235		0.844		-0.2608	-1.0393
F-Test indicates equal variances (p = 0.86)	1.14851		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.04219	0.04473	1.3616	0.00815	3.6E-09	1, 14

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root						1-Tailed	
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8			
AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8			
AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8			
*AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8	5.576	1.761	0.0741
AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8			
AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.89112		0.844		0.18464	-1.1007
F-Test indicates equal variances (p = 0.85)	1.15403		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.03899	0.04133	0.22023	0.00708	6.8E-05	1, 14

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8		
AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8		
AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8		
AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8		
*AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8	36.00	51.00
AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.72555	0.844	1.40111	1.28119
F-Test indicates equal variances (p = 0.10)	3.84482	8.88539		
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Two-Sample Test indicates significant differences				

Growth and Survival Test-Survival

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	1.0000	1.0000	0.9000	0.9000	1.0000	0.9000	1.0000	0.9000
AT2-420	0.8000	0.7000	0.9000	0.7000	0.6000	0.5000	0.7000	0.7000
AT2-421	0.5000	0.5000	0.6000	0.5000	0.4000	0.3000	0.4000	0.5000
AT2-422	0.7000	0.9000	0.8000	0.8000	0.8000	0.7000	0.8000	0.8000
AT2-423	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3000
AT2-424	0.9000	0.8000	0.9000	0.9000	0.8000	0.9000	0.9000	0.9000

			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	0.9500	1.0000	1.3305	1.2490	1.4120	6.547	8		
AT2-420	0.7000	0.7368	0.9990	0.7854	1.2490	13.789	8		
AT2-421	0.4625	0.4868	0.7471	0.5796	0.8861	12.496	8		
AT2-422	0.7875	0.8289	1.0959	0.9912	1.2490	7.399	8		
AT2-423	0.0625	0.0658	0.2495	0.1588	0.5796	68.462	8		
*AT2-424	0.8750	0.9211	1.2136	1.1071	1.2490	5.413	8	48.00	51.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.80007	0.844	-0.3944	-1.7108
F-Test indicates equal variances (p = 0.47)	1.75877	8.88539		
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Two-Sample Test indicates significant differences				

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8	S.D.
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222	0.0051
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129	0.01053
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860	0.01873
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000	0.012
AT2-423	0.1500	0.0700							0.05657
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933	0.00932

			Transform: Untransformed				
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8
*AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8
AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2
AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.93574	0.922	0.5543	2.94885
Bartlett's Test indicates unequal variances (p = 4.89E-04)	22.154	15.0863		

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000
AT2-423	0.1500	0.0700						
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8			
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8	-1.509	1.761	0.0073
AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8			
AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8			
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2			
AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96734		0.844		0.21565	0.02217
F-Test indicates equal variances (p = 0.08)	4.25358		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates no significant differences	0.00728	0.06023	0.00016	6.8E-05	0.15342	1, 14

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000
AT2-423	0.1500	0.0700						
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933

			Transform: Untransformed					Rank	1-Tailed
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8		
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8		
*AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8	44.00	51.00
AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8		
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2		
AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8		

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.01)	0.79955	0.844	2.04657	6.6242
F-Test indicates unequal variances (p = 2.82E-03)	13.4682	8.88539		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Two-Sample Test indicates significant differences

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000
AT2-423	0.1500	0.0700						
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8			
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8			
AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8			
*AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8	2.839	1.761	0.0081
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2			
AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97811		0.844		-0.1838	0.30949
F-Test indicates equal variances (p = 0.04)	5.52851		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.00812	0.06714	0.00069	8.5E-05	0.01314	1, 14

Reviewed by: JK

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000
AT2-423	0.1500	0.0700						
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8			
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8			
AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8			
AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8			
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2	0.273	6.314	0.2528
AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8			

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.84496		0.781		-0.0038	3.58871
F-Test indicates unequal variances (p = 2.16E-05)	122.844		16.2356			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Heteroscedastic t Test indicates no significant differences	0.25281	2.09027	0.00019	0.00042	0.51975	1, 8

Reviewed by: JR

Growth and Survival Test-Growth

Start Date:	7/22/2022	Test ID:	TN-22-611	Sample ID:	Benchmark
End Date:	8/1/2022	Lab ID:		Sample Type:	Sediment
Sample Date:		Protocol:		Test Species:	HA-Hyalella azteca
Comments:					

Conc-	1	2	3	4	5	6	7	8
Control	0.1290	0.1230	0.1122	0.1233	0.1230	0.1178	0.1170	0.1222
AT2-420	0.1275	0.1429	0.1300	0.1271	0.1200	0.1400	0.1171	0.1129
AT2-421	0.0860	0.1320	0.0850	0.0840	0.0800	0.0700	0.1000	0.0860
AT2-422	0.1257	0.0900	0.1125	0.0950	0.1088	0.1171	0.1138	0.1000
AT2-423	0.1500	0.0700						
AT2-424	0.1189	0.1225	0.1067	0.1144	0.1025	0.1067	0.1100	0.0933

			Transform: Untransformed					1-Tailed		
Conc-	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	0.1209	1.0000	0.1209	0.1122	0.1290	4.220	8			
AT2-420	0.1272	1.0516	0.1272	0.1129	0.1429	8.276	8			
AT2-421	0.0904	0.7472	0.0904	0.0700	0.1320	20.726	8			
AT2-422	0.1079	0.8918	0.1079	0.0900	0.1257	11.126	8			
AT2-423	0.1100	0.9095	0.1100	0.0700	0.1500	51.426	2			
*AT2-424	0.1094	0.9043	0.1094	0.0933	0.1225	8.522	8	3.079	1.761	0.0066

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.98022		0.844		-0.287	0.50675
F-Test indicates equal variances (p = 0.13)	3.3351		8.88539			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Homoscedastic t Test indicates significant differences	0.00662	0.05471	0.00054	5.6E-05	0.00816	1, 14

Reviewed by: JR

ATTACHMENT IV

Report Quality Assurance Record
(2 pages)

REPORT QUALITY ASSURANCE RECORD

Client: Benchmark

Project Number: F0022.TOX

Author: Michael Channon

EA Report Number: 8946

REPORT CHECKLIST

QA/QC ITEM	REVIEWER	DATE
1. Samples collected, transported, and received according to study plan requirements.	[signature]	9/29/22
2. Samples prepared and processed according to study plan requirements.	[signature]	9/29/22
3. Data collected using calibrated instruments and equipment.	[signature]	9/29/22
4. Calculations checked:		
- Hand calculations checked	[signature]	9/29/22
- Documented and verified statistical procedure used.	[signature]	9/29/22
5. Data input/statistical analyses complete and correct.	Jessica M Redfern	9/29/2022
6. Reported results and facts checked against original sources.	Jessica M Redfern	9/29/2022
7. Data presented in figures and tables correct and in agreement with text.	Jessica M Redfern	9/29/2022
8. Results reviewed for compliance with study plan requirements.	[signature]	9/29/22

	AUTHOR	DATE
9. Commentary reviewed and resolved.	[signature]	9/30/22

10. All study plan and quality assurance/control requirements have been met and the report is approved:

[signature] PROJECT MANAGER	9/30/22 DATE
Jessica M Redfern QUALITY CONTROL OFFICER	9/29/2022 DATE
[signature] SENIOR TECHNICAL REVIEWER	9/30/2022 DATE

Macroinvertebrate community and sediment toxicity data from the Niagara River Area of Concern, New York (ver. 2.0, May 2023)

Dates

Publication Date

2021-12-16

Start Date

2019

End Date

2022

Last Revision

2023-05-31

Citation

George, S.D., Baldigo, B.P., Duffy, B.T., and Reynolds K.A., 2021, Macroinvertebrate community and sediment toxicity data from the Niagara River Area of Concern, New York (ver. 2.0, May 2023): U.S. Geological Survey data release, https://doi.org/10.5066/P9ZI0EJL.

Summary

A data release containing information on macroinvertebrate communities and sediment toxicity in the Niagara River and adjacent areas collected during a sampling effort conducted between 2019 and 2020, and a sampling effort conducted in 2022. During the first sampling effort, bed sediments were collected at 60 sites in the Niagara River, 5 sites on lower Smoke Creek, and 6 sites on Hoyt Lake for use in sediment toxicity testing and determination of grain size distribution and total organic carbon concentration. Additionally, macroinvertebrate samples were collected from the 60 sites on the Niagara River. During the second sampling effort, bed sediments were collected at 10 sites on lower Smoke Creek (5 of which were repeated from the first sampling effort), 5 reference sites on upper Smoke Creek, and 6 sites on Hoyt Lake (all of which were repeated from the first sampling effort) for toxicity testing, macroinvertebrate community assessment, and and determination of grain size distribution and total organic carbon concentration. Additionally, sediments were collected at 10 sites in the Black Rock Canal, 5 reference sites in the upper Black Rock Canal, and 5 sites in Erie Basin Marina for macroinvertebrate community assessment. The selection of site locations and analyses was done by the U.S. Army Corps of Engineers and the New York State Department of Environmental Conservation based on existing data gaps and prior sediment chemistry data. For both sampling efforts, in situ habitat measurements were taken at the time of sample collection at all sites. All sediment samples were collected using a petite Ponar dredge. Ten-day sediment toxicity tests were performed using two test species, Chironomus dilutus and Hyalella azteca, following standard USEPA test methods. Macroinvertebrates were identified to the lowest practical taxonomic resolution and used to calculate metrics of biological integrity following standard New York State Department of Environmental Conservation procedures. A morphological deformity analysis was also conducted on the mentum mouthpart of midge larvae in the genus Chironomus as an additional measure of toxicity following standard New York State Department of Environmental Conservation procedures. The data release has five separate tables: one containing site locations and habitat information, one containing the results of sediment toxicity tests, one containing macroinvertebrate identifications, one containing standard New York State Department of Environmental Conservation metrics of macroinvertebrate community integrity calculated from the macroinvertebrate identifications, and one containing the results of the morphological deformity analysis.

Suggested citation: George, S.D., Baldigo, B.P., Duffy, B.T., and Reynolds, K.A., 2021, Macroinvertebrate community and sediment toxicity data from the Niagara River Area of Concern, New York (ver. 2.0, May 2023): U.S. Geological Survey data release, https://doi.org/10.5066/P9ZI0EJL.

Water Body	Site ID	Year	C. dilutus Test Date	H. azteca Test Date	Test Type	Replicate Number	Number C. dilutus Surviving	Percent C. dilutus Surviving [1]	Growth C. dilutus (mg)	Biomass C. dilutus (mg)	Number H. azteca Surviving	Percent H. azteca Surviving [2]	Growth H. azteca (mg)	Biomass H. azteca (mg)
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	10	100	1.485	1.485	8	80	0.05125	0.041
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.79125	1.59222	10	100	0.048	0.048
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	8	80	1.6	1.28	10	100	0.042	0.042
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	8	80	1.61571	1.25667	6	60	0.05167	0.031
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.73111	1.73111	10	100	0.048	0.048
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	8	80	1.435	1.148	7	70	0.05571	0.039
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.59778	1.438	7	70	0.04	0.028
Smoke Creek	SC1-2-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	8	80	1.32571	1.03111	8	80	0.045	0.036
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	9	90	1.6875	1.5	10	100	0.074	0.074
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	8	80	1.9225	1.538	10	100	0.09	0.09
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	1.27889	1.151	7	70	0.07	0.049
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	10	100	1.646	1.646	10	100	0.111	0.111
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	1.43556	1.292	10	100	0.08	0.08
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.5225	1.35333	9	90	0.09889	0.089
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.68375	1.49667	10	100	0.077	0.077
Smoke Creek	SC1-4-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	1.56667	1.41	9	90	0.08333	0.075
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	9	90	1.14667	1.032	9	90	0.08	0.072
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.06125	0.94333	10	100	0.058	0.058
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	1.47857	1.29375	7	70	0.05571	0.039
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	8	80	1.28375	1.027	9	90	0.07556	0.068
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.211	1.211	10	100	0.065	0.065
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	10	100	1.225	1.225	8	80	0.06625	0.053
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	8	80	1.26	1.008	9	90	0.06	0.054
Smoke Creek	SC1-6-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	1.26444	1.138	8	80	0.0525	0.042
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.25	1	8	80	0.07125	0.057
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.36667	1.23	10	100	0.063	0.063
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	1.18889	1.07	9	90	0.04444	0.04
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	8	80	1.24875	0.999	9	90	0.06222	0.056
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.267	1.267	8	80	0.05625	0.045
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.36	1.224	9	90	0.06222	0.056
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.2325	1.09556	10	100	0.049	0.049
Smoke Creek	SC1-6-D Dup	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	10	100	1.009	1.009	9	90	0.03778	0.034
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	6	60	0.98333	0.59	5	50	0.078	0.039
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	5	50	0.814	0.407	6	60	0.04667	0.028
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	0.96778	0.871	7	70	0.05	0.035
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	7	70	1.23714	0.866	6	60	0.06833	0.041
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	0.93111	0.838	6	60	0.03667	0.022
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.03667	0.933	7	70	0.05857	0.041
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	6	60	0.92333	0.554	8	80	0.0575	0.046
Smoke Creek	SC1-8-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	8	80	1.13125	0.905	7	70	0.07143	0.05
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	0	0	no survival	no survival	3	30	0.03333	0.01
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	0	0	no survival	no survival	3	30	0.03667	0.011
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	0	0	no survival	no survival	4	40	0.06	0.024
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	0	0	no survival	no survival	7	70	0.04286	0.03
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	0	0	no survival	no survival	5	50	0.036	0.018
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	0	0	no survival	no survival	5	50	0.05	0.025
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	0	0	no survival	no survival	4	40	0.03	0.012
Smoke Creek	SC1-9-D	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	0	0	no survival	no survival	3	30	0.03667	0.011
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	9	90	1.20667	1.086	4	40	0.025	0.01
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	10	100	1.325	1.325	7	70	0.02857	0.02
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	1.35667	1.221	5	50	0.04	0.02
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	10	100	0.812	0.812	6	60	0.05167	0.031
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.51444	1.51444	5	50	0.022	0.011
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	7	70	1.29714	0.908	6	60	0.03333	0.02
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.09889	0.989	2	20	0.04	0.008
Smoke Creek	SC2-1-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	0.96778	0.871	6	60	0.05167	0.031
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	0.26875	0.215	3	30	0.04333	0.013
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	8	80	0.16875	0.135	6	60	0.04	0.024
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	7	70	0.20429	0.143	4	40	0.035	0.014
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	8	80	0.24625	0.197	5	50	0.044	0.022
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	0.21444	0.193	5	50	0.032	0.016
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	0.20333	0.183	6	60	0.02667	0.016
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	7	70	0.26857	0.188	8	80	0.0275	0.022
Smoke Creek	SC2-5-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	7	70	0.39	0.273	5	50	0.04	0.02
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	4	40	0.5175	0.207	7	70	0.04857	0.034
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	5	50	0.252	0.126	4	40	0.0275	0.011
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	4	40	0.35	0.14	3	30	0.04667	0.014
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	3	30	0.40667	0.122	1	10	0.08	0.008
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	3	30	0.39333	0.118	3	30	0.04333	0.013

Suggested citation: George, S.D., Baldigo, B.P., Duffy, B.T., and Reynolds, K.A., 2021, Macroinvertebrate community and sediment toxicity data from the Niagara River Area of Concern, New York (ver. 2.0, May 2023): U.S. Geological Survey data release, https://doi.org/10.5066/P9ZI0EJL.

Water Body	Site ID	Year	C. dilutus Test Date	H. azteca Test Date	Test Type	Replicate Number	Number C. dilutus Surviving	Percent C. dilutus Surviving [1]	Growth C. dilutus (mg)	Biomass C. dilutus (mg)	Number H. azteca Surviving	Percent H. azteca Surviving [2]	Growth H. azteca (mg)	Biomass H. azteca (mg)
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	4	40	0.3175	0.127	2	20	0.04	0.008
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	3	30	0.47667	0.143	2	20	0.05	0.01
Smoke Creek	SC2-6-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	4	40	0.46	0.184	3	30	0.05667	0.017
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.2425	0.994	9	90	0.09667	0.087
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.525	1.35556	10	100	0.113	0.113
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	2.19778	1.978	10	100	0.107	0.107
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	10	100	1.033	1.033	10	100	0.135	0.135
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.18111	1.18111	10	100	0.114	0.114
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	10	100	1.053	1.053	10	100	0.102	0.102
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.30111	1.171	10	100	0.112	0.112
Smoke Creek	SC2-7-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	10	100	1.168	1.168	10	100	0.128	0.128
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.57571	1.22556	9	90	0.10889	0.098
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.27222	1.145	10	100	0.111	0.111
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	10	100	1.329	1.329	10	100	0.115	0.115
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	7	70	1.4	0.93333	10	100	0.097	0.097
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	1.3475	1.19778	10	100	0.123	0.123
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.08556	0.977	10	100	0.153	0.153
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	10	100	1.218	1.218	10	100	0.116	0.116
Smoke Creek	SC2-10-B	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	10	100	1.44778	1.44778	10	100	0.209	0.209
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.12375	0.899	10	100	0.131	0.131
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	10	100	1.45333	1.45333	10	100	0.125	0.125
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	10	100	1.235	1.235	8	80	0.11875	0.095
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	9	90	1.5225	1.35333	10	100	0.128	0.128
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	1.28444	1.156	9	90	0.12556	0.113
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.36111	1.225	10	100	0.136	0.136
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	10	100	1.45333	1.45333	10	100	0.13	0.13
Smoke Creek	SC11-UR-31S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	1.16889	1.052	10	100	0.146	0.146
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	9	90	1.24556	1.121	10	100	0.102	0.102
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	10	100	1.328	1.328	10	100	0.116	0.116
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	7	70	1.318	0.82375	10	100	0.171	0.171
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	9	90	1.47875	1.31444	9	90	0.15333	0.138
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	9	90	1.67667	1.509	10	100	0.14	0.14
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	10	100	1.578	1.578	10	100	0.159	0.159
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.50875	1.34111	9	90	0.15222	0.137
Smoke Creek	SC11-UR-35N	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	1.85222	1.667	10	100	0.158	0.158
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	10	100	1.425	1.425	10	100	0.13	0.13
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	10	100	1.307	1.307	10	100	0.128	0.128
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	7	70	1.19	0.833	10	100	0.148	0.148
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	10	100	1.361	1.361	10	100	0.148	0.148
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	8	80	1.66	1.245	10	100	0.112	0.112
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.39	1.23556	10	100	0.111	0.111
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	9	90	1.25	1.125	10	100	0.124	0.124
Smoke Creek	SC11-UR-038	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	8	80	1.38571	1.07778	10	100	0.159	0.159
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.35625	1.085	10	100	0.125	0.125
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	8	80	1.1425	0.914	9	90	0.12778	0.115
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	9	90	1.16222	1.046	9	90	0.09333	0.084
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	9	90	1.38778	1.249	8	80	0.1225	0.098
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	8	80	1.31571	1.02333	10	100	0.101	0.101
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.48444	1.336	10	100	0.105	0.105
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	8	80	1.43375	1.147	10	100	0.123	0.123
Smoke Creek	SC11-UR-39S	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	8	80	1.235	0.988	10	100	0.101	0.101
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	1	8	80	1.535	1.228	9	90	0.12778	0.115
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	2	9	90	1.36714	1.19625	10	100	0.129	0.129
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	3	8	80	1.70429	1.32556	10	100	0.127	0.127
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	4	9	90	1.25375	1.11444	10	100	0.122	0.122
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	5	10	100	1.47667	1.47667	10	100	0.108	0.108
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	6	9	90	1.6575	1.47333	10	100	0.129	0.129
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	7	10	100	1.79625	1.79625	8	80	0.1225	0.098
Smoke Creek	SC11-UR-047	2022	July 29-August 8, 2022	July 22-August 1, 2022	Standard	8	9	90	1.31143	1.1475	10	100	0.106	0.106

Notes:

1. Chironomus Dilutus: Macroinvertebrate, aquatic insect (aka. lake fly or non-biting midge)
2. Hyalella Azteca: Macroinvertebrate, freshwater epibenthic amphipod crustacean

APPENDIX B

Summary of Cleanup Objectives

EXHIBIT B
SUMMARY OF THE CLEANUP OBJECTIVES

The goal for the corrective measure program is to achieve restricted (industrial) use of the site (and commercial use in select areas where the anticipated use is recreational activity) and to restore groundwater quality to meet applicable SCGs, to the extent feasible. At a minimum, the corrective measures shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at this facility through the proper application of scientific and engineering principles.

The established cleanup objectives at this site are:

Compound	Soil Cleanup Objective[1] (ppm or mg/kg)	Groundwater Cleanup Objective[2] (ppb or ug/L)	SCG[3] ClassA (ppm)	SCG[4] Class C (ppm)
VOCs				
Benzene	89/0.06	1	0.53	1.9
Chlorobenzene	1,000/1.1	5	0.20	1.7
1,2-Dichlorobenzene	1,000/1.1	3	0.28	2.5
Cis-1,2-Dichloroethene	1,000/0.25	5	NS	NS
Trans-1,2-Dichloroethene	1,000/0.19	5	1.2	11.0
Ethylbenzene	780/1	5	0.43	3.7
Styrene	NV/NV	5	NS	NS
Toluene	500/0.7	5	0.93	4.5
1,2,4-Trichlorobenzene	NV/NV	5	35	55
Trichloroethene	400/0.47	5	1.8	8.6
1,1,1- Trichloroethane	1,000/0.68	NS	1.9	3.5
1,2,4-Trimethylbenzene	380/3.6	5	3.4	30
1,3,5-Trimethylbenzene	380/8.4	5	NS	NS
Vinyl Chloride	27/0.02	2	NS	NS
Xylenes, total	1,000/1.6	5	.590	5.2
SVOCs				
Acenaphthene	1,000/98	20	NS	NS
Benzo(a)anthracene	11/1	0.002	NS	NS

Compound	Soil Cleanup Objective[1] (ppm or mg/kg)	Groundwater Cleanup Objective[2] (ppb or ug/L)	SCG[3] ClassA (ppm)	SCG[4] Class C (ppm)
Benzo(a)pyrene	1.1/22	ND	NS	NS
Benzo(b)fluoranthene	11/1.7	0.002	NS	NS
Benzo(k) fluoranthene	110/1.7	0.002	NS	NS
Biphenyl (1,1'-biphenyl)	NV/NV	5	NS	NS
Bis(2-ethylhexyl)phthalate	NV/435	5	NS	NS
Chrysene	110/1	0.002	NS	NS
2,4-Dimethylphenol	NV/NV	1	NS	NS
Indeno(1,2,3-cd)pyrene	11/8.2	0.002	NS	NS
2-Methylphenol	1,000/0.33	1	NS	NS
4-Methylphenol	1,000/0.33	1	NS	NS
Naphthalene	1,000/12	10	NS	NS
Phenol	1,000/0.33	1	NS	NS
Total PAHs	5003	NV	4	35
PFAS				
Perfluorooctanoic acid (PFOA)[5]	0.6/0.0011	0.01	NS	NS
Perfluorooctanesulfonic acid (PFOS)[5]	0.44/0.0037	0.01	NS	NS
Metals				
Arsenic	16/16	25	10	33
Barium	10,000/820	1,000	NS	NS
Cadmium	60/7.5	5	1	5
Chromium	800/19	50	43	110
Cyanide	10,000/40	200	NS	NS
Lead	3,900/450	25	36	130
Mercury, total	5.7/0.73	0.7	0.2	1
Selenium	6,800/4	10	NS	NS
Silver	6,800/8.3	0.1	1	2.2
PCBs/Pesticides				
Total PCBs	25/3.2	0.09	0.1	1

1. 6NYCRR Part 375: Industrial Soil Cleanup Objectives (ISCOs)/Protection of Groundwater SCOs.
2. SCG: Standard Criteria or Guidance - Ambient Water Quality Standards and Guidance Values (TOGs

1.1.1), 6 NYCRR Part 703 - Surface Water and Groundwater Quality Standards, and Part 5 of the New York State Sanitary Code (10 NYCRR Part 5).

3. SCG: Class A- The Department's Screening and Assessment of Contaminated Sediment (June 2014).
4. SCG: Class C- The Department's Screening and Assessment of Contaminated Sediment (June 2014).
5. Further assessment is warranted if any other individual perfluorinated compound (not PFOA or PFOS) is detected in water at or above 0.100 ug/L; or if the total concentration of PFAS (including PFOA and PFOS) is detected in water at or above 0.500 ug/L. Based upon Sampling, Analysis, and Assessment of Per and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs (January 2021).

ppm: parts per million, which is equivalent to milligrams per kilogram, mg/kg, in soil.ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water. ppt: parts per trillion, which is equivalent to nanograms per liter, ng/L, in water.

ND = Not Detected.
NV = No Value.
NS= No Standard.

APPENDIX C

Site-Wide Health and Safety Plan

Site-Wide Health and Safety Plan (HASP)

Tecumseh Redevelopment Inc.
Lackawanna, New York

September 2025

Prepared for:

Tecumseh Redevelopment Inc.
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Prepared by:

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Site-Specific Emergency Information

Emergency Phone Numbers

Most emergency services can be obtained by calling 911. Where 911 service is not available, use the telephone numbers provided in the below table. The following is a master emergency phone list for use by the project management personnel. A more condensed version of the emergency numbers listed below will be posted throughout project work areas. Emergencies encountered on the site will be responded to by a combination of off-site emergency services and on-site personnel.

Emergency Contact Information			
Title	**Contact**		**Telephone**
Operations Manager (OM)	Thomas H. Forbes, P.E.		716-864-1730
Project Principal (PP)	Thomas H. Forbes, P.E.		716-864-1730
Project Manager (PM)	Lori E. Riker, P.E.		716-474-7510
Site Supervisor (SS)	John T. Deth		716-863-0333
Site Health and Site Safety Officer (SHSO)	John T. Deth		716-863-0333
Office Health and Safety Manager (OHSM)	Paul W. Werthman		716-997-9584
Corporate Health and Safety Director (CHSD)	Brian Hobbs, CIH, CSP		631-807-0193
WorkCare, Inc. (formerly AllOne Health)	Occupational Health Care Management Provider		800-350-4511
Client Emergency Contact	Thomas H. Forbes, P.E.		716-864-1730
Outside Assistance			
Agency	**Contact**	**Telephone**	**Address/Location**
Ambulance/emergency medical services (EMS)	AMR West Seneca	911 or 716-882-8400	3809 Seneca Street, Buffalo, New York 14224
Police	Lackawanna Police	**911** or 716-827-6418	714 Ridge Road, Lackawanna, New York 14218
Fire	Lackawanna Fire Division Station 1	911 or 716-827-6436	55 Ridge Road, Lackawanna, New York 14218
Site Address	2303 Hamburg Turnpike, Lackawanna, New York 14218		

Directions to Mercy Hospital; see Figure 1:

- From the Dona Street Extension, turn left (north) onto Hamburg Turnpike (Route 5)
- Proceed north on Hamburg Turnpike (Route 5) to the Tifft Street Exit and turn right onto Tifft Street
- Take Tifft Street east crossing South Park Avenue and McKinley Parkway
- Bear left on Edgewood Avenue
- Turn right on Abbott Road

- Mercy Hospital will be on right hand side. Follow signs to emergency room (ER).

Directions to WellNow Urgent Care; see Figure 1:

- From the Dona Street Extension, turn left (north) onto Hamburg Turnpike (Route 5)
- Proceed north on Hamburg Turnpike (Route 5) to the Ridge Road Exit and turn right onto Ridge Road
- Take Ridge Road east
- WellNow Urgent Care is on the left

1. Introduction

This Site-specific Health and Safety Plan (HASP) has been prepared by Roux Environmental Engineering and Geology, D.P.C. (Roux)[1] for use during sampling and remedial activities performed by Roux on the Corrective Measures Study (CMS) Area of the Tecumseh Redevelopment Inc. (Tecumseh) Site, located at 2303 Hamburg Turnpike, Lackawanna, New York 14218 (Site; Figure 2). This HASP was prepared in general accordance with the requirements of the Occupational Safety and Health Administration (OSHA) standards promulgated at 29CFR 1910.120 and 29CFR 1926.65, both commonly referred to as the Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard. In accordance with the HAZWOPER Standard, this Site-specific HASP was prepared to address the safety and health hazards associated with the sampling and remedial activities being performed at the Site by Roux and to provide requirements and procedures for the protection of Roux employees, subcontractor personnel, government oversight personnel, Site personnel, and the general public. It also addresses client- and Site-specific requirements for health and safety. Additionally, subcontractors may be required to submit their own HASP as it relates to their specific work activities and will be kept onsite during such work.

Implementation of this HASP is the joint responsibility of the Project Manager (PM), the Site Health and Safety Officer (SHSO), and all field staff, with assistance from the Project Principal (PP), Office Health and Safety Manager (OHSM), and Corporate Health and Safety Director (CHSD). For this project, the PM is Ms. Lori E. Riker; the PP is Mr. Thomas H. Forbes, P.E.; the Site Supervisor (SS) and Site Health and Safety Officer (SHSO) is Mr. John T. Deth; the OHSM is Mr. Paul W. Werthman; and the CHSD is Mr. Brian Hobbs.

This HASP will be introduced to, reviewed, and signed off on by all Roux personnel through a formal training session prior to commencing work. A copy of the HASP will be kept at the Site at all times. The Roux SHSO or PM will be responsible for posting any changes, amendments, memos, etc. to the HASP. Any revisions to this HASP will be signed by appropriate personnel, which can include Roux's PP, CHSD, and SS. Any changes will be announced to all workers at the next safety meeting.

1.1 Roles and Responsibilities

The Roles and Responsibilities (R&Rs) of Roux personnel are provided in Roux's Policies and Procedures Manual. Only those R&Rs specific to HASP requirements are listed below.

Project Manager (PM)

The PM has responsibility and authority to direct all work operations. The PM coordinates safety and health functions with the SHSO, has the authority to oversee and monitor the performance of the SHSO, and bears ultimate responsibility for the proper implementation of this HASP. The specific duties of the PM are:

- Preparing and coordinating the Site work plan
- Providing Site supervisor(s) with work assignments and overseeing their performance
- Coordinating safety and health efforts with the SSHO

[1] Formerly Benchmark Civil/Environmental Engineering and Geology, PLLC in association with TurnKey Environmental Restoration, LLC (Benchmark-TurnKey).

- Ensuring effective emergency response through coordination with the Emergency Response Coordinator (ERC)
- Serving as primary Site liaison with public agencies and officials and Site contractors

Site Health and Safety Officer (SHSO)

The SHSO has the full responsibility and authority to develop and implement this HASP and to verify compliance. The SHSO reports to the Project Manager. The SHSO is on Site or readily accessible to the Site during all work operations and has the authority to halt Site work if unsafe conditions are detected. The specific responsibilities of the SHSO include:

- Managing the safety and health functions on this Site
- Serving as the Site's point of contact for safety and health matters
- Ensuring Site monitoring, worker training, and effective selection and use of PPE
- Assessing Site conditions for unsafe acts and conditions and providing corrective action
- Assisting the preparation and review of this HASP
- Maintaining effective safety and health records as described in this HASP
- Coordinating with the SS and others as necessary for safety and health efforts

Site Supervisor (SS)

The SS is responsible for field operations and reports to the PM. The SS ensures the implementation of the HASP requirements and procedures in the field. The specific responsibilities of the SS include:

- Executing the work plan and schedule as detailed by the PM
- Coordination with the SHSO on safety and health
- Ensuring Site work compliance with the requirements of this HASP

Employees

All Roux employees are responsible for reading and following all provisions of the Corporate Health and Safety Manual, including this HASP. Employees report to the SS at the project Site. Each employee is also responsible for the following:

- Wearing all appropriate PPE as outlined within this HASP
- Attending all safety meetings
- Inspecting tools and equipment prior to use, and taking any defective tools or equipment out of service
- Appropriately documenting field events as they occur within a logbook or equivalent
- Properly operating machinery and/or equipment only if trained to do so
- Stopping work operations if unsafe conditions exist
- Identifying and mitigating hazards when observed
- Reporting all incidents and near misses to the Roux SHSO and SS immediately
- Knowing where emergency equipment is located (e.g. first aid kit, fire extinguisher)

Subcontractors and Visitors

Subcontractors and visitors are responsible for complying with the same health and safety requirements. It is the responsibility of all to make sure subcontractors and visitors comply and uphold the HASP. Subcontractors and visitors have the following additional responsibilities:

- Designating a qualified safety representative for the project that can make the necessary changes in work practices, as necessary
- Attending all safety meetings while participating in Roux Site work activities
- Reporting all incidents and near misses to Roux SHSO and SS immediately
- Conducting initial and periodic equipment inspections in accordance with manufacturer and regulatory guidelines
- Providing copies of all safety data sheets (SDS) to Roux SHSO for materials brought to the Site

2. Background

Relevant background information is provided below, including a general description of the Site; a brief review of the Site's history with respect to hazardous material use, handling, and/or storage; and a review of known and potential releases of hazardous substances at the Site.

2.1 Site Description

Tecumseh owns land at 2303 Hamburg Turnpike, approximately 2 miles south of the City of Buffalo (see Figure 2). Most of Tecumseh's property is in the City of Lackawanna (the City), with portions of the property extending into the Town of Hamburg. Tecumseh's property is bordered by NY State Route 5 (Hamburg Turnpike) on the east; Lake Erie to the west and northwest; and other industrial properties to the south and the northeast. Figure 3 provides an overview of the Tecumseh property, including major leased or licensed parcels, and adjacent parcels owned by others.

On-site hazards include exposure to historic contaminants in soil/fill and/or groundwater including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganic compounds (e.g., metals).

Additional hazards include active work areas proximate or on-site with heavy equipment, loud noises, falling/ tripping hazards, etc. Due to the nature of the Site, additional hazards may also be present that may consist of, but are not limited to, plants, animals, and varied terrain.

2.2 Site History

The Tecumseh property is located on a portion of the Site of the former Bethlehem Steel Corporation (BSC) Lackawanna Works in a primarily industrial area. The property was formerly used for production of steel, coke, and related products by BSC. Steel production on the property was discontinued in 1983 and the coke ovens ceased activity in 2000. Tecumseh acquired the property, along with other BSC assets, out of bankruptcy in 2003.

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of the 1,100-acre Tecumseh property was initiated by BSC under an Administrative Order issued by the United States Environmental Protection Agency (USEPA) in 1990. Tecumseh completed the RFI in January 2005. In September 2006, USEPA approved the RFI and terminated Bethlehem Steel's (and in turn Tecumseh's) obligation under the 1990 Administrative Order. Tecumseh entered into an Order on Consent with the New York State Department of Environmental Conservation (NYSDEC) to undertake a CMS at certain solid waste management units (SWMUs) primarily on the western slag fill and coke manufacturing portion of the property.

Tecumseh and the NYSDEC executed an Order on Consent (File No. R9-20190927-126) on September 24, 2020 for implementation of corrective action, closure, and post-closure care for the CMS Area (commonly referred to as the Global RCRA Order). The complete regulatory history of the Tecumseh CMS Area is presented in the November 2021 Final Statements of Basis (SOBs).

2.3 Known and Potential Releases of Hazardous Substances at the Site

The CMS Area was formerly used to house portions of BSC's steel making operations. The slag and other industrial fill materials contain highly variable and sometimes elevated concentrations of metals, as well as VOCs and SVOCs. In addition, groundwater in contact with the soil/fill materials described above may exhibit elevated concentrations of historic contaminants in groundwater. Emerging contaminants 1,4-dioxane and per-l and polyfluoroalkyl substances are also identified as potential chemical hazards which site workers might be exposed.

2.3.1 Parameters of Interest

Constituents of potential concern (COPCs) on-site include:

- **Volatile Organic Compounds (VOCs)** – VOCs present at elevated concentration may include benzene, toluene, ethylbenzene, and xylene (i.e., BTEX). These VOCs are typically associated with storage and handling of petroleum products such as gasoline.
- **Semi-Volatile Organic Compounds (SVOCs) –** SVOCs present at elevated concentrations may include base-neutral SVOCs from oils, greases, and fuels associated with the operation of locomotive engines, steel mills, petroleum bulk storage, and other historic steel manufacturing operations. Specifically, polycyclic aromatic hydrocarbons (PAHs), which are byproducts of incomplete combustion and impurities in petroleum products. Although PAHs are commonly found in urban soil environments, they may be present at the Site at concentrations that are elevated compared to typical "background" levels. Naphthalene is a natural component of fossil fuels such as petroleum and coal; it is also formed when natural products such as wood or tobacco are burned.
- **Inorganic Compounds** – Inorganic compounds present at elevated concentrations due to steel making activities may include arsenic, cadmium, chromium, lead, and mercury. Several of these parameters are components of coke and slag that are prevalent in the planned work areas.
- **Emerging Contaminants -**

In addition, groundwater in contact with the soil/fill materials described above may exhibit elevated concentrations of corresponding soluble COPCs (e.g., BTEX).

3. Scope of Work

Roux personnel will be on-site to observe the general investigation activities described below. Detailed activities are more fully described in the individual Pre-Design Investigation (PDI) Work Plans for each operable unit (OU). PDI Work Plans present the approach for collecting additional investigation data prior to implementation of corrective measures outlined in the NYSDEC November 2021 Final SOBs, Corrective Measures Selection for Operable Units OU-01, 09, and 10 (Ref. 1); Operable Units OU-05 & OU-08 (Ref. 2); and Operable Units OU-06 & OU-07 (Ref. 3). Specifically, the PDI Work Plans address requirements for additional data collection needed to design remedial measures. The information gathered during the PDI will be presented in Remedial Design/Remedial Action (RD/RA) Work Plans. This HASP will be revised to address any new hazards resulting from the PDIs.

4. Site Control

This Site control program is designed to reduce the spread of hazardous substances from contaminated areas to clean areas, to identify and isolate contaminated areas of the Site, to facilitate emergency evacuation and medical care, to prevent unauthorized entry to the Site, and to deter vandalism and theft.

4.1 Site Map

A map of this Site, showing Site boundaries, designated work zones, and points of entry and exit is provided in Figure 3.

4.2 Site Access

Access to the work areas at the Site is restricted to reduce the potential for exposure to its safety and health hazards. During hours of Site operation, Site entry and exit is authorized only at the points identified in Figure 3. Entry and exit at these points is controlled by Site personnel. When the Site is not operating, access to the Site is controlled by the following: prohibited vehicular access due to location of the Site and trespassing restrictions.

4.3 Buddy System

This section is not applicable for all components of the scope of work (SOW) described in Section 3. Some Site inspections, sampling, construction oversight, etc. are completed by a single Roux employee. However, when completing these tasks, the single Roux employee is accompanied either by Roux subcontractors or the Site caretaker/other representatives from Tecumseh. Any time Roux is on-site, Tecumseh is made aware and communications with Tecumseh and the Roux PM is maintained via cellular phone.

While working in the Exclusion Zone, Site workers use the buddy system. The buddy system means that personnel work in pairs and stay in close visual contact to be able to observe one another and summon rapid assistance in case of an emergency. The responsibilities of workers using the buddy system include:

- Remaining in close visual contact with partner
- Providing partner with assistance as needed or requested
- Observing partner for signs of heat stress, chemical overexposure or other difficulties
- Periodically checking the integrity of partner's PPE
- Notifying the SS or other Site personnel if emergency assistance is needed

4.4 Site Communications

The following communication equipment is used to support on-site communication:

- Cell Phones
- Verbal
- Visual/hand signals

As applicable, hand signals will be used according to the following:

Hand Signals

SIGNAL	MEANING
Hand gripping throat	Out of air, can't breathe
Grip partner's wrist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	I'm all right, okay
Thumbs down	No, negative

A current list of emergency contact numbers is included in the Site-Specific Emergency Information section at the beginning of this HASP. Emergency contact information will be maintained in on-site Roux personnel vehicle(s) or an on-site field trailer (if applicable).

4.5 Site Work Zones

The SOW does not require the implementation of work zones; however, should the need arise, this section provides details for the proper execution of work zones at this Site**.**

This Site is divided into the three major zones described below. These zones are characterized by the likely presence or absence of biological, chemical, or physical hazards and the activities performed within them. Zone boundaries are clearly marked at all times and the flow of personnel among the zones is controlled. The Site is monitored for changing conditions that may warrant adjustment of zone boundaries. Zone boundaries are adjusted as necessary to protect personnel and clean areas. Whenever boundaries are adjusted, zone markings are also changed and workers are immediately notified of the change.

Exclusion Zone

The area where contamination exists is the Exclusion Zone (EZ). All areas where excavation and handling of contaminated materials take place are considered part of the EZ. This zone will be clearly delineated by chain link fencing, caution tape, cones or other effective barriers, as necessary. Safety tape may be used as a secondary delineation within the EZ. The zone delineation markings may be opened in areas for varying lengths of time to accommodate equipment operation or specific construction activities. The SHSO may establish more than one EZ where different levels of protection may be employed or where different hazards exist. Personnel are not allowed in the EZ without:

- A buddy (co-worker)
- Required minimum level PPE
- Medical authorization
- Training certification
- Requirement to be in the zone

Contamination Reduction Zone

A Contamination Reduction Zone (CRZ) is established between the exclusion zone and the support zone. The CRZ contains the Contamination Reduction Corridor (CRC) and provides an area for decontamination of personnel and equipment. The CRZ will be used for general Site entry and egress in addition to access for heavy equipment and emergency support services. Personnel are not allowed in the CRZ without:

- A buddy (co-worker)
- Appropriate PPE
- Medical authorization
- Training certification
- Requirement to be in the zone

Support Zone

The Support Zone (SZ) is an uncontaminated area that will be the field support area for the Site operations. The SZ will contain the temporary project trailers and provides for field team communications and staging for emergency response. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel or materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

5. Job Hazard Evaluation

Roux's work at the Site is expected to entail a variety of physical, chemical, and biological hazards, all of which must be sufficiently managed to allow the work to be performed safely. Some of the hazards are Site-specific (i.e., they are associated with the nature, physical characteristics, and/or routine operation of the Site itself), while others are activity-specific (i.e., they are associated with [or arise from] the particular activity being performed). The various hazards can be grouped into the following categories:

- **Caught/Crushed** – the potential to become caught in, under, between, or by an object or parts of an object, such as equipment with parts that open and close or move up and down ("pinch points") or equipment that rotates, and the accompanying potential to have body parts cut, mangled, or crushed thereby.
- **Contact** – the potential to be struck by or against moving or stationary objects that can cause physical injury, such as heavy machinery, overhead piping, moving vehicles, falling objects, and equipment (including tools and hand-held equipment) or infrastructure with the ability to cut or impale.
- **Energy Sources** – the potential for bodily harm associated with energy sources, most notably electricity, but also including latent energy sources such as compressed air and equipment under tension (which when released could cause injurious contact or a fall).
- **Ergonomics** – the potential for musculoskeletal injury associated with lifting/carrying, pushing/pulling, bending, reaching, and other physical activity attributable to poor body position/mechanics, repetitive motion, and/or vibration.
- **Exposure** – the potential for injury/illness due to physical, chemical, or biological exposures in the work environment, including, but not limited to, temperature extremes, solar radiation, and noise (physical), chemical splashes and hazardous atmospheres (chemical), and animal/insect bites and poisonous plants (biological).
- **Falls** – the potential to slip or trip and thus fall or drop a load, resulting in bodily injury to oneself or others.

The foregoing is intended to provide Roux employees with a general awareness of the hazards involved with Site work. A more detailed review of the potential hazards associated with each specific activity planned for the Site (or on-going activity, as the case may be) is provided in the activity-specific Job Safety Analysis (JSA) forms in Appendix A. As can be seen in the JSA forms, the hazards are identified by category per the above, and specific measures designed to mitigate/manage those hazards are also identified. In preparing the JSA forms, all categories of hazards were considered, and all anticipated potential hazards were identified to the extent possible based on the experience of the personnel preparing and reviewing the JSA forms. However, there is always the possibility for an unanticipated hazard to arise, potentially as conditions change over the course of the workday. Roux personnel must maintain a continual awareness of potential hazards in the work zone, regardless of whether the hazard is identified in the JSA form. Particular attention should be paid to hazards associated with exposure to hazardous substances (see Table 1 for a listing of the hazardous substances most likely to be encountered in environmental media at the Site) and to Site personnel being located "in the line of fire" with respect to moving equipment, pinch points, and latent energy (e.g., being located or having body parts located within the swing radius of an excavator, between two sections of pipe being connected, below a piece of suspended equipment, or adjacent to a compressed air line).

5.1 Hazard Communication and Overall Site Information Program

The information in the JSAs and SDSs is made available to all employees and subcontractors who could be affected by it prior to the time they begin their work activities. Modifications to JSAs are communicated during routine pre-work briefings and periodically updated as needed in the HASP. SDSs will be maintained by the SHSO/SS for new chemicals brought on-site as needed. Appendix B includes copies of SDSs.

5.2 Noise

Noise is associated with the operation of heavy equipment, power tools, pumps, and generators. Noise is also a potential hazard when working near operating equipment such as excavators, drill rigs or pole drivers. High noise (i.e., < 85 dBA) operations may be evaluated by the SHSO utilizing a type 2 handheld sound level meter (SLM) operating on the "A"-weighted scale with slow response because this scale most closely resembles human response to noise and complies with OSHA 29CFR 1910.95. Hearing protection is required in areas with noise exposure greater than 85 dBA. Double hearing protection (ear plugs and earmuffs) should be donned in areas where the noise exposure is more than 95 dBA. Noise exposure will be controlled by hearing protection as described above or by maintaining set-backs from high-noise equipment, as warranted. Personnel handling heavy equipment and using power tools that produce noise levels exceeding those described levels above are required by OSHA 29CFR 1910.95 to wear the appropriate Noise Reduction Rating (NRR) level of hearing protection. Appropriate hearing protection will be evaluated by the SHSO as necessary in consultation with the OHSM and CHSD.

5.3 Slip, Trip, and Fall Hazards

Slip, trip, and fall hazards may include, but are not limited to, general slip and trip hazards associated with uneven ground, possible debris, wet grass, and equipment. Prior to work, walking paths will be assessed for solid footings, any ground penetrations that may cause a tripping hazard will be appropriately marked, and other areas will be noted and discussed with the field team.

Personnel shall be aware of their surroundings and footings at all time, and all accommodations should be made for proper housekeeping and organized equipment placement at the Site, where possible, to help prevent any slip, trip, and fall-related incidents. All tools and materials should be appropriately stored when not in use and placed in appropriate storage containers.

5.4 Biological Hazards

Biological hazards that may potentially be present at a Site, include poisonous plants, insects (ticks, spiders, bees), animals (snakes, dogs), etc. Information on biological hazards can be found within Roux's Biological Hazard Awareness Management Program located within Roux's Corporate Health and Safety Manual. There is also potential for transmission and/or exposure to SARS-CoV-2, the virus that causes COVID-19. Prior to beginning work, on-site protocols shall be established by the project team, including subcontractors, in accordance with federal, state, county, city, and/or other guidance, as applicable.

6. Emergency Response Plan

This emergency response plan details actions to be taken in the event of Site emergencies. The PM and SHSO are responsible for the implementation of emergency response procedures onsite. The SHSO/PM provides specific direction for emergency action based upon information available regarding the incident and response capabilities and initiates emergency procedures and notification of appropriate authorities. In the event of an emergency, Site personnel are evacuated and do not participate in emergency response activities, response is facilitated through external emergency services.

6.1 Emergency Response

The SHSO, after investigating the incident and relevant information, shall determine the level of response required for containment, rescue and medical care. Limited on-site emergency response activities could occur therefore the SHSO is responsible for notifying external emergency response agencies. The SHSO provides relevant information to the responding organizations, including, but not limited to, the hazards associated with the emergency incident, potential containment problems, and missing Site personnel.

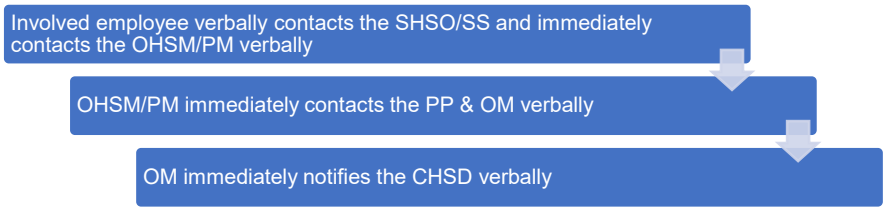
6.2 Emergency Alerting and Evacuation

If evacuation notice is given, Site workers leave the worksite, if possible, by way of the nearest exit. Appropriate primary and alternate evacuation routes and assembly areas have been identified and are shown on the Site Plan with Emergency Muster Area (Figure 3). The routes and assembly area will be determined by conditions at the time of the evacuation based on wind direction, the location of the hazard source, and other factors as determined by SHSO/PM.

Personnel exiting the Site gather at a designated assembly point. To determine that everyone has successfully exited the Site, personnel will be accounted for at the assembly point. If any worker cannot be accounted for, notification is given to the SHSO, PM, and any arriving response authorities so that appropriate action can be initiated. Subcontractors on this Site have coordinated their emergency response plans to ensure that these plans are compatible and potential emergencies are recognized, alarm systems are clearly understood, and evacuation routes are accessible to all personnel relying upon them.

6.3 Emergency Medical Treatment and First Aid

In the event of a work-related injury or illness, employees are required to follow the procedures outlined below. All work-place injury and illness situations require Roux's Project and Corporate Management Team to be notified when an injury/illness incident occurs and communication with the contracted Occupational Health Care Management Provider, WorkCare, Inc. (formerly AllOne Health) is initiated, as necessary. The Injury/Illness Notification Flowchart is provided below and within Roux's Incident Investigation and Reporting program included within Roux's Corporate Health and Safety Manual.



If on-site personnel require any medical treatment, the following steps will be taken:

a. Notify Roux's Project and Corporate Management Team for any work-related injury and/or illness occurrence and communicate with the contracted Occupational Health Care Management Provider, WorkCare, immediately following the notifications provided above.

b. Based on discussions with the Project Team, Corporate Management and the WorkCare evaluation, if medical attention beyond onsite first aid is warranted, transport the injured / ill person (IP) to the Urgent Care Center, or notify the Fire Department or Ambulance Emergency service and request an ambulance or transport the victim to the hospital, and continue communications with Corporate Management Team. An Urgent Care/Hospital Route map with location to Mercy Hospital is included as Figure 1.

c. Decontaminate to the extent possible prior to administration of first aid or movement to medical or emergency facilities.

d. First aid medical support will be provided by onsite personnel trained and certified in First Aid, Cardio Pulmonary Resuscitation (CPR), Automatic External Defibrillation (AED), and Blood-Borne Pathogens (BBP) Awareness, until relieved by emergency medical services (EMS).

e. The SHSO and PM will perform a Loss Investigation (LI) and the Project Team will complete the final Loss Report. If a Roux employee is involved in a vehicular incident, the employee must also complete the Acord Automobile Loss Notice.

7. Environmental Conditions and Response

7.1 Adverse Weather Conditions

In the event of adverse weather conditions, the SHSO or project principal will determine if work can continue without jeopardizing the health and safety of field workers. Some of the items related to adverse weather conditions to be considered prior to determining if work should continue include:

- Potential for heat stress and heat-related injuries
- Potential for cold stress and cold-related injuries
- Treacherous weather-related conditions. If wind speed is greater than 15 mph averaged over a 15-minute period or wind gusts over 25 mph, earthmoving operations will be ceased
- Limited visibility
- Electrical storm potential

Site activities will be limited to daylight hours and acceptable weather conditions. Inclement working conditions may include heavy rain, fog, high winds, and lightning. The SHSO and/or PM shall observe daily weather reports and evacuate, if necessary, in case of inclement weather conditions.

7.2 Electrical Storm Guidelines

In the event that lightning and/or thunder are observed while working onsite, all onsite activities shall stop and personnel shall seek proper shelter (e.g., substantial building, enclosed vehicle, etc.). Work shall not resume until the threat of lighting has subsided and no lightning or thunder has been observed for 30 minutes. If the possibility of lightning is forecast for the day, advise the onsite personnel on the risks and proper procedure at the pre-work safety briefing. Continuously monitor for changing weather conditions and allow enough time to properly stop work if lightning is forecast.

7.3 Environmental Stressors, Heat Stress, Heat Exhaustion, and Heat Stroke

It is the employer's responsibility to monitor weather forecasts and ambient air temperatures, both prior to the work shift and during the shift. The National Oceanic and Atmospheric Administration records average minimum/maximum temperatures of 27.8 (winter) and 69.6 (summer) degrees Fahrenheit (°F) during the year in Buffalo, New York. Based on the Site's proximity to Lake Erie, these temperatures may fluctuate dramatically.

To prevent potential heat illness, the following strategies will be implemented:

- Adjusting personnel work/rest intervals
- Monitoring for symptoms of heat illness
- Providing shaded rest areas
- Providing cool potable water so that each employee has access to at least one quart per hour for the entire shift, free of charge
- Allowing for employees to acclimatize to the weather conditions and work demands

- Observe workers during a heat wave (i.e., when the temperature is at least 80°F, and 10 degrees hotter than the average temperature of the five preceding days)
- Implementing high heat procedures when the temperature reaches 95°F

Roux's Heat Illness Prevention Plan is implemented when the when ambient temperatures exceed 80°F. Roux's Heat Illness Prevention Program can be found within Appendix C. Additional information regarding heat illnesses is provided below. This can include, but is not limited to, access to shade that is sufficient in size to fit all workers who are on break; a car with air conditioning is acceptable, too. Preventative cool-down breaks shall be allowed at any time, and anyone taking such a break will be monitored for heat illness symptoms and not required to return to work until all symptoms (if present) of heat illness have disappeared. If necessary, first aid will be offered, but if symptoms are severe, emergency response procedures will be implemented per Section 6.3. Anyone who has shown symptoms of severe heat illness will not be sent home without being offered first aid or medical treatment.

High heat procedures must be implemented when temperatures reach 95°F. These procedures include:

- Ensuring that effective communication by voice, observation, or electronic means is maintained so that employees at the work site can contact a supervisor when necessary. An electronic device, such as a cell phone or text messaging device, may be used for this purpose only if the reception in the area is reliable.
- Observing employees for alertness and signs or symptoms of heat illness. The employer shall ensure effective employee observation/monitoring by implementing one or more of the following:
    - Supervisor or designee observation of 20 or fewer employees
    - Mandatory buddy system
    - Regular communication with sole employee such as by radio or cellular phone, or other effective means of observation
- Designating one or more employees on each worksite as authorized to call for emergency medical services and allowing other employees to call for emergency services when no designated employee is available.
- Encouraging employees throughout the work shift to drink plenty of water.
- A review of the high-heat procedures during the daily tailgate meeting and remind employees of their right to take a cool-down rest when necessary.

7.3.1 Heat Stress

Heat stress is the body's response to excessive heat and can be a significant potential hazard. The risk of heat stress can be increased with heavy physical activity and/or the use of personal protective equipment (PPE) in hot, humid weather environments. There are also personal risk factors that can contribute to the risk of suffering from heat stress, such as obesity, water intake, alcohol and caffeine consumption, pregnancy, age, medication, etc. Heat illness includes heat cramps, heat exhaustion, heat syncope, and heat stroke.

7.3.2 Heat Cramps

Heat cramps may be brought on by prolonged exposure to heat. As an individual sweats, water and salts are lost by the body resulting in painful muscle cramps, typically in the legs.

First aid treatment includes, but is not limited to, shade, rest, and fluid replacement. Typically, the individual should recover within one-half hour while being monitored constantly. If the individual has not improved substantially within 30 minutes and the body temperature has not decreased, the individual should be transported to a hospital for medical attention.

Per Roux's Heat Illness Prevention Plan, employees shall have access to potable drinking water that is fresh, pure, suitably cool, free of charge, and in sufficient quantities. Access to shade shall be present when temperatures exceed 80°F and shall be available when temperatures do not exceed 80°F.

7.3.3 Heat Exhaustion

Heat exhaustion may occur in an individual who has been exposed to excessive heat while working or exercising. The circulatory system of the individual fails as blood collects near the skin to rid the body of excess heat through transference. The signs and symptoms of heat exhaustion are as follows:

- Rapid and shallow breathing
- Weak pulse
- Cold and clammy skin with heavy perspiration
- Skin appears pale
- Fatigue and weakness
- Dizziness
- Elevated body temperature

First aid treatment includes, but is not limited to, cooling the victim, elevating the feet, and replacing fluids. If the individual is not substantially improved within 30 minutes and the body temperature has not decreased, the individual should be transported to the hospital for medical attention.

7.3.4 Heat Stroke

Heat stroke occurs when an individual is exposed to excessive heat and stops sweating. This condition is classified as a MEDICAL EMERGENCY requiring immediate cooling of the victim and transport to a medical facility. The signs and symptoms of heat stroke are as follows:

- Dry, hot, red skin
- Body temperature approaching or above 105°F
- Confusion, altered mental state, slurred speech
- Seizures
- Large (dilated) pupils
- Loss of consciousness – the individual may go into a coma

First aid treatment requires immediate cooling and transportation to a medical facility. Heat stress is a significant hazard if any type of protective equipment (semi-permeable or impermeable) that prevents evaporative cooling when worn in hot weather environments.

7.4 Cold Stress

Cold stress is a danger at low temperatures and when the wind-chill factor is low. Prevention of cold-related illnesses is a function of whole-body protection. Adequate insulating clothing must be used when the air temperature is below 60°F. A work/rest regimen will be initiated when ambient temperatures and protective clothing cause a stressful situation. In addition, reduced work periods followed by rest in a warm area may be necessary in extreme conditions. The signs and symptoms of cold stress include the following:

- Severe shivering
- Abnormal behavior
- Slowing
- Weakness
- Stumbling or repeated falling
- Inability to walk
- Collapse
- Unconsciousness

First aid requires removing the victim from the cold environment and seeking medical attention immediately. Also, prevent further body heat loss by covering the victim lightly with blankets. Do not cover the victim's face. If the victim is still conscious, administer hot drinks and encourage activity such as walking, wrapped in a blanket.

8. Safety Procedures

This section of the HASP presents the specific safety procedures to be implemented during Roux's activities at the Site in order to protect the health and safety of various on-site personnel. Minimum OSHA-mandated procedures are presented first, followed by client- and Site-specific procedures. Lastly, activity-specific procedures are discussed. These Site and activity-specific procedures supplement the general safety procedures included in Roux's Corporate Health and Safety Manual, which also must be followed in their entirety.

8.1 Training

At a minimum, Site personnel who will perform work in areas where there exists the potential for toxic exposure will be health and safety-trained prior to performing work on-site per OSHA 29CFR 1910.120(e) and 29CFR 1926.65(e). More specifically, all Roux, subcontractor, and other personnel engaged in sampling and remedial activities at the Site and who are exposed or potentially exposed to hazardous substances, health hazards, or safety hazards must have received at a minimum the 40 hour initial HAZWOPER training consistent with the requirements of 29CFR 1910.120(e)(3)(i) training and a minimum of 3 days' actual field experience under the direct supervision of a trained experienced supervisor, plus 8 hours of refresher training on an annual basis. Depending on tasks performed, less training may be permitted. Evidence of such training must be maintained at the Site at all times. Furthermore, all on-site management and supervisory personnel directly responsible for or who supervise the employees engaged in Site remedial operations, must have received an additional 8 hours of specialized training at the time of job assignment on topics including, but not limited to, the employer's safety and health program and the associated employee training program, PPE program, spill containment program, and health hazard monitoring procedure and techniques, plus 8 hours of refresher training on an annual basis. Additionally, all workers who will be required to don a respirator will be properly trained on their employer's Respiratory Protection Program, which also includes being medically cleared to wear a respirator and passed a fit test, at least initially prior to use, and then annually thereafter in accordance with 29CFR 1910.134, Respiratory Protection.

Roux personnel training records are maintained in a corporate database with records available upon request from either the OHSM/SHSO/CHSD or Human Resources (HR) Department.

8.2 Site-Specific Safety Briefings for Visitors

A site-specific briefing is provided to all site visitors who enter this site beyond the site entry point. For visitors, the site-specific briefing provides information about site hazards, the site lay-out including work zones and places of refuge, the emergency alarm system and emergency evacuation procedures, and other pertinent safety and health requirements as appropriate.

8.3 HASP Information and Site-Specific Briefings for Workers

Site personnel review this HASP and are provided a Site-specific tailgate briefing prior to the commencement of work to ensure employees are familiar with this HASP and the information and requirements it contains, as well as the relevant JSAs included in Appendix A. Additional briefings are provided as necessary to notify employees of any changes to this HASP as a result of information gathered during on-going Site characterization and analysis of changing conditions. Conditions for which we schedule additional briefings

include, but are not limited to changes in site conditions, changes in the work schedule/plan, newly discovered hazards, and incidents occurring during Site work.

8.4 Medical Surveillance

The medical surveillance section of the HASP describes how worker health status is monitored at this site. Medical surveillance is used when there is the potential for worker exposure to hazardous substance at levels above OSHA Permissible Exposure Limits (PEL) or other published limits. The purpose of a medical surveillance program is to medically monitor worker health to ensure that personnel are not adversely affected by site hazards. The provisions for medical surveillance at this site are based on the site characterization and job hazard analysis found in Section 4 of this HASP and are consistent with OSHA requirements in 29CFR 1910.120(f) as applicable.

8.4.1 Site Medical Surveillance Program

Medical surveillance requirements are based on a worker's potential for exposure as determined by the site characterization and job hazard analysis documented in Section 4 and JSAs within Appendix A of this HASP and in compliance with the requirements of 29CFR 1910.120(f)(2). Based on site information and use of direct reading instruments, limited use of respirators (less than 30 days per year), and the absence of an employee-staffed HAZMAT team, a limited medical surveillance program is required and implemented at this site. The medical surveillance program provides that:

1. Workers assigned to tasks requiring the use of respirators receive medical examinations in accordance with 29 CFR 1910.134(e) to ensure they are physically capable to perform the work and use the equipment.
2. If a worker is injured, becomes ill, or develops signs or symptoms of possible over-exposure to hazardous substance or health hazards, medical examinations are provided to that worker as soon as possible after the occurrence and as required by the attending physician.
3. These medical examinations and procedures are performed by or under the supervision of a licensed physician and are provided to workers free of cost, without loss of pay, and at a reasonable time and place. In addition, the need to implement a more comprehensive medical surveillance program will be re-evaluated after any apparent over-exposure.

8.4.2 Medical Recordkeeping Procedures

Medical recordkeeping procedures are consistent with the requirements of 29CFR 1910.1020 and are described in the company's overall safety and health program. A copy of that program is available at our Islandia, New York office.

The following items are maintained in worker medical records:

- Respirator fit test and selection
- Physician's medical opinion of fitness for duty (pre-placement, periodic, termination)
- Physician's medical opinion of fitness for respirator protection (pre-placement, periodic)
- Exposure monitoring results

8.4.3 Program Review

The medical program is reviewed to ensure its effectiveness. The CHSD, in coordination with the HR Director, is responsible for this review. At minimum, this review consists of:

- Review of accident and injury records and medical records to determine whether the causes of accidents and illness were promptly investigated and whether corrective measures were taken wherever possible.
- Evaluation of the appropriateness of required medical tests based on site exposures.
- Review of emergency treatment procedures and emergency contacts list to ensure they were site-specific, effective, and current.

8.5 Personnel Protection

Site safety and health hazards are eliminated or reduced to the greatest extent possible through engineering controls and work practices. Where hazards are still present, a combination of engineering controls, work practices and PPE are used to protect employees. Appropriate PPE shall be worn by Site personnel when there is a potential exposure to chemical, biological, or physical hazards (e.g., falling objects, flying particles, sharp edges, electricity, and noise), as determined by the SHSO. The level of personal protection, type and kind of equipment selected will depend on the hazardous conditions and in some cases cost, availability, compatibility with other equipment, and performance. An accurate assessment of all these factors will be made before work can be safely executed.

Roux maintains a comprehensive written PPE program that addresses proper PPE selection, use, maintenance, storage, fit, and inspection. Roux's PPE program can be found within Appendix D. PPE to be used at the Site will meet the appropriate American National Standards Institute (ANSI) standards and the following OSHA (General/Construction Industry) standards for minimum PPE requirements.

The minimum level of PPE for entry onto the Site is Level D. If evaluation of COPCs or other physical hazards are present that require an upgrade in PPE consultation with the OHSM & CHSD will be completed to determine the appropriate level of personal protection. The following equipment shall be worn:

- Work uniform (long pants, sleeved shirt)
- Hard hat
- Steel or composite toe work boots (must comply with American Society for Testing and Materials [ASTM]) F 2412-05, Standard Test Methods for Foot Protection and ASTM F 2413-05, Standard Specification for Performance Requirements for Foot Protection)
- Safety glasses (must comply with one of the following ANSI/ISEA Z87.1-2010, ANSI Z87.1-2003, ANSI Z87.1-2003)
- Boot covers (as needed)
- Hearing protection (as needed)
- High visibility clothing (shirt/vest)
- Hand protection (e.g., minimum cut resistance meeting ANSI 105-2000 Level 2)

Jewelry shall be removed or appropriately secured to prevent it from becoming caught in rotating equipment or unexpectedly snagged on a fixed object (e.g., wrist watches, bracelets, rings, chains and necklaces, open earrings). Do not wear loose clothing and all shoulder-length hair should be tied back.

Site-specific PPE ensembles and materials are identified within task specific JSAs located within Appendix A, and any upgrades or downgrades of the level of protection (i.e., not specified in the JSA) must be approved by the PP and immediately communicated to all Roux personnel and subcontractors as applicable. PPE is used in accordance with manufacturers' recommendations.

8.5.1 Additional Personal Protection

If the Site requires Level C or B PPE or there are regulatory requirements or requests, the following PPE shall be evaluated and donned as appropriate.

As outlined above, the minimum PPE for entry onto the Site is modified Level D. Outlined below are the requirements for Level C and B PPE.

EPA Level C Protection

Personal Protective Equipment:

- Full-face, air-purifying, cartridge-equipped respirator* (Mine Safety and Health Administration/ National Institute of Occupational Safety and Health [MSHA/ NIOSH] specifically approved for protection from organic vapors or particulates)
- Chemical-resistant clothing (coverall; hooded, two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls)
- Cotton coveralls
- Gloves (outer), chemical-resistant, nitriles
- Gloves (inner), cut resistant (with minimum blade cut-rating of ANSI 105-2000 Level 2)
- Boots (inner), chemical-resistant, steel (or composite) toe and including task-specific boot requirements as consistent with ASTM F2413-11
- Boots (outer), chemical-resistant (disposable)
- Hard hat
- Hearing protection (as needed)
- Escape mask (as needed)

*Cartridges in use will be changed out based on their End of Service Life Indicator. If organic vapor (OV) cartridges are worn for benzene exposures above 1 parts per million (ppm), the cartridge shall be removed from service at the end of the calculated service life or before the next shift, whichever is sooner. For other contaminants present a cartridge change out schedule will be provided based off 3M Select & Service Life Software or in consultation with the CHSD; worst case assumptions will be made to provide a conservative estimate on cartridge change out. If multiple contaminants are present at varying degrees, the work must cease operation, as cartridges in use may not cover all contaminants present. Screening will be carried out during work activities as specified in Section 8.6 Air Monitoring Plan. Organic vapors adsorbed on an organic vapor cartridge can migrate through the carbon bed without airflow. Desorption of the contaminant after partial use of the chemical cartridge can occur after a short period (hours) without use (e.g., overnight). This is most significant for the most volatile and poorly retained organic vapors (e.g., boiling point < 65 degrees Celsius [ºC]). For organic vapors with a boiling point less than 65 degrees C, it is recommended that the organic vapor cartridge never be used longer than one shift, even if the estimated service life is greater than 8 hours, and the cartridge is used for only a short time during the shift.

Criteria for Selection-Level C:

Meeting any of these criteria warrants use of Level C protection.

- Airborne hazards are known to be present but are unlikely to exceed protection factors provided by air purifying respirators.
- Continuous total organic vapor readings in the breathing zone register between 50 ppm and to less than 100 ppm on a PID (such as a MiniRAE 3000 or other comparable instrument), and chemical specific (e.g., BTEX) readings utilizing colorimetric indicator tubes (e.g., Dräeger or Sensidyne) are undetectable.
- See the Combustible Gases table for decisions based on Lower Explosive Limit (LEL) within Section 8.5. Air Monitoring Plan.
- Measured air concentrations of known organic vapors will be reduced by the respirator to at or below one half of the PEL, and the individual and combined compound concentrations are within the service limit of the respirator cartridge.
- Atmospheric contaminant concentrations do not exceed Immediately Dangerous to Life and Health (IDLH) concentrations.
- Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect the small area of skin left unprotected by chemical-resistant clothing.
- Job functions have been determined not to require self-contained breathing apparatus.

Notes:
1. Benzene and or other specific compounds may also be monitored initially and periodically in the breathing zone utilizing activated sampling devices approved for use based on lower occupational exposure limits.
2. Modifications of Level C will be used to increase or decrease the level of skin protection during activities that increase or preclude, respectively, the degree of contact with chemical hazards. Modifications for increased protection may include, but are not limited to, the use of chemical resistant coveralls (e.g., Tyveks) and cut and chemical resistant gloves. Any modifications to Level C will require approval of the SHSO, and PM in consultation with the CHSD.

EPA Level B Protection (Contact the OHSM and/or CHSD)

Personal Protection Equipment:

- Pressure-demand, self-contained breathing apparatus (MSHA/NIOSH approved)
- Chemical-resistant clothing (overall and long-sleeved jacket; coveralls; hooded, one or two-piece chemical-splash suit; disposable chemical-resistant coveralls)
- Cotton coveralls
- Chemical-resistant gloves (outer) nitriles
- Gloves (inner), cut-resistant (with minimum blade cut rating of ANSI Level 2)
- Boots (inner), chemical-resistant, steel (or composite) toe, and task-specific boot requirements as consistent with ASTM F2413-11
- Boots (outer), chemical-resistant, (disposable)
- Hard hat
- Hearing protection (as needed)
- 2-way radio communications (intrinsically safe)

Criteria for Selection-Level B:

Meeting any one of these criteria warrants use of Level B protection.

- PID instrument (such as a MiniRAE 3000 or other comparable instrument) readings in the breathing zone are greater than 50 ppm and less than 100 ppm and benzene is detectable utilizing colorimetric indicator tubes (e.g., Dräeger or Sensidyne).
- Airborne hazards are known to be present but are not identified or quantified.
- The type(s) and atmospheric concentration(s) of toxic substance(s) have been identified and require the highest level of respiratory protection, but a lower level of skin and eye protection. These are atmospheres:
    - With IDLH concentrations
    - Exceeding limits of protection afforded by a full-face, air-purifying respirator
    - Containing substances requiring supplied-air PPE, but substances and/or concentrations do not represent a serious skin hazard
    - Containing less than 19.5% oxygen
- Site operations make it highly unlikely that the small, unprotected area of the head or neck will be contacted by splashes of extremely hazardous substances.
- If work is performed in an enclosed space.

Jewelry shall be removed or appropriately secured to prevent it from becoming caught in rotating equipment or unexpectedly snagged on a fixed object. (e.g., wrist watches bracelets, rings, chains and necklaces, open earrings). Do not wear loose clothing and all shoulder length hair should be tied back.

Site-specific PPE ensembles and materials are identified within task specific JSAs located within Appendix A, and any upgrades or downgrades of the level of protection (i.e., not specified in the JSA) must be immediately communicated to all Roux personnel and subcontractors, as applicable. PPE is used in accordance with manufacturers' recommendations.

8.5.2 Hearing Conservation

Hearing protection is made available when noise exposures equal or exceed an 8-hour time-weighted average sound level of 85 dBA. Hearing protection is required when the 8-hour time weighted average sound level $\geq$ 85 dBA, or when noise levels exceed 140 dBA at any point or exceeds 115 dBA for at least 15 minutes. Where noise exposure meets or exceeds this level, noise is listed as a physical hazard in the JSA for the tasks/operation, and hearing protection is included as one of the control measures (PPE).

8.6 Monitoring

An air monitoring program is important to the safety of on- and off-site personnel, and the surrounding area. A preliminary survey, to establish background conditions in the immediate sampling area, may be made prior to the initiation of Site work including, but not limited to, monitoring wind direction (e.g., wind socks) and approximate temperature during all invasive Site activities. Monitoring at the upwind and downwind portion of the Site perimeter will be conducted. This will provide a real-time method for determination of vapor and/or particulate releases to the surrounding community as a result of ground intrusive investigation work.

Ground intrusive activities are defined in the Generic Community Air Monitoring Plan and attached as Appendix E. Ground intrusive activities include soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells. Non-intrusive activities include the collection of soil and sediment samples or the collection of groundwater samples from existing wells. Continuous monitoring is required for ground intrusive activities and periodic monitoring is required for non-intrusive activities. Periodic monitoring consists of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring while bailing a well, and taking a reading prior to leaving a sampling location. This may be upgraded to continuous if the sampling location is in close proximity to individuals not involved in the Site activity (i.e., on a curb of a busy street). The action levels below will be used during periodic monitoring.

Work zone air monitoring will be performed to verify that the proper level of PPE is used, and to determine if increased protection or work stoppage is required. The following equipment shall be used to monitor conditions:

- A photoionization detector (PID) with a lamp energy of 10.6 eV will be used to provide direct readings of organic vapor concentrations during intrusive activities to determine that personnel protection is adequate. Concentrations shall be recorded during intrusive activities with the potential to encounter contaminant vapors.
- Colorimetric detection tubes shall be used based on PID action levels to qualitatively identify possible contaminants as applicable.
- A pre-calibrated multi-gas meter with combustible LEL, oxygen (O2), carbon monoxide (CO), and hydrogen sulfide (H2S) sensors shall be used to monitor the potential for oxygen-deficient atmospheres, explosive concentrations of organic vapors, and toxic gases during intrusive operations. The calibration for this device will be performed using a known gas composition calibration mixture.

Personal exposure monitoring using activated charcoal tubes may be considered based on whether or not the area sample results are at or above half of the PEL. The decision to perform the monitoring will be made by, and under the control of, the CHSD.

Below are monitoring action levels for Site-specific COPCs. In the event PID readings above the thresholds identified below are sustained for 5 minutes in the breathing zone, worker protection will require upgrading following notification to the OHSM and applicable parties.

8.6.1 Action Levels for Air Monitoring

PPE can remain at Level D if breathing zone VOC concentrations are less than 5 ppm and benzene is not detected. Personnel are required to evacuate the Site when breathing zone VOC readings exceed 25 ppm.

The following tables include summaries of the air monitoring, work practices, and action levels for the expected contaminants. The action levels to initiate testing with colorimetric tubes for airborne volatiles is 1 ppm (PID reading) and is based on the PEL for benzene (1 ppm). The colorimetric tubes are used to confirm the presence or absence of specific constituents, and they do not provide a measured concentration.

Air Monitoring Summary and Action Levels Organic Vapors	
PID Reading in Breathing Zone (ppm)	**Action**
0-1 ppm above background	Continue monitoring
>1-5 ppm sustained 60 seconds	Continue monitoring, if applicable initiate additional collection of BTEX using colorimetric tubes.
<5 ppm and no presence of BTEX	Continue Monitoring, ventilate space
≥ 5 ppm - ≤ 25 ppm and no presence of BTEX	Ventilate space until PID reads < 5 ppm. If < 5 ppm cannot be achieved, upgrade to Level C[1].
≥ 25 ppm	Ventilate space and evacuate area. Consult with CHSD.

Background concentrations should be established at the beginning of each work day. It may be necessary to re-establish background concentrations if ambient conditions vary through the day.

1. Measured air concentrations of known organic vapors will be reduced by the respirator to one half of the PEL or lower, and the individual and combined compound concentrations shall be within the service limit of the respirator cartridge.

Air Monitoring Summary and Action Levels Combustible Gases	
Lower Explosive Limit (LEL) Reading	**Action**
< 4% LEL	Site activities will continue with normal monitoring
4% – 20% LEL	Stop work until levels dissipate to <4% LEL
> 20% LEL	Potential explosion hazard. Halt all site activities, research source of release, aerate work area, suppress source.

8.6.2 Explosive Hazard

Methane is a common gas constituent that is generated during the decomposition of organics. Methane, a non-toxic compound, does not have an OSHA PEL or other exposure limits based on toxicity. However, methane is explosive under certain conditions. The LEL for methane is 5% in air, or 50,000 ppm by volume. At high concentrations, methane can also displace oxygen and cause asphyxiation. Because methane is lighter than air, it does not tend to accumulate in low-lying areas and will rapidly mix with atmospheric air if encountered during drilling activities. Methane concentrations will be continuously monitored using a pre-calibrated gas meter while excavation takes place.

8.6.3 Air Monitoring Equipment and Calibration

A PID calibrated to an appropriate calibration mixture will be used to detect organic vapors in and around the work areas. Monitoring will be conducted in and around all work areas and at the workers' breathing zone before activities commence to establish a background level, then at 15-minute intervals throughout the day. All equipment will be calibrated according to the manufacturer's recommendation. A calibration log will be maintained and will include the name of the person who performed the calibration, the date and time calibrated, and the instrument reading at the time of calibration. A manual bellows pump or equivalent with colorimetric tubes for specific compounds will be used to determine the course of action related to upgrading or downgrading the level of respiratory protection, as applicable.

If air monitoring data indicate safe levels of potentially harmful constituents at consistent intervals (5-minute intervals), then monitoring can be conducted less frequently (every 30 minutes). This determination will be made by the onsite SHSO. Monitoring data, including background readings and calibration records, will be documented. Work to be performed on-site will conform to Roux's Standard Operating Procedures (SOPs). Conformance with these guidelines as well as the guidelines described in this HASP will aid in mitigating the physical and chemical hazards mentioned throughout this HASP.

8.7 Tailgate Safety Meetings

A designated Site worker will provide daily safety briefings (e.g., tailgate meetings) including, but not limited to, the following scenarios:

- When new operations are to be conducted
- Whenever changes in work practices must be implemented
- When new conditions are identified and/or information becomes available

Daily safety briefings shall be recorded on the Roux Daily Tailgate Health and Safety Meeting Log/Daily Site Safety Checklist, and all completed forms will become a part of the project file.

8.8 Spill Containment

Spill containment equipment and procedures should, at a minimum, meet the requirements of the Site's Spill Prevention, Control and Countermeasure Plan, if applicable. Otherwise, spill containment equipment and procedures must be considered depending on the task, including, but not limited to, chemical/product transfer points and handling.

8.8.1 Initial Spill Notification and Response

Any worker who discovers a hazardous substance spill will immediately notify the SHSO. The worker will, to his/her best ability, report the hazardous substance involved, the location of the spill, the estimated quantity of material spilled, the direction/flow of the spill material, related fire/explosion incidents, and any associated injuries without compromising their own safety.

8.8.2 Spill Evaluation and Response

The SHSO is responsible for evaluating spills and determining the appropriate response. When this evaluation is being made, the spill area will be isolated and demarcated to the extent possible. If necessary to protect nearby community members, notification of the appropriate authorities is made by the PM as

appropriate. On-site response is limited to small spills (e.g., <10 gallons); large spills require external emergency responders who will be contacted by the SHSO.

8.9 Decontamination

The decontamination section of the HASP describes how personnel and equipment are decontaminated when they leave the EZ. This section also describes how residual waste from decontamination processes is disposed. The site decontamination procedures are designed to achieve an orderly, controlled removal or neutralization of contaminants that may accumulate on personnel or equipment. These procedures minimize worker contact with contaminants and protect against the transfer of contaminants to clean areas of the site and off-site. They also extend the useful life of PPE by reducing the amount of time that contaminants contact and can permeate PPE surfaces. Decontamination is facilitated within the CRZ at this site, if applicable.

8.9.1 Decontamination Procedures for Personnel and PPE

The following are general decontamination procedures established and implemented at this site:

1. Decontamination is required for all workers exiting a contaminated area. Personnel may re-enter the SZ only after undergoing the decontamination procedures described below in the next section.
2. Protective clothing is decontaminated, cleaned, laundered, maintained, and/or replaced as needed to ensure its effectiveness.
3. PPE used at this site that requires maintenance or parts replacement is decontaminated prior to repairs, or
4. PPE used at this site is decontaminated or prepared for disposal on the premises. Personnel who handle contaminated equipment have been trained in the proper means to do so to avoid hazardous exposure.
5. This site uses an off-site laundry for decontamination of PPE. The site has informed that facility of the hazards associated with contaminated PPE from this site.
6. The site requires and trains workers that if their permeable clothing is splashed or becomes wetted with a hazardous substance, they will immediately exit the work zone, perform applicable decontamination procedures, shower, and change into uncontaminated clothing.
7. Procedures for disposal of decontamination waste meet applicable local, State, and Federal regulations.

8.9.2 Decontamination Procedures for Equipment

All tools, equipment, and machinery from the EZ or CRZ are decontaminated in the CRZ prior to removal to the SZ. Equipment decontamination procedures are designed to minimize the potential for hazardous skin or inhalation exposure and to avoid cross-contamination and chemical incompatibilities.

General Equipment Decontamination Procedures:

1. Decontamination is required for all equipment exiting a contaminated area. Equipment may re-enter the SZ only after undergoing the equipment decontamination procedures.
2. Vehicles that travel regularly between the contaminated and clean areas of the site are carefully decontaminated each time they exit the EZ and the effectiveness of that decontamination is monitored to reduce the likelihood that contamination will be spread to other parts of the site.
3. Particular attention is given to decontaminating tires, scoops, and other parts of heavy equipment that are directly exposed to contaminants and contaminated soil.

4. Procedures for disposal of decontamination waste shall meet applicable local, State, and Federal regulations.

The following items may be used to decontaminate equipment:

- Fresh water rinse
- Non-phosphorus detergent wash
- Acetone rinse
- Distilled water rinse
- A steam cleaner or pressure washer (heavy equipment only)

8.9.3 Monitoring the Effectiveness of Decontamination Procedures

Visual examination and sampling are used to evaluate the effectiveness of decontamination procedures. Visual examination is used to ensure that procedures are implemented as described and that they appear to control the spread of contaminants under changing site conditions. Visual examination is also used to inspect for signs of residual contamination or for contaminant permeation of PPE.

Personnel who work in contaminated areas of the site, either the CRZ or EZ, are trained in the principles and practices of decontamination described in this section of the HASP and in related SOPs. If site procedures are changed as a result of inspection and monitoring, all affected employees are notified of these changes.

8.10 Confined Space Entry

Confined space entry is not expected to be performed on-site; however, the following is a list of the safety requirements for confined space entry at the Site:

- **ROUX PERSONNEL ARE NOT AUTHORIZED TO ENTER AN OSHA PERMIT REQUIRED CONFINED SPACE.**
- Currently the scope of work **DOES NOT** require personnel to enter permitted confined space for this project.
- Any changes to the field activities that may necessitate confined space entry will be reported to the Project Principal and OHSM.

Confined space is defined as any space, depression, or enclosure that:

- Has limited opening for entry and egress
- Is large enough for an employee to enter and perform assigned work
- Is not intended for continuous occupancy

A permit required confined space is one that meets the definition of a confined space and has one or more of the following characteristics:

- May contain or produce life-threatening atmospheres due to oxygen deficiency, the presence of toxic, flammable, or corrosive contaminant.
- Contains a material that has the potential for engulfment.

- Has an internal configuration that may cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section.
- Contains any other serious safety or health hazards.

Although Roux personnel will not perform confined space entry, it is expected that subcontractors performing cleaning and mitigation and/or remedial measures activities may be required to enter structures that are considered to be a permit required confined space. Permitting of the confined space as well as hazard mitigation for entry will be completed by the subcontractor in accordance with 29CFR 1910.146 or 1926.1201-1213 and/or applicable local/client requirements.

8.11 Client and Site-Specific

In addition to the OSHA-specific procedures discussed above, there are other job-specific requirements as may be necessary to meet Cleveland Cliffs safety program. Appendix F includes Cleveland Cliffs health and safety requirements.

8.12 Unusual or Significant Risks

Field activities that appear to have unusual or significant risks that cannot be adequately managed with existing risk tools such as LMRAs (Last Minute Risk Assessments), HASPs, traffic safety plans, work permits, design and operation and maintenance (O&M) practices, equipment Hazard and Operability Studies (HAZOPS), or other safety tools must be referred to the CHSD to help with the assessment and management of the associated potential safety risks. Examples include the use of explosives for demolition, use of firearms to control wildlife, rappelling, demolition over water, diving, etc.

8.13 Activity-Specific Hazards

In addition to the general hazards discussed above, there are activity-specific hazards associated with each work activity planned for the Site. An activity-specific JSA has been completed for each of the activities planned for the Site. JSAs are provided in Appendix A. In the event that new work activities or tasks are planned, JSAs will be developed and implemented prior to performing the new activities. In the absence of a JSA, the personnel performing work must prepare a field JSA and receive clearance from a designated competent safety official prior to performing any task with significant risk. In emergency situations where time is critical Risk Assessments (LMRAs) will be used to identify the task, associated hazards and mitigative actions to take. For lower risk activities (as deemed by the discretion of a Competent Person) where a JSA is determined to not be needed, the individual(s) conducting the activities must perform LMRAs prior to and during the work.

8.13.1 Electrical and Other Utility Assessment and Accommodations

Roux shall perform a site walk to identify any potential overhead electrical or utility lines. All applicable guidelines will be followed in the vicinity of overhead power and utility lines (see Section 8.13.3 below).

Roux has also reviewed all available Site maps showing buried utility lines to identify potential hazards, which revealed that no underground hazards are known to exist in the vicinity of the areas of the Site pertinent to this HASP.

8.13.2 Subsurface Work

Subsurface work activities will require adherence to Roux's Corporate Subsurface Utility Clearance Management program found within Appendix G.

8.13.2.1 Excavations and Trenching

Trenching and excavation work activities carried out by Roux and their subcontractors shall comply with applicable OSHA standards (i.e., 29 CFR 1926.650-652). Regional Notification Centers (i.e., Underground Services Alert) shall be notified at least two working days prior to the start of any digging or excavation work per state requirements (i.e., 811-One Call). Personnel responsible for excavation activities will be trained in their job responsibilities. Additionally, for trenches 4 feet or deeper, where employees will enter, the trench needs to have a stairway, ladder or other safe means of egress, and located so that employees don't have to travel farther than 25 feet horizontally. Where employees will enter trenches greater than 5 feet deep, the trench must have some type of protective system or sloped sidewalls appropriately to prevent cave-ins.

The SHSO or other responsible Roux personnel will be present on-Site during all Roux contracted excavation and backfill operations and will supplement health and safety monitoring conducted by Subcontractor air quality screening to ensure that appropriate levels of protection and safety procedures are utilized. The proximity of chemical, water, sewer, and electrical lines will be identified by Roux and/or their subcontractor before any subsurface activity or sampling is attempted. Prior to any excavation activities, trees, shrubbery, and other objects that can potentially pose as a hazard during excavation should be supported or removed from the excavation area. The following safe work practices will be implemented during this task:

- The proximity of chemical, water, sewer, and electrical lines will be identified by a facility representative prior to beginning any subsurface activity.
- At the start of every day, a competent person will inspect excavations to evaluate if the area is stable and safe to enter. Inspections will be conducted as needed throughout the excavation operations. If deemed necessary, a competent person may also conduct inspections after rainfall or any other event that can potentially affect the integrity of the excavation. Employees will not enter excavations where water has accumulated until protective measures have been implemented.
- Prior to entering excavations greater than 4 feet in depth, air monitoring for oxygen and hazardous atmospheres must be conducted to assure atmospheric conditions are within normal levels described in Section 8.6. Continuous air monitoring with a standard multi-gas detector (O^2, LEL%, CO, H^2S) shall be used during the course of work within an excavation; if action limits are reached workers shall safely exit the excavation. Upgrades to worker protection should be evaluated with the SHSO and PP in consultation with the CHSD. Emergency rescue equipment, such as breathing apparatuses and safety harnesses connected to an extraction device, will be readily available in the event of hazardous atmospheric conditions.
- While earthmoving, stay out of the excavator's delineated heavy equipment exclusion zone and away from the excavation sides where there is potential for cave-in (within excavations that are 6 feet or more in depth, a delineated perimeter 6 feet away from the excavated edge is required).
- During loading and unloading operations, stand away from haul trucks and other vehicles to avoid contact with any falling loads.
- Traffic cones, caution tape, or other barriers will be set up around the perimeter of the excavation when employees are working along the excavation edge and for any excavation that will be left open overnight or unattended for more than two days.

Maximum Allowable Slopes

Soil or Rock Type	Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[3]
Stable Rock	Vertical (90°)
Type A[2]	3/4 : 1 (53°)
Type B	1 : 1 (45°)
Type C	1 1/2 : 1 (34°)

Reference: 29CFR 1926 Subpart P Appendix B Sloping and Benching Table B-1

Notes:

[1] Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

[2] A short-term maximum allowable slope of 1/2H : 1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 meters) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 meters) in depth shall be 3/4H : 1V (53°).

[3] Sloping or benching for excavations greater than 20 feet deep shall be designed and stamped by a registered professional engineer.

Proper stockpiling (i.e., 2 feet minimum distance from the excavation edge), containment, transport, storage, and disposal practices will be utilized and is dependent upon the potential type and amount of waste generated during operations. The location of safety equipment and evacuation procedures will be established prior to initiation of operations according to this HASP.

8.13.3 Heavy Equipment

Use of heavy equipment at the Site will require adherence to Roux's Corporate Heavy Equipment Exclusion Zone Management Program found within Appendix H. Additionally, operation of the drill rig/other heavy equipment will maintain clearances from overhead power lines in accordance with the following Table A from 29CFR 1926.1408.

Minimum Required Clearances for Energized Overhead Power Lines

Nominal System Voltage of Power Line (KV)	Minimum Required Clearance (feet)
0-50	10
51-100	12
101-200	15
201-300	20
301-500	25
501-750	35
751-1000	45

1 kilovolt (KV) = 1,000 volts

8.14 Traffic Control

If Site operations encroach upon public streets or highways and a hazard exists to Site personnel because of traffic conditions, a traffic control plan will be implemented in accordance with the United States Department of Transportation's (DOT's) "Manual on Uniform Traffic Control Devices."

8.15 Sanitation

Sanitation facilities will be provided in accordance with the sanitation standards (29CFR 1910.141, 29CFR 1926.51 and 29CFR 1928.110). Sanitation facilities will be maintained and kept in good conditions at all times.

9. Fire Prevention and Protection

9.1 General Approach

Recommended practices and standards of the National Fire Protection Association (NFPA) and other applicable regulations will be followed in the development and application of project Fire Protection Programs. When required by regulatory authorities, the project management will prepare and submit a Fire Protection Plan for the approval of the contracting officers, authorized representative, or other designated official. Essential considerations for the Fire Protection Plan will include:

- Proper Site preparation and safe storage of combustible and flammable materials.
- Availability of coordination with private and public fire authorities.
- Adequate job-site fire protection and inspections for fire prevention.
- Adequate indoctrination and training of employees.

9.2 Equipment and Requirements

Fire extinguishers will be provided by each contractor/subcontractor and are required on all heavy equipment and in each field trailer. Fire extinguishers will be inspected, serviced, and maintained in accordance with the manufacturer's instructions. At a minimum, all extinguishers shall be checked monthly, weighed semi-annually, and recharged if necessary. Recharge or replacement shall be mandatory immediately after each use.

9.3 Flammable and Combustible Substances

All storage, handling, or use of flammable and combustible substances will be under the supervision of qualified persons. All tanks, containers, and pumping equipment, whether portable or stationary, used for the storage and handling of flammable and combustible liquids, will meet the recommendations of the NFPA.

9.4 Hot Work

If the SOW necessitates welding/blowtorch operation or saw cutting, the hot work permit in Appendix A will be completed by the SSHO and reviewed/issued by the Project Manager.

10. Field Team Review

Each person performing work at or visiting this Site shall sign this section after site-specific training is completed and before being permitted to access the CRZ or EZ.

I have read and understand this Site-Specific HASP. I will comply with the provision contained therein.

Site/Project: Tecumseh Redevelopment Site/Pre-Design Investigations and Remedial Activities

Name & Company	Signature	Date

11. Approvals

By their signature, the undersigned certify that this HASP is approved and will be used at the Tecumseh Redevelopment Site.

John T. Deth – Site Health and Safety Officer	Date
Paul W. Werthman - Office Health and Safety Manager	Date
Lori E. Riker, P.E. – Project Manager	Date
Thomas H. Forbes, P.E. – Project Principal	Date

TABLES

1. Toxicological Properties of Hazardous Substances Present at the Site

TABLE 1
TOXICOLOGICAL PROPERTIES OF HAZARDOUS SUBSTANCES PRESENT AT THE SITE

Site-Wide Health and Safety Plan
Tecumseh Redevelopment Site
Lackawanna, New York

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
VOLATILE ORGANIC COMPOUNDS (VOCs)									
Benzene	71-43-2	TWA 0.5 ppm STEL 2.5 ppm	Ca TWA 0.1 ppm ST 1 ppm	TWA 1 ppm ST 5 ppm	Ca [500 ppm]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]	Eyes, skin, respiratory system, blood, central nervous system, bone marrow	Colorless to light yellow liquid with an aromatic odor [Note: Solid below 42 °F] BP: 176°F Fl.Pt. = 12°F LEL: 1.2% UEL: 7.8% Class IB Flammable liquid. Fl.P. below 73°F and BP at or above 100°F.
Ethyl benzene	100-41-4	TWA 20 ppm	TWA 100 ppm (435 mg/m^3) ST 125 ppm (545 mg/m^3)	TWA 100 ppm (435 mg/m^3)	800 ppm [10%LEL]	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma	Eyes, skin, respiratory system, central nervous system	Colorless liquid with an aromatic odor. BP: 277°F Fl.Pt. = 55°F LEL: 0.8% UEL: 6.7% Class IB Flammable Liquid below 73°F and BP at or above 100°F
Toluene	108-88-3	TWA 20 ppm (ototoxicant)	TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3)	TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)	500 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage	Eyes, skin, respiratory system, central nervous system, liver, kidneys	Colorless liquid with a sweet, pungent, benzene-like odor. BP: 232°F Fl.P: 40°F LEL: 1.1% UEL: 7.1% Class IB Flammable Liquid Fl.P. below 73°F and BP at or above 100°F.
Xylene (m, o & p isomers)	108-38-3, 95-47-6, 106-42-3	TWA 20 ppm	NA	NA	NA	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys	Colorless liquid with an aromatic odor BP: 282°F, 292°F, 281°F Fl. Pt. 82°F, 90°F, 81°F LEL: 1.1%, 0.9%, 1.1% UEL: 7.0%, 6.7%, 7.0% Class IC Flammable Liquid at or above 73°F and below 100°F.
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCs)									
Acenaphthene	83-32-9	https://cameochemicals.noaa.gov/chemical/10358				Inhalation, ingestion, skin and/or eye contact	Irritation of the skin, eyes, mucous membranes and upper respiratory tract, vomiting	Skin, eyes, mucous membranes and upper respiratory tract	White needles BP: 534 ° F Fl.Pt. = NA LEL: 0.6% UEL: NA
Acenaphthylene	208-96-8	https://cameochemicals.noaa.gov/chemical/16157				Inhalation, ingestion, skin and/or eye contact			Colorless crystalline solid BP: 509 to 527 ° F at 760 mm Hg Fl.Pt. = NA LEL: NA UEL: NA
Anthracene (as coal tar pitch volatiles)	120-12-7	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Benzo[a]anthracene	56-55-3	https://cameochemicals.noaa.gov/chemical/16171				Inhalation, injestion, skin and/or eye contact			Colorless leaflets or plates or coarse gold powder with a greenish-yellow fluorescence. May reasonably be expected to be a carcinogen. BP: 815° F at 760 mm Hg Fl.Pt. = NA LEL: NA UEL: NA

TABLE 1
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Site-Wide Health and Safety Plan
Tecumseh Redevelopment Site
Lackawanna, New York

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Benzo[a]pyrene (as coal tar pitch volatiles)	50-32-8	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Benzo[b]fluoranthene	205-99-2	None listed	https://cameochemicals.noaa.gov/chemical/16172			Inhalation, injestion, skin and/or eye contact			Needles or yellow fluffy powder BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Benzo[g,h,i]perylene	191-24-2	https://cameochemicals.noaa.gov/chemical/16174				Inhalation, injestion, skin and/or eye contact	Inhalation of material may be harmful. Contact may cause burns to skin and eyes. Inhalation of Asbestos dust may have a damaging effect on the lungs. Fire may produce irritating, corrosive and/or toxic gases. Some liquids produce vapors that may cause dizziness or suffocation. Runoff from fire control may cause pollution.	Lungs, skin, eyes	Colorless to white crystalline solid. Water insoluble. BP: NA Fl.Pt. = NA LEL: NA UEL: NA
Benzo[k]fluoranthene	207-08-9	https://cameochemicals.noaa.gov/chemical/16173				Inhalation, injestion, skin and/or eye contact	When heated to decomposition this compound emits acrid smoke and irritating fumes.		Pale yellow needles or yellow crystalline solid BP: 896° F Fl.Pt. = NA LEL: NA UEL: NA
Chrysene (as coal tar pitch volatiles)	218-01-9	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
Dibenz(a,h)anthracene	53-70-3	https://cameochemicals.noaa.gov/chemical/16192				Inhalation, injestion, skin and/or eye contact	Symptoms of exposure to this compound may include irritation. This compound is harmful if swallowed or inhaled. It may cause irritation. When heated to decomposition it emits acrid smoke, irritating fumes and toxic fumes of carbon monoxide and carbon dioxide.	Lungs	White crystals or pale yellow solid. Sublimes BP: 975° F Fl.Pt. = NA LEL: NA UEL: NA
Fluoranthene	206-44-0	https://cameochemicals.noaa.gov/chemical/16213				Inhalation, injestion, skin and/or eye contact	When heated to decomposition this compound emits acrid smoke and fumes.		Light yellow fine crystals BP: 482° F Fl.Pt. = NA LEL: NA UEL: NA
Fluorene	86-73-7	https://cameochemicals.noaa.gov/chemical/16214				Inhalation, injestion, skin and/or eye contact			White leaflets. Sublimes easily under a vacuum. Fluorescent when impure. BP: 563° F Fl.Pt. = NA LEL: NA UEL: NA
Indeno[1,2,3-cd]pyrene	193-39-5	https://cameochemicals.noaa.gov/chemical/16218				Inhalation, injestion, skin and/or eye contact			Yellow crystals BP: 997° F Fl.Pt. = NA LEL: NA UEL: NA

TABLE 1
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Lackawanna, New York

Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Naphthalene	91-20-3	TWA 10 ppm [skin]	TWA 10 ppm (50 mg/m3) ST 15 ppm (75 mg/m3)	TWA 10 ppm (50 mg/m3)	250 ppm	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage	Eyes, skin, blood, liver, kidneys, central nervous system	Colorless to brown solid with an odor of mothballs. [Note: Shipped as a molten solid.] BP: 424°F Fl.P: 174°F LEL: 0.9% UEL: 5.9% Combustible Solid, but will take some effort to ignite
Phenanthrene	85-01-8	https://cameochemicals.noaa.gov/chemical/16236				Inhalation, injestion, skin and/or eye contact	Symptoms following exposure to this compound may include skin sensitization, dermatitis, bronchitis, cough, dyspnea, respiratory neoplasm, kidney neoplasm, skin irritation, and respiratory irritation.	Skin, respiratory tract	Colorless monoclinic crystals with a faint aromatic odor. Solutions exhibit a blue fluorescence. BP: 642° F Fl.Pt. = 340° F LEL: NA UEL: NA
Pyrene (see coal tar pitch volatiles)	129-00-0	TWA 0.2 mg/m3 (as Benzene solubles)	Ca TWA 0.1 mg/m3 (cyclohexane-extractable fraction)	TWA 0.2 mg/m3 (benzene-soluble fraction) [1910.1002]	Ca [80 mg/m3]	Inhalation, skin and/or eye contact	Dermatitis, bronchitis, [potential occupational carcinogen]	Respiratory system, skin, bladder, kidneys	Black or dark-brown amorphous residue BP: NA Fl.Pt. = NA LEL: NA UEL: NA Combustible Solids
METALS									
Arsenic	7440-38-2	TWA 0.01 mg/m3	Ca C 0.002 mg/m3 [15-minute]	[1910.1018] TWA 0.010 mg/m3	Ca [5 mg/m3 (as As)]	Inhalation, skin absorption, skin and/or eye contact, ingestion	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin, [potential occupational carcinogen]	Liver, kidneys, skin, lungs, lymphatic system	Metal: Silver-gray or tin-white, brittle, odorless solid BP: Sublimes Fl.Pt. = NA LEL: NA UEL: NA Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame
Cadmium	7440-43-9	TWA 0.01 mg/m^3 total dust TWA 0.002 mg/m^3 (as Cd) respirable fraction	Ca	TWA 0.005 mg/m^3	Ca [9 mg/m3 (as Cd)]	Inhalation, ingestion	Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]	Respiratory system, kidneys, prostate, blood	Silver-white/blue tinged lustrous, odorless solid. BP: 1409°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible - will burn in powder form
Chromium	7440-47-3	TWA 0.5 mg/m^3 (metal) TWA 0.003 mg/m^3 (water-soluble Cr III compounds) TWA 0.0002 mg/m^3 (water-soluble Cr VI compounds) STEL 0.0005 mg/m3 (water-soluble Cr VI compounds)	TWA 0.5 mg/m^3	TWA 1 mg/m^3	250 mg/m^3 (as Cr)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin; lung fibrosis (histologic)	Eyes, skin, respiratory system	Blue-white to steel-gray, lustrous, brittle, hard, odorless solid. BP: 4788°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible - will burn in dust form if heated in a flame
Lead	7439-92-1	TWA 0.05 mg/m3	TWA (8-hour) 0.050 mg/m3	[1910.1025] TWA 0.050 mg/m3	100 mg/m3 (as Pb)	Inhalation, ingestion, skin and/or eye contact	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension	Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue	A heavy, ductile, soft, gray solid BP: 3164°F Fl.Pt. = NA LEL: NA UEL: NA Noncombustible Solid in bulk form

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Tecumseh Redevelopment Site
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Compound	CAS #	ACGIH TLV	NIOSH REL	OSHA PEL	IDLH	Routes of Exposure	Toxic Properties	Target Organs	Physical/Chemical Properties
Mercury	7439-97-6	TWA 0.1 mg/m3, as Hg Aryl compounds TWA 0.025 mg/m3 as Hg, inorganic forms including metallic mercury	Hg Vapor: TWA 0.05 mg/m3 [skin] Other: C 0.1 mg/m3 [skin]	TWA 0.1 mg/m3	10 mg/m3 (as Hg)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria	Eyes, skin, respiratory system, central nervous system, kidneys	Metal: Silver-white, heavy, odorless liquid. [Note: "Other" Hg compounds include all inorganic & aryl Hg compounds except (organo) alkyls.] BP: 674°F Fl.Pt. = NA LEL: NA UEL: NA Metal: Noncombustible Liquid
PCBs									
PCBs (total)	11097-69-1, 53469-21-9	TWA 0.5 mg/m3 [skin] TWA 1 mg/m3 [skin]	Ca TWA 0.001 mg/m3 Ca TWA 0.001 mg/m3	TWA 0.5 mg/m3 [skin] TWA 1 mg/m3 [skin]	Ca [5 mg/m3] Ca [5 mg/m3]	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen]	Skin, eyes, liver, reproductive system	Colorless to pale-yellow, viscous liquid or solid (below 50°F) with a mild, hydrocarbon odor BP: 689-734°F, 617-691°F Fl.Pt. = NA, NA LEL: NA UEL: NA Nonflammable Liquid, but exposure in a fire results in the formation of a black soot containing PCBs, polychlorinated dibenzofurans, and chlorinated dibenzo-p-dioxins.

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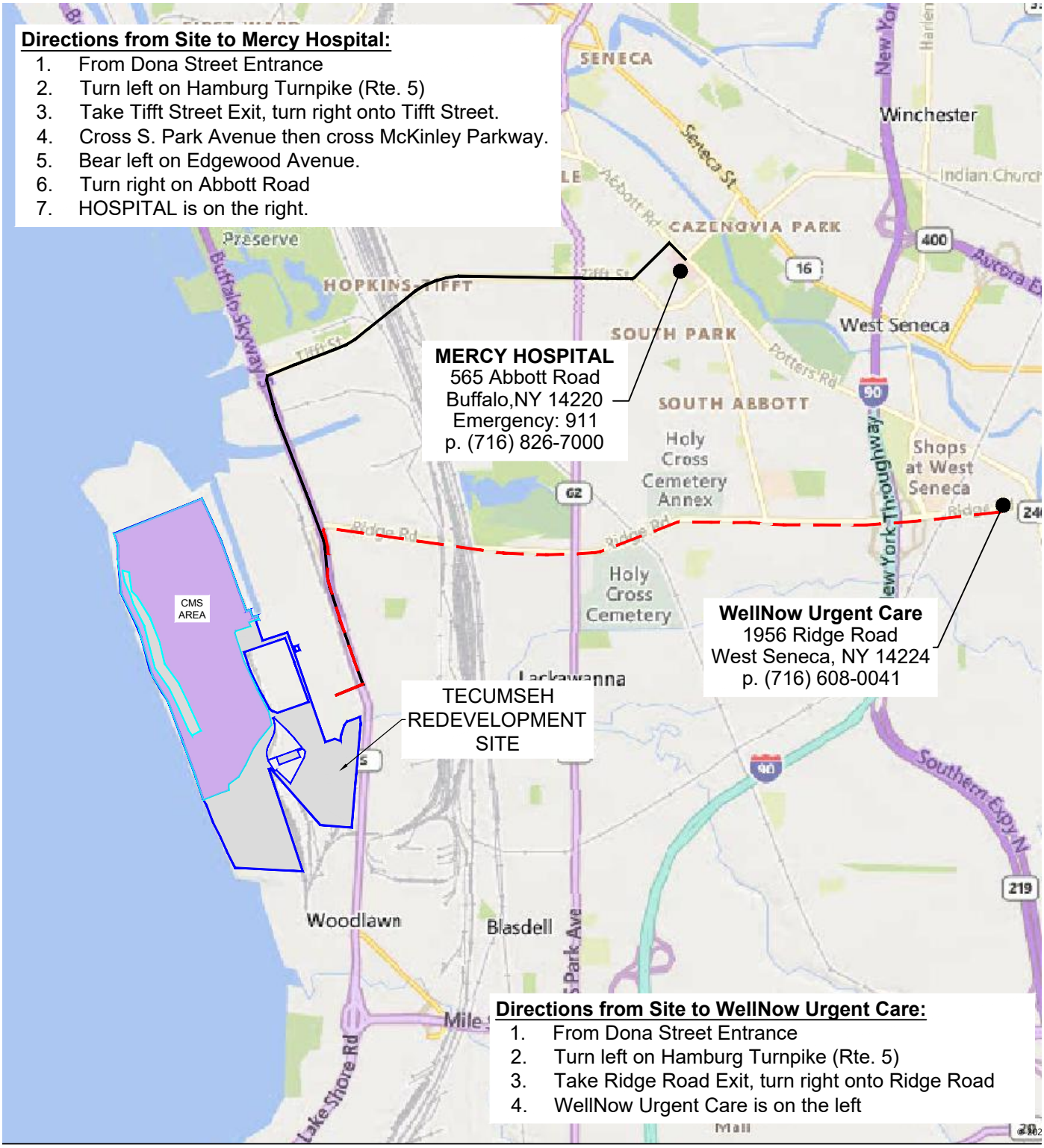
Abbreviations:

ACGIH – American Conference of Governmental Industrial Hygienists.
BP – boiling point at 1 atmosphere, °F
C – Ceiling, is a concentration that should not be exceeded during and part of the working exposure.
Ca – Carcinogenic.
CAS# - Chemical Abstracts Service registry number which is unique for each chemical.
DSEN - Dermal Sensitization
Ft Pt. – Flash point
IDLH - Immediately Dangerous to Life and Health concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
LEL – Lower explosive (flammable) limit in air, % by volume (at room temperature)
mg/m^3 – Milligrams of substance per cubic meter of air
NIOSH - National Institute for Occupational Safety and Health.
OSHA – Occupational Safety and Health Administration
OTO - Ototoxicant
PEL - OSHA Permissible Exposure Limit (usually) a time weighted average concentration that must not be exceeded during any 8 hour work shift of a 40 hr work week.
ppm – parts per million
REL – NIOSH Recommended Limit indicated a time weighted average concentration that must not be exceeded during any 10 hour work shift of a 40 hr work week
RSEN - Respiratory Sensitization
SG - Specific Gravity
STEL – ACGIH Short-term exposure limit (ST)
TLV - ACGIH Threshold Limit Values (usually 8 hour time weighted average concentrations).
TWA – 8-hour, time-weighted average
UEL – Upper explosive (flammable) limit in air, % by volume (at room temperature)
VP - Vapor Pressure

FIGURES

1. Routes to Urgent Care and Hospital
2. Site Location and Vicinity Map
3. Site Plan with Emergency Muster Area



LEGEND:

ROUTE TO MERCY HOSPITAL

ROUTE TO WELLNOW URGENT CARE

N

4000' 0 4000'

Title:

ROUTES TO URGENT CARE AND HOSPITAL

EMERGENCY RESPONSE PLAN

TECUMSEH REDEVELOPMENT SITE

LACKAWANNA, NEW YORK

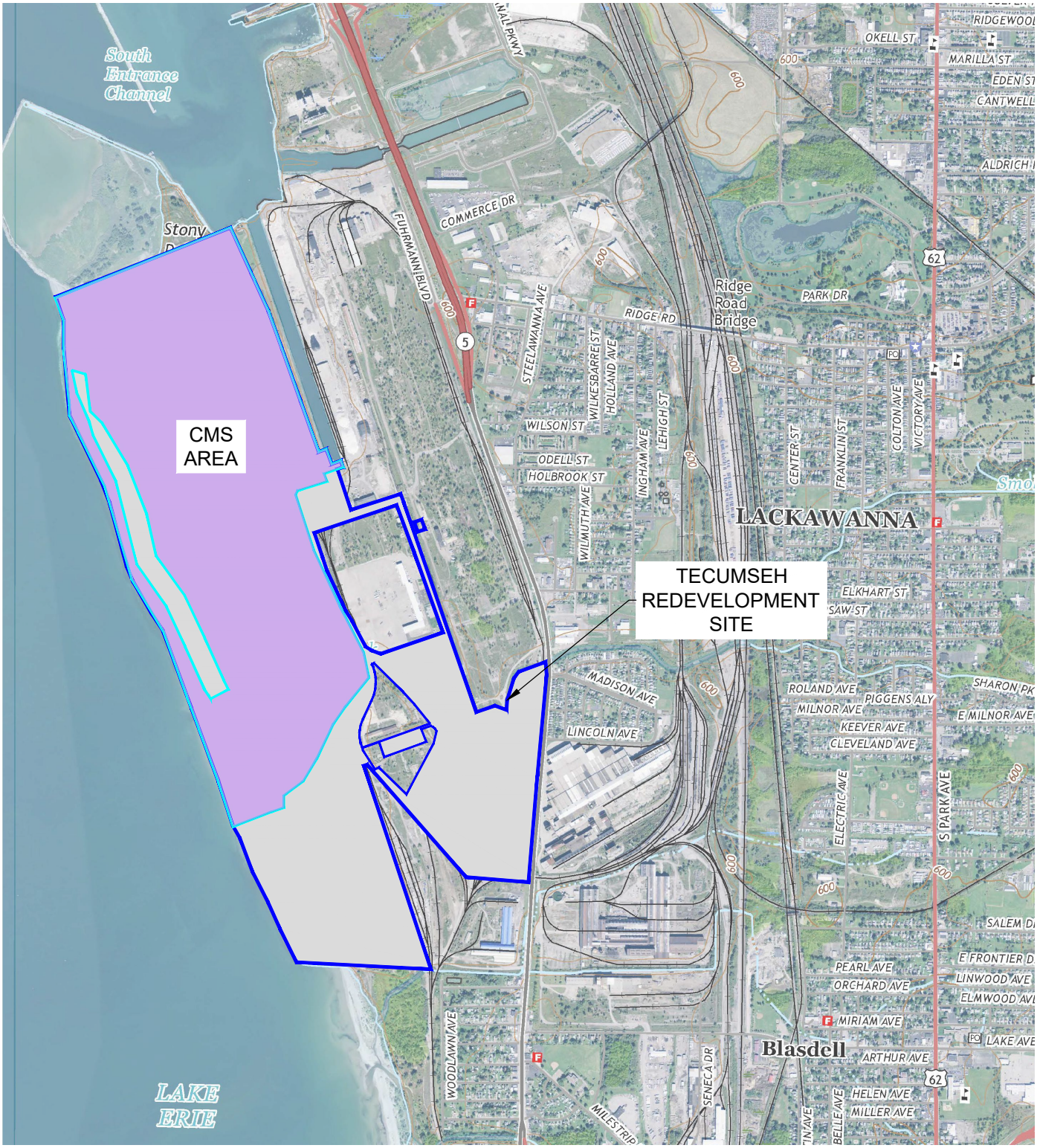
Prepared for:

TECUMSEH REDEVELOPMENT INC.

ROUX

Compiled by: JJY	Date: SEPTEMBER 2025	FIGURE
Prepared by: CEH	Scale: AS SHOWN	1
Project Mgr: LER	Project: 4395.0013B000	
File: FIGURE 1; HOSPITAL ROUTE MAP.DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\BROWNFIELD CLEANUP PROGRAM (BCP)\SITE-WIDE HASP\2025 UPDATE\FIGURE 1; HOSPITAL ROUTE MAP.DWG



LEGEND:

TECUMSEH PROPERTY

CMS AREA

BASE MAP USGS QUAD BUFFALO SE 2016

N

2000' 0 2000'

Title:

SITE LOCATION MAP & VICINITY MAP

HEALTH AND SAFETY PLAN
TECUMSEH REDEVELOPMENT SITE
LACKAWANNA, NEW YORK

Prepared for:

TECUMSEH REDEVELOPEMNT INC.

ROUX

Compiled by: JJY	Date: SEPTEMBER 2025	FIGURE
Prepared by: CEH	Scale: AS SHOWN	2
Project Mgr: LER	Project: 4395.0013B000	
File: FIGURE 2; SITE LOCATION AND VICINITY MAP.DWG		

STEEL WINDS II FACILITY (NORTH) (PARCEL 1: ± 1.79 AC.)

STEEL WINDS I FACILITY (± 29.01 AC.)

U.S.A.C.E. SEDIMENT DISPOSAL AREA

LAND

INDUSTRIAL WATER SYSTEM (6 PUMP)

BUFFALO OUTER HARBOR

CITY OF LACKAWANNA

CITY OF BUFFALO

STEEL WINDS II FACILITY (SOUTH) (PARCEL 2: ±11.18 AC.) (PORTION OF PARCEL 2 IN LACKAWANNA: ± 2.12 AC.) (PARCEL 2A: ± 0.33 AC.) (PARCEL 3: ± 3.31 AC.)

CMS AREA
(Site No. 915009)

SOUTH BUFFALO RAILROAD CO. (COAL HANDLING) (± 33.66 ACRES)

EMERGENCY MUSTER AREA

ARTMEIER COMMODITY SUPPLY
PORTION OF BCP SITE NO. C915199I
(± 3.14 AC.)

GATEWAY METROPORT SHIP CANAL

GATEWAY TRADE CENTER (G.T.C.)

1951 HAMBURG TURNPIKE LLC
(BCP SITE NO. C915199D)
(± 16.19 AC)

LACKAWANNA SOLAR LAND LLC
PORTION OF BCP SITE NO. C915199C
(± 3.80 AC)

LACKAWANNA SOLAR LAND LLC
(BCP SITE NO. C915199E
(± 10.24 AC)

LACKAWANNA SOLAR LAND LLC
(BCP SITE NO. C915199I)
(± 13.97 AC)

WELDED TUBE USA
(BCP SITE NOs. C915199G & C915199H)
(± 46.15 AC)

SMOKES CREEK

STEEL SUN SOLAR FARM III-5 & III-6
BCP SITE NOs. C915199E & C915199F
(± 11.99 ACRES & ± 10.89 ACRES)

BUFFALO AND ERIE COUNTY INDUSTRIAL LAND DEVELOPMENT CORPORATION

NIAGARA WIND SUBSTATION 11A (± 0.38 AC.)

SITE ACCESS LOCATION (2 OF 2)

SITE ACCESS LOCATION (1 OF 2)

SOUTH BUFFALO RAILROAD COMPANY

SRI LUMBER YARD
(BCP SITE NO. C915199I)
(± 14.62 AC)

BUFFALO CRUSHED STONE

BUFFALO SPECIALTY STEEL

METALICO BUFFALO (FMR. GALVANIZING MILL)

REPUBLIC ENGINEERED PRODUCTS INC. (BAR MILL)

GREAT LAKES INDUSTRIAL DEVELOPMENT, LLC (FMR. HOT / COLD MILL)

BLASDELL CREEK / SOUTH BRANCH

BLASDELL CREEK / NORTH BRANCH

1000’ 0 1000’

LEGEND:

- TECUMSEH PROPERTY BOUNDARY
- CMS BOUNDARY AREA
- EXISTING BUILDING / STRUCTURE
- RAILROAD TRACK
- APPROXIMATE BOUNDARY OF LICENSED OR LEASED PROPERTY WITHIN SITE BOUNDARY
- APPROXIMATE BOUNDARY OF FORMER TECUMSEH PROPERTY. NOW OWNED BY OTHERS
- STEEL WINDS I & II FACILITY ABOVE-GROUND ELECTRIC UTILITY
- STEEL WINDS I & II FACILITY BURIED ELECTRIC UTILITY

Title:

SITE PLAN WITH EMERGENCY MUSTER AREA

HEALTH AND SAFETY PLAN
TECUMSEH REDEVELOPMENT SITE
LACKAWANNA, NEW YORK

Prepared for:

TECUMSEH REDEVLOPMENT INC.

ROUX

Compiled by: JJY	Date: SEPTEMBER 2025	FIGURE 3
Prepared by: CEH	Scale: AS SHOWN	
Project Mgr: LER	Project: 4395.0013B000	
File: FIGURE 3; SITE PLAN (AERIAL).DWG		

F:\CAD\TURNKEY\TECUMSEH REDEVELOPMENT\BROWNFIELD CLEANUP PROGRAM (BCP)\SITE-WIDE HASP\2025 UPDATE\FIGURE 3; SITE PLAN (AERIAL).DWG

APPENDICES

A. Job Safety Analysis (JSA) Forms
B. SDSs for Chemicals Used
C. Heat Illness Prevention Program
D. Personal Protective Equipment (PPE) Management Program
E. Generic Community Air Monitoring Plan
F. Cleveland Cliffs Health and Safety Program
G. Subsurface Utility Clearance Management Program
H. Heavy Equipment Exclusion Zone Policy

APPENDIX A

Job Safety Analysis (JSA) Forms

JOB SAFETY ANALYSIS	Ctrl. No. CVD-19	DATE: 04/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**Fieldwork**	**Working in Areas Affected by Coronavirus**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Kristina DeLuca	Health and Safety Specialist	Brian Hobbs	CHSD
		Ray Greenidge	Sr. Compliance Mgr.

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES – Leather/cut-resistant in field and nitrile as needed
☒ HARD HAT – In field	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING – High visibility vest in field	☒ Face Covering
☒ SAFETY GLASSES – In field	☒ SAFETY SHOES – Steel/composite toe in fie		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Cloth face covering, nitrile gloves, hand soap, water source, hand sanitizer, disinfectant spray and disinfectant wipes.

Commitment to Safety – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

SOCIAL DISTANCING: Maintain 6' of distance between yourself and all other people at all times. If you do not believe the scope of work can be conducted while maintaining this distance, contact your Project Manager immediately.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Project Preplanning	N/A	• Review and follow COVID-19 CDC, Roux, Client and local orders/protocols. • Ensure all workers are fit for duty - anyone feeling sick should remain at home even if symptoms do not align with COVID-19. If a worker has been in contact with someone potentially positive or positive for COVID-19, contact your Office Manager. • Determine PPE needs and ensure adequate supply of disinfectant wipes/spray, soap and water or hand sanitizer at Site. Due to high demands and limited supply, plan ahead. • Use the minimum number of employees necessary to safely complete the work.
2. Mobilization	**Exposure:** Becoming infected or infecting co-workers	**Personal/Rental/Roux Owned Vehicle** • Do not carpool, unless all individuals are fully vaccinated. • Verify workers/other people are not approaching vehicle prior to exiting the vehicle. Maintain 6' of distance from general public, as appropriate. **Public Transportation** • Public transit should not be used unless absolutely necessary. Consider renting a car rather than taking public transit. If public transit is required, wear appropriate face covering/mask and apply social distancing (6 ft). Wash hands or use hand sanitizer immediately after. **Hotel Stay (Refer to COVID-19 H&S Guidance for more info)** • If a hotel stay is deemed necessary for the given field work, ensure that you clean your room upon initial arrival. • Place the "Do Not Disturb" placard on the room while away and limit housekeeping services to the extent feasible during your stay to minimize the reintroduction and spread of the virus from others. Wash hands or use hand sanitizer often.
3. Tailgate Meeting	**Exposure:** Becoming infected or infecting co-workers	• Perform outside or indoors in areas with ample ventilation. • If unvaccinated, maintain at least a 6+ ft distance between you and others. • Discuss primary infection prevention measures listed below. • Discuss COVID-19 symptoms with coworkers and subcontractors to ensure fitness for duty. Anyone exhibiting signs or symptoms should be instructed to leave the Site, contact your Project Manager.

[1] Each Job or Operation consists of a set of tasks / steps. Be sure to list all the steps needed to perform job.
[2] A hazard is a potential danger. Break hazards into six types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards, energy source; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

4. Site Activities	**Exposure:** Becoming infected or infecting co-workers	• Coordinate field activities at the beginning of the day (i.e. Tailgate meeting) to minimize time spent in crowded spaces or overlap while completing job tasks. • Don cloth face coverings as appropriate. • Apply social distancing (6+ ft) when interacting with others if unvaccinated. If anyone comes within 6 ft of you while conducting work and your work prevents you from moving away, politely ask them to move back. If others are unable to move from your space, stop work and leave area. • Minimize shaking hands or touching others. • Minimize sharing of equipment or other items with co-workers and subcontractors unless wearing appropriate PPE (e.g. nitrile gloves), as appropriate. • If anyone is experiencing COVID-19 signs or symptoms in your vicinity, stop work and leave the area. • Do not work in areas with limited ventilation with others. • Cover your mouth and nose with tissue or paper towel or with your elbow when coughing or sneezing and wash hands or use hand sanitizer immediately after. If sick contact SHSO/PM and leave Site immediately. • Clean work surfaces/areas with approved cleaners you're responsible for (ex: desk, office doorknob, computer, etc.) at least daily. • Avoid public spaces and going out to eat by bringing your own lunch to the Site. If performing work in high density urban areas, it is recommended all food must be consumed at or in your vehicle or within designated work trailer. Wash hands or use hand sanitizer before eating and immediately after.

Primary Infection Prevention Measures

- Wash your hands often with soap and water for at least 20 seconds.
  - If soap and water are not available, use an alcohol-based sanitizer that contains at least 60% alcohol. Key times to wash hands include after blowing your nose, coughing or sneezing, after using the restroom, and before eating or preparing food.
- Do not touch your eyes, face, nose and mouth with unwashed hands.
- Cover your mouth and nose with a tissue when you cough or sneeze or use the inside of your elbow. Throw potentially contaminated items (e.g. used tissues) in the trash.
- Avoid close contact/secondary contact with people and potentially contaminated surfaces.
  - Apply appropriate social distance (6+ feet).
  - Minimize handshaking/touching others and use caution when accessing public spaces.
- Clean frequently touched surfaces daily. Commonly touched items can include but are not limited to tables, doorknobs, light switches, countertops, handles, desks, phones, keyboard, toilets, sinks and field equipment. If surfaces are dirty, they should be cleaned with soap and water prior to disinfection. If surface cannot be cleaned/disinfected, then wash hands or use sanitizer as soon as possible.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS	Ctrl. No. GEN-001	DATE: 04/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Construction – Concrete and Asphalt**	**Asphalt Paving**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
David Kaiser	Senior Engineer	Brian Hobbs	Corporate Health & Safety Director
		Ray Greenidge	Sr. Compliance Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut Restant / Leather / Nitrile / Chemical resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING: Long-sleeved high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel or composite toed		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Hand Tools, Spreader Box, Dump Truck, Asphalt Cement Kettle, Traffic Control (36" cones, flags, caution tape), vehicle chocks, 20-lb. Type ABC Fire Extinguisher

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone (HEEZ) around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Position dump truck and offload asphalt.	**1a. CONTACT:** With Site traffic and unauthorized personnel.	1a. **Maintain and enforce the EZ**. Equipment being moved into position must have spotters to guide it into position. Never position vehicle with the bed raised.
	1b. CAUGHT: In pinch points of tailgate chutes.	1b. Don leather or Kevlar gloves prior to opening tailgate chutes. Keep hands clear of potential pinch points between tailgate chute and scuttle doors, tailgate, pin latch, etc. Spotter to remain in line-of-sight of driver at all times. If the driver cannot see the spotter, stop immediately.
	1c. FALL: From trip hazards (i.e. rocks, broken asphalt, tools, etc.)	1c. Identify and avoid trip hazards prior to starting work. Remove stones, tools not in use, etc. Equipment not in use to be stored out of the work area.
	1d. CONTACT: With overhead lines and structures.	1d. Identify and avoid overhead hazards prior to raising bed. Maintain EZ between truck/bed and overhead structures.
	1e. EXPOSURE: To hot asphalt.	1e. Do not handle hot asphalt using your hand. Only use hand tools (i.e., shovel, garden hoe, etc.) to handle asphalt. Personnel to stand clear of scuttle doors and maintain EZ. Personnel to stand at side of truck using truck tailgate as barrier and stay out of the line-of-fire of the asphalt being dumped.
	1f. OVEREXERTION: From opening tailgate chutes.	1f. Use proper body positioning while lifting and opening tailgate (back straight, shoulders square, feet secure on ground).
2. Paving operation with asphalt paving spreader box and/or hand tools.	**2a. EXPOSURE/CONTACT:** To hot asphalt.	2a. Workers will avoid contact with spreader box (if used) and hot asphalt during operation and take breaks to limit exposure to high heat radiating from asphalt mix. Workers will avoid walking on asphalt when not necessary to keep exposure to heat to a minimum. Wear long sleeves and cut-resistant gloves.
	2b. CONTACT: Moving truck back against spreader (if used).	2b. Maintain EZ. Spotters will keep personnel out of path of trucks and keep workers away until truck is backed up against spreader. Workers will not stand between truck and spreader; wear long sleeve high visibility clothing.
	2c. CAUGHT: In pinch points.	2c. Workers will keep hands and limbs away from potential pinch points between truck and spreader (if used).
	2d. OVEREXERTION: Muscle strain.	2d. Workers using rakes and shovels will use correct posture with their back straight and knees bent. Keep load close to body. Loads over 45-lbs. shall be lifted by 2 or more workers or by mechanical means.

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[2] A hazard is a potential danger. Break hazards into six types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Compacting and sealing new asphalt using a plate compactor or vibratory roller.	**3a. OVEREXERTION:** From handling and using equipment	3a. Use proper body positioning while lifting (knees bent, back straight, shoulders square). Loads over 45-lbs. shall be lifted by 2 or more workers or by mechanical means. Take frequent breaks to rest arms and hands or 10-15 minute shifts between 2 operators.
	3b. FALL: From trip hazards.	3b. See 1c. above.
	3c. EXPOSURE: To faulty equipment and fuel.	3c. Inspect the compactor/roller for proper operation prior to use (i.e., cracked housing, exposed wires, broken handle, etc.). When refueling is necessary verify that the engine is cool prior to fueling. Deploy sorbent pads around compactor to capture any residual fuel; wear chemical resistant gloves while refueling.
	3d. CAUGHT: In pinch points or between equipment and site structures.	3d. Keep hands clear of potential pinch points while operating compactor. Do not stand between compactor/roller and structure. Use of mechanical walk-behind tamper is to be used when within 2'-0" of building or structure so as to limit possible contact with building/structure.
4. Leave work zone.	**4a. EXPOSURE:** To hot asphalt.	4a Paving work zone will remain isolated until asphalt is cool enough to open to vehicle and pedestrian traffic.
	4b. CONTACT: With excess asphalt and debris.	4b. Work zone will be cleaned up to remove excess asphalt and any debris which could be "spit" out of tires of vehicles.
	4c. FALL: To tools and debris.	4c. Tools will be stored in designated areas and debris cleaned up to remove any slip, trip and fall hazards.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-002	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**UTV ATV Use**	**Driving**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Laura Sugano	Staff Assistant Geologist	Brian Hobbs	CHSD
Raymond Olson	Staff Assistant Geologist	Martin Hamper	Senior Geologist
Timothy Zei	Project Geologist	Christopher Battista	Senior Construction Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Helmet
☒ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility long-sleeved clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-toe and non-skid boots		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Inspect vehicle and parts	1a. **CONTACT: Collision or Rollover** Severe injury/disability, property damage, monetary loss (insurance premiums, deductibles, loss of license/job) caused by collision with or struck by other vehicles, obstructions, pedestrians, animals, etc. Common factors that may lead to CONTACT incident, but not limited to: • Brake failure • Malfunctioning lights and signals • Low tire air pressure or tire failure. • Steering malfunction • Improperly secured load • Dirty or damaged windshield	1a. Complete a basic vehicle inspection before driving. Inspect tires and wheels, controls and cables, lights and electrical systems, oil and fuel, and chain/driveshaft. 1a. Examine engine exterior and run equipment in a safe area where it can be towed, if needed. 1a. Make sure the vehicle has a fire extinguisher and first aid kit. 1a. Test brakes and steering prior to traveling into work area or across active driveways or roadways. 1a. Inspect all equipment and supplies to confirm they are properly secured.
2. Driving on site.	2a. **CONTACT: Collision or Rollover** Severe injury/disability, property damage, monetary loss (insurance premiums, deductibles, loss of license/job) caused by collision with or struck by other vehicles, obstructions, pedestrians, animals, etc. Common factors that may lead to CONTACT incident, but are not limited to: • Distracted driving (cell phone, GPS, etc.) • Lack of situational awareness • Weather conditions (wet/icy roads) • Fatigue • Obstructed vision • Loose or unsecure objects • Crossing roads and/or highways • Uneven terrain • Crossing water • Obstacles (rocks, logs, etc.)	2a. Driver should have a valid driver's license and be on an approved drivers list by the project manager (PM) or the Office Health and Safety Manager (OHSM). 2a. Driver and all occupants must wear seat belts. 2a. When crossing a road and/or highway, be aware that UTVs handle differently on pavement than other vehicles. Yield to oncoming traffic and look both ways. Take back roads, if necessary, and minimize time on roads. If possible, follow the UTV with an automobile, with its hazard lights on. Be familiar with and obey all traffic regulations. 2a. Be aware of uneven terrain. Travel straight up or down slopes, if possible. Avoid traveling at excessive speed and making sharp turns. 2a. Assess the depth and bottom of any body of water prior to crossing. If the water is more than six-inch deep, fast-moving or if rocks or other obstacles are present, do not enter or attempt to cross the water body. 2a. Remove or avoid all obstacles. Travel slowly and analyze the path ahead. Confirm no tree branches or other contact hazards are present. Confirm the ground is solid and stable enough to support the UTV.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Parking	3a. **CONTACT: Collision**	3a. Always Set the parking brake. 3a. Always shut the engine prior to leaving the operator's seat. 3a. Never park on a slope. 3a. Park the vehicle outside of the work area when possible.

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[2] A hazard is a potential danger. Break hazards into six types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS	Ctrl. No. GEN-003	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Construction - Excavation**	**Backfilling Excavation & Compaction**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
David Kaiser	Project Engineer	Brian Hobbs	CHSD
Edward Lacina	Senior Construction Manager		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather/ cut-resistant level 2
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER _____
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: reflective DOT approved safety	
☒ SAFETY GLASSES	☒ SAFETY TOE BOOTS		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Payloader, Backhoe, Dump Trucks, Mechanical gas powered tampers, Excavator with hydraulic tamper. APR when tamping if dust present. Two-way radios.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone (HEEZ) around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Pre-construction meeting: Review proposed excavation locations	**1a. CONTACT:** Potential for contact with subsurface utilities and above ground utilities	1a. Call state 811 for mark out service and one call ticket. 1a. Obtain private utility mark out service as necessary. 1a. Review and mark proposed excavations w/white paint. 1a. Identify all "Critical" zones. A Critical zone is any area within 10 feet of any operating utility. 1a. Complete subsurface clearance checklist. 1a. Soft dig must be conducted within 2 lateral feet of any suspected underground utility. 1a. Protection of aboveground utilities identified as being located within the work zone must be coordinated w/ client and utility owner.
2. Secure Work Area	**2a. CONTACT:** Potential for personnel to enter the work area. Potential for equipment to contact, or crush personnel. **2b. EXERTION:** Potential for muscle strain or tear while installing traffic cones and barrel	2a. Ensure work area is secure and inform others of work activity. Establish a HEEZ using 42" traffic cones, barrels & snow fencing or telescoping poles. Use of flag persons to maintain clear traffic and to minimize motorist confusion during set-up of new traffic pattern. HEEZ to include tip/swing radius of equipment. 2a. Dump Truck/Excavator/Payloader/Backhoe equipment to be set-up by personnel who are familiar with machinery. Spotters shall be in place for all equipment. and to control access to the HEEZ 2a. Truck wheels are chocked when driver is not in truck and engine shut off. 2a. Personnel shall stay out of the exclusion zone (10' minimum or greater than the equipment boom) while equipment is maneuvering. 2b. Keep back straight, keep load close to the body and bend knees while lifting and working. If over 50 lbs., use 2 or more laborers for lifting or use of equipment.

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3. Backfilling excavation, and compaction	**3a. CONTACT:** Traffic and live equipment. . **3b. EXPOSURE:** Fumes from gas powered tamper **3c. FALL:** Slips, trips, fall hazards. **3d. OVEREXERTION:** Muscle strain, or tear. **3e. EXPOSURE:** Noise from tamper. Dust inhalation.	3a. Equipment and trucks shall be isolated from other workers, subcontractors and third party traffic with 42" traffic cones, barricades, snow fencing or telescoping poles, and/or Jersey barriers. Spotters shall direct dump truck for placement of fill near excavation. Pay loader/ Excavator, as directed by spotter, shall move fill into trench where it shall be placed in layers and compacted by mechanical means. 3a. Spotters will wear florescent vests at all times. 3a. Spotters will remain out of the exclusion zone, line-of-fire from equipment and third-party vehicles. 3a. Spotters and operators will have radios for communication, when other visual and/or hand signals are insufficient. 3a. Locate all overhead utilities. All personnel and machinery should maintain a minimum 10' distance from overhead electric lines. Refer to OSHA chart for distances and voltage. 3a. For excavations engineered (shored, sloped, benched} all personnel, equipment, and materials must remain a minimum of 2 feet from edge of excavation. 3b. Fueling of all equipment will be done outside of work area in a well-ventilated area. Refueling will be done only after a 2-5-minute cool down. 3c. Work area will be clean and free of any debris to remove slip, trip and fall hazards. All tools will be kept in designated areas. Insure work area is well illuminated. 3c. Workers should only be working in areas that have been leveled with a machine. 3c. All persons working at elevations over 6' shall use a guardrail system or personal fall arrest system while around excavation. 3d. Keep knees bent and back straight while transferring/ lifting/lowering tamper from elevated areas. Utilize a co-worker to avoid staining muscles. 3d. Keep knees bent and back straight while maneuvering tamper. Utilize a co-worker to avoid staining muscles. 3e. Workers will wear hearing protection during compaction tamper activities. 3e. Wear NIOSH approved dust mask for personal comfort. If dust is visible for extended time, limit by wetting down area. 3e. If dust continues stop work and evaluate if increase in APR is needed with approval and clearance.
4. Secure/leave site.	**4a. FALL:** Slip, trip, fall	4a. Clear work area of all debris and store all equipment in designated areas/containers before opening to traffic. 4a. Replace fencing and barricades as needed to secure path before opening roadway or area up to traffic(vehicle, pedestrian and/or bicycle).

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-004	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Construction - Concrete and Asphalt**	**Concrete Form Assembly and Concrete Pouring**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
David Kaiser	Senior Engineer	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☒ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut resistant and Nitrile/Latex
☒ HARD HAT	☒ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Chaps, dust mask
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: reflective DOT approved safety	
☒ SAFETY GLASSES	☒ SAFETY TOE BOOTS: Steel /composite toe boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Wheel Barrow, Trowels, Concrete Floats and Hand Tools (Extension Poles), Waterproof Boot Covers, Traffic Cones, Caution Tape, Portable Eye Wash Station

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Set-up work zone	**1a. CONTACT:** Moving equipment, third party traffic.	1a. Secure work area using barricades/barrels/cones and caution tape/safety fence. Use flagmen to control third party traffic. **Maintain minimum heavy equipment exclusion zone (EZ)** around equipment and live loads. 1a. When machines are operating, all workers will remain outside of EZ unless operator is in "HANDS OFF" mode.
2. Assembly of concrete forms (i.e. plywood, lumber, rebar, etc.)	**2a. CONTACT:** Contacting materials being lowered into work area. Potential for cuts and abrasions and to be contacted by nails while assembling. **2b. EXERTION:** Muscle strain. **2c. EXPOSURE:** Noise, dust, fumes. **2d. CAUGHT:** Pinch points, caught between, Crushed	2a. Workers will keep fingers and limbs out of the line-of-fire of tools, equipment and live loads. Workers will use inspected rigging and only attach rigging to manufacturer installed lifting points. Loads will be controlled with non-conductive tag lines from outside the EZ. Wear hard hat. See JSA for applicable cutting tool. 2b. When transporting and working with forms, workers will keep backs straight, knees bent, and loads close to their body. Any load more than 50 lbs., will be lifted by two or more workers or a mechanical lifting device. 2c. Workers will wear hearing protection, face shields and chaps when using all power tools. Fuel powered tools will be fueled away from the work zone in a well-ventilated area. Refueling will be done after a minimum cool down period of 5 minutes. See JSA for applicable cutting tool. 2d. Keep hands away from rigging while hooking/unhooking materials; wear cut resistant gloves.
3. Setup concrete trucks and chute	**3a. CONTACT/CAUGHT:** Potential for truck to contact personnel, fingers to be pinched while setting up chutes. Contact with overhead power lines. **3b. OVEREXERTION:** Strain, pulled muscles.	3a. Spotters will guide concrete trucks into position; wheel chocks will be set before work begins when trucks are parked. Workers will stay out of exclusion zone until truck is parked and secured. Keep hands clear of potential pinch points when assembling chutes. 3a. A minimum clearance of 10 feet shall be maintained from all overhead power lines. That distance may be reduced if shielding is in place or it is determined that lines are low voltage. Refer to site-specific HASP. 3b. All workers will keep back straight and bend their knees when lifting. Two workers or mechanical means will be used when load exceeds 50 lbs.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Pour concrete into forms	**4a. CONTACT:** Splashing from wet concrete.	4a. Portable eye wash stations shall be set up nearby for easy access; wear safety glasses. Nitrile or latex gloves and water proof boots or boot covers shall be worn to eliminate skin contact with concrete. Any concrete splashed onto non-waterproof clothing shall be removed to avoid skin irritation.
	4b. EXPOSURE: Concrete dust.	4b. Stand upwind while mixing dry concrete. Use dust mask or air purifying respirator to avoid silica inhalation.
5. Concrete finishing work with hand tools and/or vibrate to settle and remove air from poured cement,	**5a. ENERGY SOURCE:** Potential for personnel to be exposed to live electricity.	5a. Electrical tools shall be inspected for defects prior to being used. Any extension cords shall be heavy duty rated and be free from defects (no exposed wires). All electrical connections shall be connected to GFCI outlets. Generators shall be run in well ventilated locations.
	5b. OVEREXERTION: Potential muscle strain while vibrating cement, stepping over forms/rebar reinforcements. During use of hand tools to finish concrete, worker can overextend to reach far end of poured area.	5b. Constantly check/observe where you are walking; wear composite or steel-toed boots. Keep back straight and knees bent while settling concrete with vibrator. 5b. If worker needs to reach the far end of a poured area with finishing tools, they shall use extension poles and not over reach to maintain balance. Maintain even footing while using finishing tools. Use spotter during extension pole use.
	5c. CONTACT: Potential hand tools with extension poles/handles to contact nearby workers/pedestrians/vehicles/overh ead power lines.	5c. During use of hand tools to finish poured concrete workers will alert work crew. If utilizing extension poles/handles worker will use a spotter to make sure no contact is made with other workers, pedestrians, vehicles or overhead power lines.
6. Cleanup of work area and tools.	**6a. CONTACT/FALL:** Potential slip, trip, and fall on materials and tools left in the work area.	6a. Place additional materials and tools in designated storage areas. Remove any garbage from the work area.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-005	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Construction**	**Cutting with Gas-powered Saw, Sawzall or Plasma Cutter**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Ray Greenidge	Sr. Compliance Manager	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☒ REFLECTIVE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☒ FACE SHIELD (gas powered saw and plasma cutter) ☒ HEARING PROTECTION ☒ SAFETY SHOES: Steel-toed boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent Long sleeved shirt and / or reflective safety vest	☒ GLOVES: Cut-resistant, leather, nitrile ☒ OTHER: Chaps for gas powered saw. Welding suit for plasma cutting.

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Sawzall/extension cord

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Set up/ Secure work area.	**1a. CONTACT:** Personnel could enter the work area	1a. Establish the work zone using 42" cones, caution tape, or fixed rigid barrier. Inform others of work activity.
2. Precutting procedure.	**2a. CONTACT:** Improper blade, malfunctioning guards, unsecured materials, flying debris	2a. Inspect all equipment for defects, replace or service if not functioning optimally. Check that all guards are working and in place, replace if missing. Ensure that blades are sharp and clean to avoid binding and/or burning. Cut on flat/secure work surfaces. Do not cut badly warped wood or boards with knots or nails. 2a. Unplug saw before handing it off to another person. 2a. Wear safety glasses, long-sleeved shirt and leather gloves. Utilize job specific PPE such as welding jacket or chaps when using gas powered saw or a plasma cutter.
	2b. EXPOSURE: Loud noises, dust, bright UV light	2b. When using gas powered saw, wet down area to be cut prior to cutting if high dust levels are anticipated. 2b. Wear hearing protection. Wear a dust mask if large amounts of dust are expected; cut upwind if possible. 2b. When plasma cutting, wear a face shield with shaded glasses rated to block UV light generated by the plasma cutter.
	2c. ENERGY SOURCE: Potential for electric shock	2c. Inspect extension cord for damage. If damaged, tag out and repair / replace. Do not operate saw while standing in water. Ensure GFCI protection at outlet or via attachment. 2c. Ensure all electrical equipment is rated for the task.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Saw Cutting.	**3a. CONTACT:** Fingers could be cut, lacerated or amputated by reciprocating blade; also flying debris and sparks	3a. Cut away from body. Keep fingers away from moving blade. No loose clothing. Never leave saw running unattended. Unplug saw before changing blades or making adjustments / repairs. Set-up barrier to contain sparks. Cut on flat/secure work surfaces. 3a. Wear Safety glasses 3a. Ensure that the saw blade stops rotating/reciprocating before placing saw on the ground.
	3b. CONTACT: Amputation and line of fire injury.	3b. Maintain a minimum 15-foot exclusion zone and ensure that operator and other personnel are kept out of the line-of-fire of the equipment.
	3c. FALL: Tripping hazards caused by cutting/grinding debris, extension cords.	3c. Keep debris generated in designated storage containers. Keep work area free of Slip, Trip and Fall hazards. 3c. Do not route extension cords through walking/working path.
	3d. EXERTION/ERGONOMICS: Lifting heavy or awkward materials may cause muscle strain.	3d. Maintain Proper Body Position while operating lifting and moving with equipment. Keep load close to body, knees bent, and back straight. 3d. Take frequent breaks or switch personnel if cutting for an extended period of time.
	3e. EXPOSURE: Personnel may be exposed to fire hazard during Hot Work Activities.	3e. Complete Hot Work Permit, Designate Fire Watch. 3e. Conduct work zone inspection: – Verify that all combustible or flammable materials or equipment fuel sources have been removed from within 35 feet of the proposed hot work. – If combustible or flammable materials or equipment fuel sources have not been removed from within 35 feet of the hot work, verify that engineering and procedural controls have been emplaced: curtains, blankets, wetting, ventilation. 3e. Two 20-lb. Type ABC Fire extinguishers required. 3e. Conduct continuous air monitoring / Lower Explosive Limit (LEL) screenings. Action Level: 10% of the LEL. 3e. If ambient air concentrations exceed LEL Action Levels, STOP WORK and contact supervisor. 3e. Wear hard hat, long sleeved-shirt and safety glasses. Utilize job specific PPE such as welding jacket or chaps and welding glasses when using gas powered saw or a plasma cutter.
4. Secure area when leaving tools unattended.	**4a. CONTACT:** Unauthorized personnel may enter the work area	4a. Unplug saw when not being used. Store equipment in designated storage areas when not being used.
	4b. FALL: Slip/trip/fall	4b. Store tool in designated storage location when it is not being used, secure all extension cords, keep all equipment out of walkways. 4b. Keep work area free of Slip, Trip and Fall Hazards.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-006	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE:	WORK ACTIVITY (Description):	
Generic	**Drilling**	**Direct Push Soil Borings / Well Installation**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Timothy Zei	Project Hydrogeologist	Raymond Olson	OHSM
		Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing, Long Sleeve Shirt	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Geoprobe or Truck-Mounted Direct Push Drill Rig, Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Macrocore liners, Liner Opening Tool, 20 lb. Type ABC Fire Extinguisher, 42" Cones & Flags, "Work Area" Signs, Water

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"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization of drilling rig (ensure the Subsurface Clearance Protocol and Drill Rig Checklist are completed)	**1a. CONTACT:** Equipment/property damage.	1a. The drill rig's tower/derrick will be lowered and secured prior to mobilization. 1a. A spotter should be utilized while moving the drill rig. If personnel move into the path of the drill rig, the drill rig will be stopped until the path is again clear. Use a spotter for all required backing operations. 1a. Set-up the work area and position equipment in a manner that eliminates or reduces the need for backing of support trucks and trailers. 1a. When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver visibility. 1a. Inspect the driving path for uneven terrain. Level or avoid if needed. 1a. Drill rig should have a minimum **exclusion zone which encompasses its tip radius** for non-essential personnel (i.e., driller helper, geologist) when the rig is moving/ in operation.
	1b. FALL: Slip/trip/fall hazards.	1b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 1b. Use established pathways and walk on stable, secure ground.
	1c. CONTACT: Crushing from roll-over.	1c Geoprobe should cross all hills/obstructions head on with the mast down to reduce risk of roll-over.
2. Raising tower/derrick of drill rig	**2a. CONTACT:** Overhead hazards.	2a. Prior to raising the tower/derrick, the area above the drilling rig will be inspected for wires, tree limbs, piping, or other structures, that could come in contact with the rig's tower and/or drilling rods or tools. 2a. Maintain a safe distance of 10' from overhead structures.
	2b. CONTACT: Pinch Points/Amputation Points when raising the rig and instability of rig	2b. Inspect the equipment prior to use and avoid pinch/amputation points. 2b. Lower outriggers to ensure stability prior to raising rig tower/derrick. 2b. If the rig needs to be mounted, be sure to use three points of contact.
3. Advancement of drilling equipment and well installation	**3a. CONTACT:** Flying debris	3a. Be aware of and avoid potential line-of-fire hazards and wear required PPE such as eye, ear, and hand protection.
	3b. EXPOSURE: Noise and dust.	3b. Wet borehole area with sprayer to minimize dust. 3b. Stand upwind and keep body away from rig. 3b. Dust mask should be worn if conditions warrant. 3b. Wear hearing protection when the drill rig is in operation.
Assess [1]JOB STEPS	**Analyze [2]POTENTIAL HAZARDS**	**Act [3]CRITICAL ACTIONS**

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3. Advancement of drilling equipment and well installation (Continued)	**3a. CONTACT:** Flying debris **3b. EXPOSURE:** Noise and dust. **3c. FALL:** Slip/trip/fall hazards. **3d. CAUGHT:** Limb/extremity pinching; abrasion/crushing. **3e. CONTACT:** Equipment imbalance during advancement of drill equipment. **3f. EXPOSURE:** Inhalation of contamination/vapors. **3g. EXERTION:** Potential for muscle strain/injury while lifting and installing well casings, lifting sand bags, and/or lifting rods.	3c. Contain drill cuttings and drilling water to prevent fall hazards from developing in work area. 3c. See 1b. 3d. Ensure all Emergency Safety Stop buttons function properly. 3d. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 3d. Inspect the equipment prior to use for potential pinch/amputation points. Keep hands away from pinch/amputation points and use of tools is preferable compared to fingers and hands. 3d. Inspect drill head for worn surface or missing teeth; replace if damaged or blunt. 3d. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3d. All non-essential personnel should stay away from the immediate work area; position body out of the line-of-fire of equipment. 3d. Drillers and helpers will understand and use the "Show Me Your Hands" Policy. 3d. Spinning rods/casing have an **exclusion zone of tip radius** while in operation. 3e. Drillers will advance the borehole with caution to avoid causing the rig to become imbalanced and/or tip. 3e. The blocking and leveling devices used to secure the rig will be inspected by drillers and Roux personnel regularly to see if shifting has occurred. 3e. In addition, personnel and equipment that are non-essential to the advancement of the borehole will be positioned away from the rig at a distance that is at least as far as the boom is high (**minimum exclusion zone**). 3f. Monitor ambient air for dangerous conditions using a calibrated photoionization detector (PID) to periodically monitor the breathing zone of the work area. 3f. If a reading of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional precautions in accordance with the site specific health and safety plan. 3f. Use a multi-gas meter to monitor ambient air for dangerous conditions (i.e. unsafe levels of carbon monoxide when drilling indoors or the presence of explosive vapors). 3g. Keep back straight and bend at the knees. 3g. Utilize team lifting or mechanical means for objects over 50lbs. 3g. Use mechanical lifting device for odd shaped objects.
4. Remove sample liner.	**4a. EXERTION:** Potential for muscle strain/injury while removing liner from probe rod. **4b. CONTACT:** Pinch points and cuts **4c. EXPOSURE:** Inhalation and/or dermal contact with contaminants.	4a Utilize team lifting or mechanical means for objects over 50lbs. 4a. Use hydraulic liner extruder if available. 4b. Place liner on sturdy surface when opening. 4b. Don cut-resistant gloves and use appropriate liner cutter when opening liners. 4b. Always cut away from the body. 4c. Wear chemical-resistant disposable gloves when handling liners. 4c. See 3f.
5. Decontaminate equipment.	**5a. EXPOSURE/CONTACT**: To contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, vapors). **5b. EXPOSURE:** To chemicals in cleaning solution including ammonia.	5a. Wear chemical-resistant disposable gloves and safety glasses. 5a. Contain decontamination water so that it does not spill. 5a. Use an absorbent pad to clean spills, if necessary. 5a. Spray equipment from side angle, not straight on, to avoid backsplash. 5a. See 3b and 3f. 5b. See 4a. Review SDS to ensure appropriate precautions are taken and understood.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-007	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**General Site Activity**	**Driving**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Valerie Sabatasso	Project Scientist	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather/ cut-resistant level 2
☒ HARD HAT: when outside vehicle	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER _____
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: high visibility vest, when outside vehicle	
☒ SAFETY GLASSES:when outside vehicle	☒ SAFETY TOE BOOTS: when outside vehicle		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Motor Vehicle (i.e. car, truck, SUV)

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Driving to/leaving Site	**1a. CONTACT:** Severe injury/disability, property damage, monetary loss (insurance premiums, deductibles, loss of license/job) caused by collision with or struck by other vehicles, obstructions, pedestrians, animals, etc. *Common factors that may lead to CONTACT incident, but not limited to: • distracted driving (cell phone, GPS, radio, billboards, "rubber necking") • lack of situational awareness • unfamiliarity with traffic patterns/road layout • weather conditions (wet/icy roads, hydroplaning, black ice) • weariness • high speeds • obstructed vision (solar glare, debris on windshield, blind spots, large vehicle at the front) • changes in travel pathway (construction, snow banks, non-operational signals, potholes, detours, special events) • improper vehicle maintenance (non-operational signal light, worn tires, cracked windshield, ineffective wipers) • loose or unsecure objects	1a. PLAN AHEAD – review/make yourself familiar with maps and driving directions before beginning the drive to the Site. Do not attempt to drive and review maps/directions at the same time. Pull over and stop your vehicle before looking at maps/directions. 1a. Complete a basic vehicle inspection before driving. Verify Inspection and Registration are current, tires and wipers are in good condition, all lights are functional, all glass/mirrors are undamaged, the horn is functional, roof/hood/trunk are free from accumulated snow and visibility is not impaired due to snow/ice/frost/fog on windows. 1a. Do not hang items in car that can obstruct your view or become projectiles in a collision. 1a. Do not get distracted using touch screen radios or GPS units built into newer models. Keep your eyes on the road and stay alert. 1a. Follow posted speed limits and obey traffic signals and roadway signs. 1a. Always wear your seat belt and shoulder harness when driving. 1a. When driving around large vehicles and trucks, maintain extra space as these vehicles may not be able to see a smaller car too close. 1a. Follow the "Rules of the Road" including: using your turn signals, coming to a complete stop, and allowing vehicles the right of way (yield) when they are when traffic laws require. 1a. Apply the Smith Five Keys® of safe driving • Aim High in Steering® - Expand eye lead time to a minimum of 15 seconds • Get the Big Picture® - Maintain proper a 4 second minimum following distance at all times - Scan mirrors every 5-8 seconds to achieve a circle of awareness - Position your vehicle so you can see relevant/non-relevant objects • Keep Your Eyes Moving® - Try to maintain about 180 degrees of visibility - Avoid blank and fixed stares. Avoid focusing on one object for more than 2 seconds • Leave Yourself an Out® - Avoid traveling in traffic clusters - Surround yourself with space - Anticipate the actions of others

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Driving to/leaving Site (cont'd)	**1a. CONTACT:** Severe injury/disability, property damage, monetary loss (insurance premiums, deductibles, loss of license/job) caused by collision with or struck by other vehicles, obstructions, pedestrians, animals, etc.	• Make Sure They See You® - Maintain eye contact with on-coming vehicles/pedestrians - Use warning devices (e.g., hand signals, high-lights, horns etc.) - Proper timing is essential 1a. Do not perform reconnaissance or inspections while driving. Your vehicle should be parked in a safe location when viewing or surveying the Site and vicinity 1a. Avoid sudden turns and stops. Don't drive recklessly – be in control of vehicle at all times. 1a. In inclement weather, first determine if work can be POSTPONED. Otherwise, plan according to weather conditions including checking forecast along entirety of travel route (especially, for long distances). Reduce speed as road conditions warrant. Travelling with winter car equipment in the winter is strongly recommended (i.e., shovel, scraper, brush, blanket, extra clothing, flashlight, bag of sand). If your vehicle has 4-wheel drive, review the operators manual and understand operating procedure prior to engaging 4-wheel drive. If at any point on your drive weather becomes too severe to proceed safely pull over if safe to do so or seek nearest cover (e.g., overpass) 1a. If feeling drowsy or sleepy, do not drive. Pull over in a safe place to rest if you experience any signs of drowsiness. Make sure to get adequate sleep the night before an early drive. 1a. Never operate a vehicle under the influence of alcohol or illegal substances or medications affecting your performance. 1a. Keep your eyes on the road. Do not call or talk on cellular phones. Pull over to a safe location if you must answer or make a call. 1a. When parking, pull-through when possible. If backing is required visually inspect area to ensure it is free from obstructions prior to backing in and relying solely on mirrors; use spotters when available.
2. Entering/Exiting Vehicle.	**2a. CAUGHT:** Personal injury (broken fingers/hand) while entering or exiting vehicles **2b. FALL:** Personal injury (twisted ankle, deep contusion, concussion, broken wrist/arm, etc.) from slip/fall on uneven or unstable or slippery surface while exiting/entering vehicle **2c. CONTACT:** Severe injury/disability, property damage, monetary loss (insurance premiums, deductibles, loss of license/job) caused by collision with or struck by other vehicles, obstructions, pedestrians, animals, etc.	2a. Open and close doors slowly. Never put hands or feet in between door and vehicle to avoid pinch points. 2b. When exiting the vehicle make sure your feet are on firm footing and weight is evenly distributed before exiting/standing. In inclement weather use hands to support yourself, by holding the car door and/or steering wheel, when exiting the vehicle. 2c. Check both directions for traffic before opening door. Do not exit vehicle if traffic does not permit you to exit safely 2c. Check anticipated path of door prior to opening, do not open door into any obstructions (e.g., bollards, high curbing)

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JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**Site Recon**	**Conduct aerial video and photo reconnaissance of site work for documentation**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
William H. Cicio	Remote Pilot In Command	Brian Hobbs	CHSD
		Chris Battista	Senior Construction Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☒ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility long sleeved clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-toe boots		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Drone, radio controller w/Wi-Fi extender, tablet/smartphone w/mount & screen sunshade, 5 lithium ion batteries, 2 battery chargers, 4 Wi-Fi antennas, radio tracking tag, tracking receivers, USB cords & car charger, optional strobe light, optional parachute system, optional floatation pods, extra propellers, propeller wrench, screw drivers, safety cones.

Commitment to Safety – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE: Maintain 10' or greater exclusion zone around drone while it is in motion.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site manager/property owner	**1a. CONTACT/EXPOSURE/FALL:** Lack of communication could result in H&S incident.	1a. Inform Site personnel of work scope, timeline and locations(s). 1a. Inquire about hazards and other activities taking place at the Site. 1a. Discuss emergency evacuation procedures and muster points with Site manager/property owner.
2. Pre-launch setup	**2a. CONTACT:** The aircraft may crash into an obstruction in the event an auto return is initiated, causing personal injury or property damage.	2a. Set RTH (Return to Home) altitude that is higher than the tallest obstacle on the site.
	2b. CONTACT: The aircraft compass may be magnetically aligned to the previous location flown, causing the aircraft to be disoriented and crash, causing personal injury or property damage.	2b. Calibrate aircraft compass.
	2c. CONTACT: Lack of GPS satellite signals will eliminate the auto return safety feature in the event of controller signal loss and may result in an uncontrolled flight that crashes, causing personal injury or property damage.	2c. Obtain a minimum of six GPS satellite signals. (Preferably nine or more) 2c. Set "Home Point" for auto return in event of critically low battery warning or loss of controller signal.
	2d. FALL: Hazards may be present at the Site that can result in trips and falls.	2d. Inspect the work area for tripping hazards. Remove or mark the hazard or relocate the staging and walking areas to avoid the hazard(s).
	2e. EXPOSURE: Biological hazards may be present in the work area.	2e. Inspect work area for biological hazards such as snakes, bees, poison ivy and ticks. Relocate launch area or remove hazard using appropriate procedure. Abide by Roux Associates Tick Policy and Procedures.
	2f. CONTACT: The site is an active construction/remediation project with heavy equipment operating across much of the Site that could strike the operator.	2f. Coordinate with Site personnel and delineate a work area outside of the heavy equipment exclusion zone for a launch/landing Site and operator work area. Identify truck/traffic routes and signal operators before entering.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Flight	**3a. CONTACT:** Flying above 400' AGL may interfere with manned aircraft in the area.	3a. Maintain sUAV flight below 400' AGL at all times per FAA regulations.
	3b. CONTACT: Losing sight of the aircraft creates a situation where unexpected obstacles can be encountered by the aircraft, causing it to crash and result in personal injury or property damage.	3b. Maintain visual line of sight (VLOS) at all times with the sUAV per FAA regulations.
	3c. CONTACT: A motor malfunction mid-flight can cause the aircraft to tumble out of the air and result in personal injury or property damage.	3c. Avoid flying directly above people per FAA regulations. 3c. Drone will be equipped with parachute system which is engaged during tumble. 3c. Drone will be equipped with floatation pods when flying extensively over bodies of water.
	3e. CONTACT: The aircraft can experience an uncontrolled fly-away due to magnetic interference, GPS drop, or equipment malfunction and eventually crash into something a distance away, resulting in personal injury or property damage.	3e. Be prepared to immediately notify the local airport ATC (Air Traffic Control) should an uncontrolled fly-away occur.
	3f. CONTACT: The aircraft motors and camera can be impacted by project generated dust and steam in the air.	3f. Coordinate with onsite personnel to avoid exposure to onsite debris from site work activities (e.g. Cement dust, steam, fugitive dusts)
	3g. CONTACT: The aircraft could contact the operator during takeoff and/or landing.	3g. The operator must stand a minimum of 10' from the launch/landing site during takeoff and return of the aircraft. 3g. In the event wind or groundcover may compromise a safe landing, the operator may conduct a hand catch retrieval using safety glove protection.
	3h. CONTACT: The aircraft could contact overhead powerlines or other energized utilities.	3h. Do not fly the aircraft within 25' of any overhead utility including powerlines, communication lines, pipe trestles and light poles.
	3i. CONTACT: Precipitation and/or high winds could make flying the aircraft dangerous and unstable which risks property damage and personal injury.	3i. Review weather forecast for site, if precipitation and/or high winds (>25 mph) are prevalent proceed to land aircraft and cease operations until precipitation and high winds stop.
	3j. PROPERTY DAMAGE/LOSS: The aircraft could lose altitude and impact water, resulting in the loss of the aircraft and add unwanted debris to the body of water.	3j. Drone will be equipped with floatation pods when flying extensively over bodies of water.
4. Landing	**4a. CONTACT:** Landing in an area that is crowded with people can be dangerous to personnel due to spinning rotors and unpredictable wind conditions.	4a. Land at the original take-off (Home) point. Otherwise, land the aircraft at a suitable unpopulated area away from site personnel. 4a. Immediately shut off motors upon touchdown.
	4b. CONTACT: The aircraft could contact the operator during takeoff and/or landing.	4b. The operator must stand a minimum of 10' from the launch/landing site during takeoff and return of the aircraft. 4b. In the event wind or groundcover may compromise a safe landing, the operator may conduct a hand catch retrieval using safety glove protection.
5. Post-Landing Check	**5a. CONTACT:** Stress cracks or damaged rotors can cause a future flight to crash, resulting in personal injury or property damage.	5a. Check equipment for any stress cracks or damage. Repair or replace parts as needed.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-009	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 1
JSA TYPE CATEGORY **Generic**	WORK TYPE **O&M**	WORK ACTIVITY (Description) **Movement of 55-Gallon Drums/Drum Handling with Mobile Carrier**		

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Michael Sarni	Technician	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut-resistant gloves
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER:
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent long sleeve shirt or long sleeve shirt and reflective safety vest.	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel or composite toe		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Mobile Drum Carrier, over-pack drum container, safety cones, and caution tape

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment (i.e. forklift) and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Preparing for and Inspection of Drum	**1a. FALL:** Tripping/falling due to uneven surface. Loose debris/garbage in work area.	1a. Clear area of loose garbage and debris. Inspect 55-gal drums for proper condition, labeling, check drum ring and bolts for tightness, inspect mobile drum carrier. 1a. Do a Test Lift to get a general sense of the weight of the drum. 1a. Inspect and use established pathways to avoid uneven terrain, weather-related hazards (i.e., debris, puddles, ice, etc.), and other obstructions. 1a. Secure work area and coordinate and communicate the planned work activities with other personnel working in the area. 1a. Delineate work area with 42" safety cones.
	1b. CONTACT/EXPOSURE: Drums could potentially be damaged or contain hazardous material. Mobile drum carrier could potentially be in poor working condition causing malfunctioning during operation.	1b. Prior to inspecting drums don cut-resistant gloves. If drum is not properly labeled, do not open and cease all drum transport activities. Immediately contact project manager and inform him/her of drum situation. 1b. Do not continue drum transport activities until further actions are determined by the project manager. 1b. If the drum is properly labeled, but leaking, improperly sealed or in poor condition, place drum in an over-pack drum. 1b. Inspect mobile drum carrier to ensure its overall integrity. Look for rust marks or potential weak points where the drum carrier could malfunction. Inspect the wheels to ensure that they easily turn and nothing is impeding their movement.
	1c. EXERTION/CAUGHT: Potential pinching/exertion hazards while securing ring/ tightening bolts	1c. Keep back straight and knees slightly bent while securing drum ring/tightening bolt. Wear cut-resistant gloves.
2. Position drum clamp tightly in between drum ribs, securing drum clamp to drum with chain	**2a. CAUGHT:** Pinching fingers between drum clamp and handle/chain.	2a. Attach drum clamp with chain and tighten until snug. Do not place hands between drum clamp and drum as the chain is tightened; wear cut resistant gloves. Keep face away from drum when handling in case of escaping vapors.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Disengage safety latches on handle, pull handle down until drum is lifted off ground and safety latches are reengaged; slightly suspending drum off the ground	**3a. EXERTION/ CONTACT:** Potential muscle strain associated with lifting/engaging drum/handle. Drum could shift/slip downward and crush toes.	3a. Ascertain whether the drum is overweight; if it is, then two people are needed to lower handle while drum is secured with clamp so that safety latches can be engaged. Keep body out of the lin-of-fire of the handle (do not position head above handle) as it is being pushed down. Do not allow feet/toes to be positioned under the drum as it is being lifted; wear steel/composite-toed boots.
	3b. CAUGHT: Fingers could be pinched while engaging/disengaging safety latches on handle	3b. Wear cut-resistant gloves while disengaging/reengaging safety latches. 3b. Avoid placing hands in pinch points.
4. Transport drums to designated location and disengage drum clamp (repeat Step 3 in reverse order)	**4a. FALL:** Tripping/ falling due to obstructions and uneven terrain. Potential for drum to fall during transport.	4a. Ensure transport path is free of potential obstructions that may cause the drum/carrier to become unstable. Position drum clamp between the ribs on the drum to prevent possible slipping.

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JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**Surveying**	**Elevation Surveying**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Bjorn Wespestad	Senior Engineer	Brian Hobbs	CHSD
William Hansen	Senior Engineer		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut-resistant or leather
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Long sleeve Shirt
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel-toe boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Surveying equipment (i.e., leveling rod/measuring ruler, tripod and autolevel).

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site manager/ property owner.	**1a. CONTACT/EXPOSURE/FALL:** Lack of communication could result in H&S incident.	1a. Inform Site personnel of work scope, timeline and location(s). 1a. Inquire about other activities taking place at the Site. 1a. If applicable, obtain General Work permit for the day.
2. Locate surveying position for instrument and rod and set-up work area	**2a. FALL:** Slip/trip hazards	2a. Inspect area for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.) and obstructions prior to setting up at the survey location. Keep eyes engaged with walking surface while in movement. Remember "Walking is Working." 2a. Conduct housekeeping and maintain clear paths to walk in and remove debris as required.
	2b. CONTACT: Traffic (surveying locations could potentially be in parking areas and sidewalks)	2b. Be aware of oncoming traffic. Utilize a flagman / spotter for locations in streets or high-traffic areas. 2b. Place 42 inch cones around the work area and delineate work zone with caution tape, snow fencing or safety bars, if necessary. 2b. Wear appropriate PPE including long-sleeved high visibility clothing and or reflective safety vest. 2b. Face traffic, maintain eye contact with oncoming vehicles and establish a safe exit route.
	2c. OVEREXERTION: Hazard due to carrying, lifting, and bending while transporting equipment	2c. Use proper body positioning and lifting techniques; keep back straight, lift with legs, keep load close to body, and never reach with a load. 2c. Avoid carrying too much equipment at one time and team-lift equipment that is heavier than 50 lb.
	2d. CAUGHT/CONTACT: Pinch Points / sharp edges associated with setting up the tripod	2d. Wear cut resistant gloves when handling the tripod and keep fingers away from pinch points located near moving parts of the tripod. Don't carry tripod by the pointed ends.
	2e. OVEREXERTION: Hazard due to bending awkwardly to look through the autolevel	2e. When practical, set the height of the autolevel optic so as to minimize bending at the waist.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Open / close manhole cover to well that is being surveyed (if necessary).	**3a. OVEREXERTION:** Muscle strain	3a. See 2c. Bend knees when reaching to open well. Use manhole lifting hook or pry bar to avoid bending.
	3b. CAUGHT: Pinch points associated with removing / replacing manholes and working with hand tools	3b. Wear leather gloves or cut resistant gloves when working with well cover and hand tools. 3b. Use proper tools (ratchet and crowbar, pry bar or magnet for well cover) and inspect before use. 3b. Do not put fingers under well cover.
	3c. EXPOSURE: To potentially hazardous vapors To biological hazards	3c. No open flames/heat sources. 3c. To minimize exposure to vapors, allow well to vent after opening it and before survey activities begin. 3c. Work on the upwind side of manhole/well. 3.c Use caution while opening lids to inspect work area for bees and insects inside of covers. 3c. Use insect/tick repellent as necessary.
	3d. CONTACT: With traffic	3d. See 2b.
4. Perform survey.	**4a. FALL:** Slip/trip hazards	4a. See 2a.
	4b. CONTACT: Traffic (surveying locations could be potentially located in parking areas and sidewalks)	4b. See 2b. 4b. Personnel using the scope will be devoting most of their attention to the surveying activity and shall be aware of vehicular and pedestrian traffic. Personnel holding the measuring stick should be extra vigilant of survey personnel and communicate any potential hazards to the instrument person via handheld radio or similar means. Ensure reflective safety vest is worn.
	4c. ENERGY SOURCES: Electrical shock from survey rod striking overhead electric lines or lights	4c. Prior to raising and extending the survey rod, personnel should thoroughly inspect the area above the measuring point. If overhead electrical lines are encountered within 20 feet of the measuring point; stop work and consult with the Office Health and Safety Officer.
5. Break down work area.	**5a. CONTACT:** Traffic (surveying locations can potentially be in parking areas and sidewalks)	5a. See 2b.
	5b. EXERTION: Hazard due to carrying, lifting, and bending while transporting equipment	5b. See 2c.
	5c. CONTACT: Personal injury or equipment damage by striking surroundings with an extended rod or unsecured tripod leg	5c. Ensure rod is entirely collapsed prior to mobilization / demobilization between survey points. 5c. Ensure tripod legs are fully collapsed and secured with strap prior to mobilization / demobilization between set-ups.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-011	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**Construction - Excavation**	**Excavation / Trenching**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
David Kaiser	Senior Engineer	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☒ LONG SLEEVED SHIRT	☒ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility long sleeved clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-toe boots		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Jackhammer, Excavator, Backhoe, Hand Tools, Photoionization Detector, barrels, 42" traffic cones, snow fencing, telescoping poles, temporary chain link fence, ladders, shovels, digging bars, power tools (cut-off saw), Two-way radios, Sheeting, Trench box, Retractable lanyard, Harness

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or footprint of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Pre-Clearance Protocol.	**1a. CONTACT:** Damage to underground utility.	1a. Confirm that (if applicable) "Call Before You Dig" and local utility companies were contacted prior to trenching in order to confirm utility mark outs. Must have a case # before digging.
	1b. ENERGY SOURCE/CONTACT: Property damage; Pressurized water mains may cause lacerations or broken bones. Pressurized gas mains may explode causing serious injury, or death. Underground electric may cause severe burns, shock, or death.	1b. Pre-clearing of the trenching location must be conducted to a minimum of 5 vertical feet below the ground surface (10 feet minimum for Critical Zone) using soft digging methods or hand tools (shovel and non-metallic dig bar) prior to trenching. Supervisor should be contacted to discuss appropriate pre-clearing depth. **1b. Complete subsurface clearance checklist**.
	1c. FALL: Slip, Trip or Fall may cause muscle strains or tears, abrasions, lacerations, or broken bones.	1c. Be aware of the conditions when walking or loading equipment and working. Walk within established pathway avoiding uneven surfaces. Remove potential slip/trip/fall hazards.
2. Set up work zone.	**2a. CONTACT/CAUGHT:** Cuts/lacerations from equipment. Broken bones from contact by vehicle.	2a. Isolate work area from hazards with cones, barricades, and snow fencing, telescoping poles or temporary chain link fence. Utilize a flag person when necessary (i.e., third party traffic in area). Install traffic signs in roadways and for detours. Spotters will maintain and enforce exclusion zone.
	2b. FALL: Slip, Trip or Fall may cause muscle strains or tears, abrasions, lacerations, or broken bones.	2b. See 1c.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Trenching Activity.	**3a. CONTACT:** Serious injury including broken bones, muscle strains or tears, and possibly death due to contact with machine.	3a. Spotter(s) required for all heavy equipment operation. No worker shall be allowed inside the exclusion zone or along the trench/excavation area while any equipment is in operation. A minimum exclusion zone greater than the length of the equipment boom must be established. Workers only allowed in exclusion zone if the operator is in "Hands Off "mode. Operator will not operate equipment until worker is out of exclusion zone. Spotters and operators will have radios for communication, when either loses sight of one another, and/or in case of emergency.
	3b. FALL: Slip, Trip or Fall may cause muscle strains or tears, abrasions, lacerations, or broken bones	3b. Any trench/excavation deeper than 3' must have a ladder within 25' of any worker in the excavation. At least 3'(rungs) of the ladder shall be above the top of the excavation. All spoil piles shall be maintained 2' minimum from edge of excavation. 3b. Any trench/excavation deeper than 6' must have fall protection, retractable lanyard for ladder use, and 42" high guardrails along the edge of the trench/excavation.
	3c. EXPOSURE: Noise, Dust, Concrete- Asphalt, petroleum hydrocarbon vapors may cause damage to ears and lungs	3c. Air monitoring using a calibrated photoionization detector (PID) will be used to monitor the breathing zone of the work area. If a reading of >5ppm is recorded, the oversight personnel must temporarily cease work and instruct all Site personnel to step away from the area of elevated readings.
4. Setting Trench protections if necessary.	**4a. CAUGHT:** Injury due to contact with failed trench, may include muscle strains or tears, abrasions or lacerations, broken bones and possibly death.	4a. To prevent cave-ins and avoid caught by/between, excavations over 4' in depth, unless working in stable rock, shall have engineer approved shoring, sheeting or trench box. Top of protection shall be at least 2' above top of excavation.
	4b. CONTACT/CAUGHT: Injury due to rigging activities and entering exclusion zone during lifting and/or transport of shoring/trench box/material may include muscle strains or tears, abrasions or lacerations, broken bones and possibly death.	4b. Use only inspected rigging with 2, 3 or 4 lift points; wear cut-resistant gloves. Rigging to be hooked up to factory installed hook up points on equipment. Control load with non-conductive tag lines with workers out of exclusion zone. Don't stand underneath suspended load; wear steel toed boots and hard hat.
	4c. FALL: Possible injury due to fall into excavation may include muscle strains or tears, abrasions or lacerations, or broken bones.	4c. Shoring to be set and sides will be backfilled to avoid fall hazards before workers are allowed to enter area. Operator will be in "HANDS OFF" mode before workers enter work area to unhook rigging. An inspected ladder extending 3' above top of the shoring will be used to enter and exit the excavation. Workers will use three points of contact when using the ladder.
5. Secure/Leave Site. If backfilling, see excavation backfilling and compaction JSA for potential hazards and critical actions.	**5a. FALL:** Potential Slip, Trip or Fall - may cause muscle strains or tears, abrasions or lacerations, or broken bones.	5a. See 1c. 5a. All open excavations must be backfilled or secured prior to departure with steel plates, orange construction fence or temporary chain link fencing.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-012	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE:	WORK ACTIVITY (Description):
Generic	**Construction - General**	**Installation or Repair of Chain Link Fence**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Tim Unalp	SHSO	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut-resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel or Composite toed boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Fence materials, Hand tools, Power Tools, GFCI

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Secure work zone	**1a. FALL:** Slip, trip, or fall hazards associated with site conditions.	1a. Maintain good housekeeping and keep work area free of potential Slip, Trip and Fall hazards. 1b. Utilize Traffic Control devices to secure work zone (42" traffic cones with flags, and caution tape).
	1b. CONTACT: Vehicular and pedestrian traffic.	1b. Use work truck or rigid barriers to barricade the side of work area in the line-of-fire of vehicular traffic.
2. Development of anchor locations for Post-Holes for fences using either a Hammer drill or Post-Hole digger.	**2a. CONTACT:** Potential cut/abrasion hazards and splinters. Operation of hammer drill can result in ejected debris and eye hazard.	2a. De-energize power tools by removing battery packs or unplugging from electrical supply prior to switching out components (i.e., Sawsall blades or drill bits). 2a. Unplug from electrical power or remove battery pack from tools before handing them off to another person. 2a. Wear cut-resistant gloves and safety glasses.
	2b. ERGONOMICS: Back strain while maneuvering Post-Hole digger or Shovel.	2b. Utilize proper lifting techniques when using digging tools. Keep back straight, bend at the knees, keep load close to body, turn with legs, and do not twist back. 2b. Inspect post-hole digger prior to use. Ensure there are no splinters on handle. Ensure that the shovel section bolts are in good working condition. 2b. Wear leather or cut-resistant gloves.
	2c. EXPOSURE: Operation of hammer drill can generate greater than 85 dBAs	2c. Wear hearing protection. Personnel not involved in the task must stand at least 10-foot away from the operating hammer drill.
	2d. ENERGY SOURCE: Electric hazards from operation of power tools.	2d. Use heavy-duty, outdoor cords with ground, rated for the electrical load required. Inspect extension cords, verify good condition; no exposed wires, cuts, damage, worn insulation, or damaged plugs. 2d. If the use of a generator is required, do not refuel generator while it is running. Allow generator to cool for 5 minutes prior to refueling. 2d. Use GFCI power outlet.
	2e. ERGONOMICS: Vibration injury.	2e. Wear vibration resistant gloves. 2f. See 2c.
	2f. EXPOSURE: Exposure to generator noise/fumes.	2f. Position generator such that exhaust is pointed away from workers or downwind of work area. Wear hearing protection if generator cannot be positioned out of the work area and if noise levels exceed 85 dBAs.
	2g. FALL: Trip hazards from equipment being left in work zone.	2g. Maintain good housekeeping and keep work area free of Slip, Trip and Fall hazards. Stage tools in designated areas at lowest potential energy. 2g. When possible route extension cords and hoses overhead or outside of walk path.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Manual lifting of fence materials	**3a. EXERTION/ERGONOMICS:** Back strain and personal injury from lifting heavy loads.	3a. 50 lbs is the maximum allowable weight per manual lift. Use a mechanical lifting device or the buddy system if the weight is greater than 50 lbs. 3a. Keep back straight, bend at the knees, and keep load close to body when lifting. 3a. Use buddy system when lifting awkward materials.
	3b. CONTACT: Potential cut/abrasion hazards.	3b. Ensure long sleeves are covering arms, wear cut-resistant gloves. Avoid grabbing sharp edges.
4. Installation of chain link fence or fabric.	**4a. OVEREXERTION:** Back strain and personal injury from lifting heavy loads	4a. See 3a.
	4b. CONTACT: Potential cut/abrasion hazards on fencing.	4b. Avoid sharp edges on fencing; ensure long sleeved shirts are fully covering arms, wear cut-resistant gloves. 4b. Use retractable knife for cutting privacy fabric.
5. Housekeeping.	**5a. FALL:** Slip, trip, fall hazards from items left in the work zone.	5a. Clean up loose items including fabric cuttings, tools, etc. 5a. Remove Slip, Trip and Fall hazards from the work area. 5a. Inspect work area to verify it is left in a safe condition.

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JOB SAFETY ANALYSIS Ctrl. No. GEN-013	DATE 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE:	WORK ACTIVITY (Description):	
Generic	**Gauging and Sampling**	**Gauging and Sampling**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Tim Unalp	SHSO	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☒ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Composite-toed or steel-toed boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Knee pads, Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

42-inch Safety Cones, Caution Tape, Interface Probe with Ground Clamp, and/or Water Level Meter, 20-lb., Type ABC Fire Extinguisher, Buckets. Tools as needed: Socket Wrench, Screw Driver, Crow Bar, Mallet, and Wire Brush.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization to monitoring well(s).	**1a. FALL:** Personal injury from slip/trip/fall due to uneven terrain and/or obstructions.	1a. Inspect pathway and plan for most suitable designated pathway prior to mobilization. 1a. Use established pathways, walk and/or drive on stable, secure ground and avoid steep hills or uneven terrain. 1a. If working near open water with an unguarded edge, wear life vest.
	1b. CONTACT: With traffic/third parties.	1b. Identify potential traffic sources and delineate work area with 42-inch traffic safety cones. Position vehicle to protect against oncoming traffic. Use caution tape to provide a more visible delineation of the work area if necessary. 1b. Wear appropriate PPE including high visibility clothing or reflective vest. 1b. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route.
	1c. EXERTION: Muscle strain from lifting equipment	1c. Use proper lifting techniques when handling/moving equipment; bend knees and keep back straight. 4c. Use mechanical assistance or team lifting techniques when equipment is 50 lbs. or heavier. 4c. Make multiple trips to carry equipment.
	1d. EXPOSURE: To biological hazards.	1d. Inspect work area for bees and insects. 1d. Use insect/tick repellent as necessary.
2. Open/close well.	**2a. EXERTION:** Muscle strain.	2a. Use proper lifting techniques; keep back straight, lift with legs and bend knees when reaching to open/close well.
	2b. CAUGHT: Pinch/crush points associated with removing/replacing manholes and working with hand tools.	2b. Wear leather gloves or cut resistant gloves when working with well cover and hand tools. 2b. Use proper tools (ratchet and pry bar or magnet for well cover) and inspect before use. 2b. Do not put fingers under well cover.
	2c. CAUGHT: Pinch points associated with placing J-plug back onto PVC pipe.	2c. See 2b. 2c. Keep fingers out of line-of-fire when securing cap.
	2d. EXPOSURE: To potential hazardous vapors.	2d. No open flames/heat sources. 2d. To minimize exposure to vapors, allow well to vent after opening it and before sampling activities begin. 2d. Stand up-wind if possible, to avoid inhaling vapors.
3. Gauge well.	**3a. CONTACT:** With contamination (e.g. contaminated groundwater).	3a. Wear chemical-resistant disposable gloves (over cut-resistant gloves) and safety glasses when gauging well. 3a. Insert and remove probe slowly to avoid splashing. 3a. Use an absorbent pad to clean probe.
	3b. CONTACT: With traffic.	3b. See 1b.
	3c. Exposure: To static electricity, fire or explosion.	3c. Ground interface probe to a designated grounding point/rod, well casing or suitably electrically conductive surface to dissipate static electricity.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Purge and sample well	**4a. EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors) and/or sample preservatives.	4a. Open and fill sample jars slowly to avoid splashing and contact with preservatives. 4a. Wear cut-resistant gloves and chemical-resistant disposable gloves when sampling. 4a. Fill sample containers over purge container to avoid spilling water onto the ground. 4a. Use an absorbent pad to clean spills. 4a. When using a bailer to purge a well, pull the bailer slowly from the well to avoid splash hazards. 4a. When sampling or purging the water using a bailer, pour out water slowly to reduce the potential for splash hazards with groundwater. 4a. When using a tubing valve always remove the valve slowly after sample collection to release any pressure and avoid pressurized splash hazards. 4a. When collecting a groundwater sample always point sampling apparatus (tubing, bailer, etc.) away from face and body.
	4b. CONTACT: Personal injury from cuts, abrasions, or punctures by glassware or sharp objects.	4b. To avoid spills or breakage, place sample ware on even surface. 4b. Do not over tighten caps on glass sample ware. 4b. Wear chemical-resistant nitrile disposable gloves over cut-resistant (i.e., Kevlar) gloves when sampling and handling glassware (i.e., VOA vials) or when using cutting tools.
	4c. EXERTION: Muscle strain while carrying equipment.	4c. Use proper lifting techniques when handling/moving equipment, bend knees and keep back straight. 4c. Use mechanical assistance or team lifting techniques when equipment is 50 lbs. or heavier. 4c. Make multiple trips to carry equipment.
	4d. CONTACT: With traffic.	4d. See 1b.
	4e. CONTACT: Pinch points with groundwater pump components (i.e., wheel, line, clamps).	4e. Wear leather/cut-resistant gloves when working with groundwater pumps. 4e. Never place hands on or near pinch points such as the wheel, clamps or other moving parts during pump operations. 4e. Use the correct mechanisms, such as a pump reel, to lower pump into well. 4e. Never attempt to manually stop any moving part of equipment including hose reels and/or tubing.
	4f. EXERTION: Muscle strain from repetitive motion of bailing and sampling a well.	4f. See 4c. 4f. Include a stretch break when repetitive motions are part of the task.
5. Management of purge water.	**5a. EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors).	5a. Do not overfill container and pour liquids slowly so that they do not splash. 5a. Properly dispose of used materials/PPE in appropriate container in designated storage area.
	5b. EXERTION: Muscle strain from lifting/carrying and moving containers.	5b. Use proper lifting techniques when lifting / carrying or moving container(s) (see 4c.). 5b. Do not overfill container(s).
6. Decontaminate equipment.	**6a. EXPOSURE/CONTACT:** To contamination (e.g., SPH, contaminated groundwater, vapors).	6a. Work on the upwind side, where possible, of decon area. 6a. Wear chemical-resistant disposable gloves and safety glasses. 6a. Use an absorbent pad to clean spills.
	6b. CAUGHT: Pinch points associated with handling hand tools	6b. See 2b. 6b. Inspect hand tools for sharp edges before decontaminating.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-014	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE:	WORK ACTIVITY (Description):	
Generic	**Drilling**	**Hollow Stem Auger Soil Borings / Well Installation**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Douglas Ferraiolo	Project Geologist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☒ GOGGLES: Spoggles required if winds exceed 15 mph. ☐ FACE SHIELD ☒ HEARING PROTECTION: (as needed). ☒ SAFETY SHOES: Steel or Composite Toe.	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent long-sleeve shirt or long-sleeve shirt and reflective safety vest.	☒ GLOVES: Leather, Cut-Resistant, and Nitrile. ☒ OTHER: Insect Repellant, Sunscreen (as needed).

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Truck-Mounted Drilling Rig or Track Rig, Saw, Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Interface Probe, 20 lb. Type ABC Fire Extinguisher, 42" Cones & Flags, "Work Area" Signs.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization / demobilization and establish a work area.	**1a. See Mobilization/ Demobilization JSA GEN-015.**	1a. See Mobilization / Demobilization JSA GEN-015.
2. Raising tower / derrick of drilling rig.	**2a. CONTACT:** Overhead hazards.	2a. Prior to raising the tower / derrick, the area above the drilling rig will be inspected for overhead hazards (wires, tree limbs, piping or other structures) that may be contacted by the rig's tower or drilling rods. 2a. The tower / derrick must not be raised beneath overhead power lines unless approved by the Roux PM. 2a. Maintain a minimum of 10' from all overhead structures. 2a. Do not move the rig while the tower / derrick is raised.
	2b. CONTACT: Amputation / crush points when raising the rig and instability of rig.	2b. Inspect the equipment prior to use and avoid any potential amputation points. 2b. Lower outriggers to ensure stability prior to raising rig tower derrick. Keep feet and body out of the line of fire when lowering out-riggers. 2b. Inspect the set-up location for uneven terrain. Level or avoid area if needed. 2b. If the rig needs to be mounted, be sure to use three points of contact.
3. Advancement of augers for soil boring installation.	**3a. CONTACT:** Equipment imbalance during advancement of drill equipment.	3a. Drillers will advance the borehole with caution to avoid causing the rig to become imbalanced and / or tip. 3a. The blocking and leveling devices used to secure the rig will be inspected by drillers and Roux personnel regularly to see if shifting has occurred. **3a. Drillers will maintain the "Purple Zone" policy surrounding augers to ensure no personnel come into contact with augers while in use. Workers will spray paint a 3' semi-circle surrounding the augers to visually show that no personnel should enter the "Purple Zone" while drilling activities are being conducted.** 3a. In addition, personnel and equipment that are non-essential to the advancement of the borehole will be positioned away from the rig at a distance that is at least as far as the boom is high (minimum exclusion zone of 20 feet).
	3b. CONTACT: Flying / spraying debris.	3b. Wear all required PPE (especially hand, eye, and ear protection). 3b. Maintain minimum EZ distance (i.e. swing/tip radius of rig) when rig is in operation to avoid potential line of fire hazards from flying materials or debris.
	3c. CAUGHT: Limb/extremity amputation, abrasion, and crushing.	3c. Inspect the equipment prior to use for potential pinch points. 3c. Test all emergency shutdown devices prior to drilling. 3c. Inspect drill head for worn surface or missing teeth; replace if damaged or blunt. 3c. Inspect augers, do not use if auger flight is damaged or bent.
Assess	**Analyze**	**Act**

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[1]JOB STEPS	[2]POTENTIAL HAZARDS	[3]CRITICAL ACTIONS
3. Advancement of augers for soil boring installation (Continued).		3c. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3c. All non-essential personnel should stay away from the immediate work area; position body out of the line-of-fire of equipment particularly when installing auger flights and steel override casings. 3c. Drillers and helpers will understand and use the "Show Me Your Hands" Policy. 3c. Spinning augers should have an exclusion zone of 20 feet when in operation.
	3d. FALL: Slip/trip/fall hazards.	3d. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 3d. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 3d. Use established pathways and walk on stable, secure ground. 3d. Use three points of contact when mounting or dismounting the rig. 3d. Remove soil cuttings to avoid a tripping hazard from developing near augers.
	3e. EXPOSURE: Inhalation of contamination / vapors.	3e. Air monitoring using a calibrated photoionization detector (PID) to periodically monitor the breathing zone of the work area. 3e. The Action Level for breathing zone air is five parts per million (sustained) as detected by the PID. 3e. If a reading of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional appropriate precautions in accordance with the site specific health and safety plan.
	3f. EXPOSURE: Noise and dust.	3f. Wet borehole area with sprayer to minimize dust. Stand upwind and keep body positioned away from rig. 3f. Wear hearing protection while drill rig is operating and / or the noise levels exceed 85 dBA.
	3g. EXERTION: Installing well casings and lifting augers.	3g. Keep back straight and bend at the knees. 3g. Utilize team lifting for objects heavier than 50lbs. 3g. Use mechanical lifting device for odd shaped objects.
4. Installation of well materials.	**4a. CONTACT:** Installing well materials while also pulling up augers. **4b. CAUGHT:** Possible pinch or crush hazard assembling PVC and sending down the borehole. **4c. FALL:** Slip/trip/fall hazards with hand tools and materials. **4d. EXPOSURE:** Potential contamination, harmful vapors, dust, and / or noise. **4e. EXERTION:** Lifting heavy bags of materials to backfill borehole.	4a. Potential contact with augers during installation of well materials. 4a. Keep distance from augers and do not place any materials while augers are in motion. 4b. Keep all body parts out of potential pinch points while placing PVC together and sending down borehole. 4c. See 3d. 4d. See 3e and 3f. 4d. Stand upwind to avoid exposure to dust generated from packing materials. 4e. See 3g.
5. Cleaning the auger flights	**5a. CONTACT:** Cuts/scrapes or puncture wound from contacting auger.	5a. Follow "Show Me Your Hands" Procedure and make sure auger is out of gear before contacting auger with tool or hand. 5a. Pull cleaning tool across your body with handle away from body; do not push toward the auger. 5a. Do not clean more than ¾ turn around the auger at a time. 5a. Wear cut resistant and leather gloves. 5a. Always use two hands to operate cleaning tool. 5a. Inspect tool before use and remove from service if handle or metal are cracked/fatigued. 5a. Stand out of the line of fire.
6. Decontaminate equipment.	**6a. EXPOSURE / CONTACT:** To contamination (e.g., contaminated groundwater, vapors). **6b. EXPOSURE**: To chemicals in cleaning solution (including ammonia).	6a. Wear chemical-resistant disposable gloves and safety glasses. 6a. Contain decontamination water so that it does not spill. 6a. Use an absorbent pad to clean spills, if necessary. 6b. See 3e. Wear all appropriate PPE and stand upwind of any exposed cleaning solutions.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

JOB SAFETY ANALYSIS	Ctrl. No. GEN-015	DATE: 4/10/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
GENERIC	**Site Recon**	**Mobilization/Demobilization**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Tim Unalp	SHSO	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION (as needed) ☒ SAFETY SHOES: Steel Toe or composite toe	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest of high-visibility clothing; long sleeve shirt; long pants	☒ GLOVES: Leather, nitrile, and cut resistant (as needed) ☐ OTHER

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Varies

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilize/demobilize and establish work area	**1a. FALL:** Slip/trips/falls from obstructions, uneven terrain, weather conditions, heavy loads, and/or poor housekeeping.	1a. Use 3 points-of-contact/ensure secure footing when entering and exiting vehicle. 1a. Inspect walking path for uneven terrain, steep hills, obstructions, and/or weather-related hazards (i.e., ice, snow, and puddles) prior to mobilizing equipment. Use established pathways. Walk on stable/secure ground. 1a. Do not climb over stored materials/equipment; walk around. Practice good housekeeping; organize and store equipment neatly in one area at its lowest potential energy. 1a. Wear boots with adequate treads. 1a. Delineate unsafe areas with 42” cones, caution tape and/or flagging.
	1b. CONTACT: Personal injury and/or property damage caused by being struck by Site traffic or equipment used in Site activities.	1b. Observe and maintain the posted speed limits. 1b. When first arriving onsite, park vehicles in designated parking space and/or out of the way locations. Use parking brake on all vehicles and tire chocks on work trucks and trailers. 1b. Check in with Site Manager/Supervisor to ensure coordination with other Site activities and to discuss any special hazards. Ensure that short-service employees (SSE) are identified. 1b. Identify potential traffic sources. 1b. Wear PPE including high visibility clothing or reflective vest. 1b. Use a spotter while moving work vehicles; plan ahead to avoid backing whenever possible. 1b. Maintain a minimum exclusion zone when vehicles are in motion (i.e. greater than swing/tip radius of equipment). When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver-to-spotter visibility. 1b. Delineate work area with 42” cones, flags, caution tape, and/or other barriers. 1b. Position “Work Area” signs at Site entrances, if possible, or at either side of work area.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
		1b. Position largest vehicle to protect against oncoming traffic. 1b. Face traffic, maintain eye contact with oncoming vehicles, use a spotter, and establish a safe exit route. 1b. Observe potential overhead and ground surface features that may interfere with moving equipment. Clear the path of physical hazards prior to initiating mobilization.
	1c. CAUGHT: Personal injury from pinch points and being in line-of-fire of vehicle and/or equipment.	1c. Make sure driver has engaged parking brake and placed wheel chocks in a position to prevent movement. Be sure that vehicle is parked in front/down gradient (positioned to best block oncoming traffic) of work area. 1c. Wear leather gloves when handling any tools or equipment. Wear cut-resistant gloves (Kevlar or similar) when handling sharp objects/cutting tools/glass. 1c. Keep body parts away from line-of-fire of equipment. 1c. Always carry tools by the handles and/or designated carrier. Ensure sharp-edged tools are sheathed/secure. 1c. Remove any loose jewelry. Avoid wearing loose clothing and/or ensure loose clothing is secure. 1c. Secure all items on the equipment, tighten up any items or features that have potential to shift or break during mobilization.
	1d. OVEREXERTION: Muscle strains while lifting/carrying equipment.	1d. Use body positioning and lifting techniques that avoid muscle strain; keep back straight, lift with legs, turn with whole body, keep load close to body, and never reach with a load. 1d. Ensure that loads are balanced. Use assistance (mechanical or additional person) to carry equipment that is either unwieldy or over 50 lbs.
	1e. EXPOSURE: Personal injury from exposure to biological and environmental hazards.	1e. Inspect area to avoid contact with biological hazards (i.e. poisonous plants, stinging insects, ticks, etc.). 1e. Wear long sleeved clothes treated with Permethrin, apply insect repellant containing DEET to exposed skin, and inspect clothes and skin for ticks during and after work. 1e. Apply sunscreen (SPF 15+) if exposure to sun for 30 minutes or more is expected.
	1f. EXPOSURE: Weather related injuries.	1f. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, nausea, rapid and shallow breathing). Take breaks in cool places and hydrate as needed. 1f. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks in warm areas as needed. 1f. Wear clothing appropriate for weather and temperature conditions (e.g., rain jackets, snow pants, multiple layers). 1f. If lightning is observed, wait 30 minutes in a sheltered location (car is acceptable) before resuming work.
	1g. EXPOSURE: Personal injury from noise hazards.	1g. Wear hearing protection if sound levels exceed 85 dBA (if you must raise your voice for normal conversation).

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-016	DATE: 4/10/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Construction – Concrete & Asphalt**	**Concrete Sidewalk Flag / Well Pad Replacement**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Ron Lombino	Senior Hydrogeologist	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☒ FACE SHIELD: (When Jackhammering) ☒ HEARING PROTECTION: (While Jackhammering or when Compressor is Running) ☒ SAFETY SHOES: Steel or Composite toe	☐ AIR PURIFYINGRESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: High visibility long sleeved shirt/ Safety vest	☒ GLOVES: Cut Resistant and/or Leather ☒ OTHER: Dust Mask

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Concrete Truck, Concrete Mixer, Jack Hammer, Air Saw or Gas-Powered Saw, Compressor, Hand Tools, Wheel Barrel, Multi-Gas Meter, Safety Cones, Caution Tape, 20-lb. Type ABC Fire Extinguisher, "Work Area" Signs, Pressurized Water Sprayer, Flush-Mounted Curb Boxes

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Verify pre-clearance protocol and mobilize/demobilize.	**1a. CONTACT:** Property damage, personal injury, or underground utilities.	1a. Confirm that local utility companies were contacted prior to sidewalk flag / concrete pad replacement. Obtain One Call Tickets **1a. Walk the Site to evaluate utility markings and review maps and complete subsurface clearance form.**
	1b. CONTACT: With traffic (including any unintended movement of the work truck), contact / interference with other site activities.	1b. Identify potential traffic hazards. 1b. Use a spotter while moving work vehicles; plan ahead to avoid backing up when unnecessary. Use additional spotters if necessary. 1b. Ensure that truck has wheel chocks in place when parked and compressor is chocked if detached from truck. 1b. Delineate work area with cones, flags, caution tape, and/or other barriers. Construct pedestrian walkway, if needed. Use truck to barricade if possible. 1b. Maintain a minimum exclusion zone based on equipment. 1b. Position "Men at Work" signs at site entrances or on either side of exclusion zone. 1b. Face traffic, maintain eye contact with oncoming vehicles, use a spotter, and establish a safe exit route; wear bright colored clothing/safety vest.
2. Concrete saw cutting and jackhammering.	**2a. CONTACT:** Flying debris and hoses.	2a. Wear PPE (especially hand, eye, ear and face shield). 2a. Use anti-whip devices on compressor hoses. 2a. Maintain a minimum exclusion zone based on equipment. 2a. If third party vehicles are close by, ask third parties to move vehicles or construct shield (e.g. poly sheeting or plywood) to protect cars.
	2b. EXPOSURE: Inhalation/exposure to hazardous vapors and/or concrete dust, noise.	2b. Monitor breathing zone with a calibrated PID and multi-gas meter. If vapors sustain levels > 5 ppm, the Roux field personnel must temporarily cease work and instruct all Site personnel to step away from the area of elevated readings. 2b. Wet concrete while using saw to minimize dust. If possible, use Vactron as dust suppression in freezing weather conditions. 2b. Stand upwind and keep body behind saw. 2b. No open flames/heat sources. 2b. Wear hearing protection when saw, jackhammer or air compressor is in operation.
	2c. EXERTION: Poor body positioning and/or from handling equipment and materials.	2c. Keep back straight, lift with legs, keep load close to body, and never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use the buddy system for maneuvering loads greater than 50 lbs. or a mechanical lifting device.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
2. Concrete saw cutting and jackhammering (Continued).	**2d. FALL:** Tripping/falling due to uneven terrain, weather conditions, and materials /equipment stored at the Site, broken up concrete.	2d. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 2d. Equipment and tools will be staged in a designated, convenient, stable, and orderly manner. Store at the lowest point of potential energy and out of the walkway and immediate work area. 2d. Ensure power cords and water lines are grouped when used within the work area. 2d. Concrete flag and flush-mounted curb box will be finished flush to grade so as not to present a slip/trip hazard. 2d. Place concrete chunks into an appropriate disposal container (drum, roll-off, dump truck, etc.).
	2e. CAUGHT: Pinch points associated with the equipment and vacuum hose.	2e. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 2e. Inspect the equipment prior to use for potential pinch points. 2e. Test all emergency shutdown devices prior to performing task. 2e. Inspect saw blade for worn surface or missing teeth; switch blade if damaged or blunt. 2e. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 2e. All non-essential personnel should stay away from the immediate work area; position body out of the line-of-fire of equipment. Maintain established exclusion zone distance. 2e. Use the **"Show Me Your Hands"** Policy.
3. Mixing/Pouring concrete and installing manhole.	**3a. CONTACT:** Burn from handling/pouring concrete.	3a. Wear required PPE (including Nitrile gloves, long sleeved shirts, safety glasses) when handling dry/wet concrete and forming concrete flags. 3a. Inspect all transfer equipment (Concrete Truck, wheel barrel, etc.) prior to pouring concrete. 3a. All non-essential personnel should stay away from the immediate work area; position body out of line-of-fire of equipment and concrete flow. Maintain established exclusion zone distance.
	3b. EXERTION: Poor body positioning and use or from handling equipment and materials.	3b. See 2c.
	3c. FALL: Tripping/falling due to uneven terrain, weather conditions, and materials/equipment stored at the site.	3c. See 2d.
	3d. EXPOSURE: Concrete silicates pose dermal and inhalation hazard.	3d. Wear nitrile {inner} gloves and long sleeve shirt to mitigate dermal contact. 3d. Dust mask must be worn for personnel mixing concrete.
4. Move drum to designated staging area (if used).	**4a. Refer to Drum Handling JSA for Potential Hazards.**	4a. **Refer to Drum Handling JSA for Critical Actions.**
5. Decontaminate equipment	**5a. EXPOSURE:** Wet concrete and dust.	5a. Wear chemical-resistant disposable gloves and safety glasses. 5a. Use an absorbent pad to clean spills.
	5b. EXPOSURE: Chemicals in cleaning solution including ammonia.	5b. See 3a.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-017	DATE: 04/10/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE:	WORK ACTIVITY (Description):	
GENERIC	**Drilling**	**Monitoring and Recovery Well Development**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Ron Lombino	Senior Hydrogeologist	Brian Hobbs	CHSD
Courtney Lind	Senior Engineer		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut-resistant and Nitrile
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Insect repellant, sunscreen (as needed)
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION (as needed)	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Composite-toe or steel toe boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment as needed: Truck Rig or support truck, Trailer, 42-inch Safety cones and flags, Caution Tape, Interface Probe, Power Source, Submersible Pump, Surge Block/Plunger, 20 lb. Type ABC Fire Extinguisher, Holding Tanks and/or Buckets, Absorbent Pads, 5-gas meter, Tools as needed: Socket and Pipe Wrench, Screw Driver, Pry Bar, Ratchet, Vault Key, Clamp or Vice Grip.

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"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization / Demobilization (**Review Mobilization and Demobilization JSA - GEN-015**)	**1a. CONTACT:** Equipment/property damage.	1a. The truck rig's tower/derrick will be lowered and secured prior to mobilization. 1a. Set-up the work area / position equipment in a manner that eliminates or reduces the need for backing of trucks and trailers. 1a. All non-essential personnel should **maintain an exclusion zone greater than the swing/tip radius of equipment.** 1a. Beep horn twice before backing up. 1a. When backing up with an attached trailer use a spotter Level or avoid if needed.
	1b. FALL: Slip/trip/fall hazards.	1b Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Store equipment at lowest potential energy.
2. Open/close well.	**2a. EXERTION:** Muscle strain (some wells have large vault covers).	2a. Keep back straight, lift with legs, keep load close to body, and never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use the buddy system or mechanical means when lifting objects heavier than 50 lbs or when the shape makes the object difficult to lift.
	2b. CAUGHT: Pinch points associated with removing/replacing manholes and working with hand tools.	2b. Wear cut-resistant/leather gloves when working with well vault/cover and hand tools. Do not put fingers under well vault/cover. 2b. Use ratchet and pry bar for well cover and inspect before use.
	2c. EXPOSURE: Potentially hazardous vapors.	2c. No open flames/heat sources. 2c. Allow well to vent after opening it and before starting development activities to minimize exposure to vapors. Air monitoring must be performed prior to set up and during the well development activities. Work on upwind side of well.
	2d. CONTACT: Traffic.	2d. Wear required PPE including high visibility clothing or reflective vest. 2d. Delineate work area with 42" safety cones and/or other barriers. Position vehicle to protect against oncoming traffic. 2d. Face traffic, maintain eye contact with oncoming vehicles, and establish a safe exit route.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Develop well (mechanical surging).	**3a. CAUGHT:** Cut hazards and finger pinch points.	3a See 2b. 3a. Use required PPE including leather/cut-resistant gloves when handling development equipment. Identify finger/hand pinch points. Keep hands away from active surge equipment. 3a. All non-essential personnel should **maintain an exclusion zone greater than the swing/tip radius of equipment.**
	3b. CONTACT/EXPOSURE: Contamination (e.g., SPH, contaminated groundwater, vapors).	3b. See 2c. 3b. Wear Nitrile gloves and safety glasses. Insert and remove surge block/plunger and line/cable slowly to avoid splashing at the surface. 3b. Use an absorbent pad to clean any spills.
	3c. EXERTION: Muscle strain from lifting equipment.	3c. See 2a. 3c. Use mechanical device to insert and remove surge block/plunger if greater than 50lb.
	3d. CONTACT: Injury while handling wench line/cable, or with active surging equipment.	3d. If using a drill rig, inspect all wench lines/cables for any kinks or if frayed prior to use. Replace any damaged lines/cables. Review **Drill Rig checklist prior to development activities**. 3d. See 3a.
4. Purging well (pumping water to holding tanks/drums/buckets).	**4a. CAUGHT:** Pinch points associated with connecting hose to tank. Pinch points associated with handling pump and hoses.	4a. See 3a. 4a. Ensure that fingers are not placed near coupling when attaching and securing hose(s). Do not place fingers under pump/hoses. Wear leather or cut-resistant gloves when handling pump/hose(s). 4a. Keep hands clear from any line-of-fire.
	4b. FALL: Using side mounted ladder when attaching hose to tank. Slip, trip, fall from lines/hoses	4b. Inspect ladder steps to make sure steps are not bent/damaged and free of debris/fluid. 4b. Use three points of contact always when using a ladder. 4b. Use a hoist or other mechanical means to secure and move hoses. 4b. Utilize anti-whip cords and secure couplings on all pressurized hoses. Keep hoses and lines coiled and organized out of designated walking paths around the work zone.
	4c. CONTACT: Contamination (e.g., SPH, contaminated groundwater).	4c. Secure water hose to holding tanks/drums/buckets with clamp, vice grip, or similar tool. 4c. Do not overfill tanks, and purge/transfer liquids in such a manner that they do not splash. (See 3b). 4c. Dispose of used materials/PPE in the designated impacted PPE container.
	4d. EXERTION: Muscle strain from lifting/carrying equipment.	4d. See 2a.
	4e. FALL: Spilled purge water.	4e. Clean up any spills using absorbent pads or spill kits.
5. Decontaminate equipment	**5a. CONTACT/EXPOSURE:** Contamination (e.g., SPH, contaminated groundwater, vapors).	5a. See 3b.
	5b. EXPOSURE/CONTACT: Chemicals in cleaning solution	5b. Decontaminate equipment in a well-ventilated area. Wear nitrile gloves to avoid skin contact with cleaning solutions.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-018	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description) :
GENERIC	**Construction**	**Installing and Working on Scaffolding**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Tom Henderson	Senior Scientist	Brian Hobbs	CHSD
Nick Cuomo	Senior Technician		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☒ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Safety-toed boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Reflective vest, Long sleeve shirt	☒ GLOVES: Leather, Level 2 Cut Resistant ☒ OTHER: Personal Fall Arrest System (PFAS) or Fall Prevention System (PFS)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Caution tape, 42"-high cones/barricades, scaffolding, ladders, signage, and hand tools.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Secure work zone.	**1a. CONTACT:** Struck By pedestrian and/or vehicular traffic entering the work area.	1a. Define work **EZ** around scaffold construction area excluding equipment staging areas. Expand EZ for tip over distance, if needed. Use 42" cones, barricades, "Caution" tape, and warning signage. Communicate task to surrounding workers. Only designated workers donned with required standard PPE (including Level 2 cut-resistant gloves) allowed entry to EZ.
	1b. FALL: Slip/trip/fall hazards in EZ.	1b. Remove material and equipment obstructions from walkways and store in designated staging areas.
	1c. EXPOSURE: Potential hazardous atmosphere.	1c. Conduct air monitoring using direct-reading instruments.
	1d. ENERGY SOURCE: Electrocution (if applicable).	1d. Conduct LO/TO procedures; Engage Public Utility to cover, relocate, or remove overhead electric lines prior to Work Zone entry. Follow HASP and OSHA Standard 1926.451(f)(6) for required specific clearance distances.
2. Unload scaffolding components.	**2a. CONTACT:** Lacerations, cuts, and abrasions.	2a. Wear ANSI Level 2 cut-resistant gloves if pre-work material inspection yields sharp edges.
	2b. CAUGHT-CRUSHED: Fingers / hands in pinch points.	2b. Position your fingers/hands where they can't be caught between a lifted load and adjacent objects. Wear leather gloves to protect from pinching/crushing.
	2c. FALL: Fall from height; Trip/fall while moving equipment into position.	2c. Ascend/descend materials from/onto delivery truck-bed using 3-points of contact; If the truck bed does not have a built-in ladder, use an A-frame step ladder of sufficient height that the worker will not need to use the top 2 steps;
		2c. Keep materials, scaffolding, and hand tools in designated staging area(s) until needed to avoid clutter and trip hazards.
	2d. ERGONOMICS: Strain from moving material into position.	2d. Use buddy system or lifting-apparatus when lifting materials heavier than 50-lbs. Use proper lifting techniques including straight back, bent knees, load-weight near body, don't reach/extend load away while handling/moving components, avoid twisting.
3. Inspect scaffolding components prior to set-up.	**3a. FALL:** From damaged or malfunctioning scaffold components.	3a. Designate **Competent Person (CP)** for this task:_____ (insert name above). **CP** responsibilities**:** - Remains on-site for all phases of scaffold work. - Inspects scaffold components including wheels, brakes, connections, pins, framing, platforms, guard rails, and ladders per OSHA 1926 subsection L. - Trains workers to erect the scaffold structure, hazard-recognition, scaffold's safe use, fall prevention / protection, load capacities, falling objects, electrical hazards, access, maintenance, operation, repair, dis-assembly, use of ties/braces, inspection. - Uses only manufacturer-supplied braces and hardware (no substitutions). - Removes damaged components from service. - Tags scaffold to alert workers of its condition.

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[2] A hazard is a potential danger. Break hazards into six types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards. Energy Sources-electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Scaffold assembly (erecting / moving scaffolding from ground level).	**4a. CONTACT:** STRUCK-BY materials/ tools/ equipment falling from scaffold platform causing bone fractures, lacerations, cuts, abrasions.	4a. **Maintain 10' EZ** minimum or tip-over radius (where possible) around the scaffold erection area; Set up scaffolding on firm, level surfaces. Use leveling jacks to provide stable base and eliminate scaffold movement. 4a. Wheeled-base scaffold wheels to remain locked except during relocation. Workers must disembark with tools during repositioning, and then relock wheels. 4a. While working over 6ft, ensure that hand tools and equipment are securely tied off using rated rope or a lanyard to prevent contact with ground workers. 4a. Use only manufacturer-supplied braces and hardware (no substitutions). 4a. When hoisting materials overhead to workers verify rope is free of rips or tears and has appropriate weight rating. Verify materials are securely fastened with rope. 4a. Wear required PPE including hard hat, safety glasses, reflective vest, safety-toe boots, long sleeve shirt, PFAS harness with lanyard attached to approved anchor points.
	4b. CAUGHT-CRUSHED: Pinch point during scaffold assembly.	4a. Use manufacturer-approved platforms (18"-width minimum) or marked, scaffold-grade planking so that the working platform surface is filled between the front uprights and the guardrails. 4a. Gaps between the uprights/platforms/planks not to exceed 1". 4" high toe-boards are required to prevent objects from falling from decking to lower levels. 4b. Keep fingers/limbs away from pinch points and frame-work connections during assembly. Wear leather gloves for hand protection.
	4c. FALL: From Ladder / End-frame / Stair access to platform while ascending / descending Fall due to Elevated Platform Failure Fall from elevation. Fall due to Scaffold failure.	4c. Use ladder / built-in scaffolding end-frame steps / stairs to ascend and descend scaffolding, ***NOT*** cross-bracing. Ladders must be inspected, clear scaffolding platform by a 3'-minimum, and be tied-off. Maintain 1:4 slope ratio, 3-points of contact while ascending/descending, with weight centered between rails. Install swing gates at scaffold staircases (if staircases are used). 4c. Use only "Scaffold-Grade" marked planking; Planking to overlap frame-work edges 6"-12" ***only***; Install cross braces in all sections except access and material-delivery points; Scaffolding to be tied into work-face for every 30' in elevation; Working platform must be within 14" from work-face. 4c. Personal Fall Arrest Systems (PFAS) to be used above 6'; Fall protection anchor point installations (excluding the scaffold being worked from) prioritized after platform assembly and used; Calculate that fully deployed PFAS will not allow user to touch the ground during potential falls. 4c. If scaffold tiers are erected above workers *and* OSHA compliant top-rails (42"), mid-rails (21"), toe-boards (4") are employed, safety harnesses are not required; CP conducts final inspection of completed scaffold structure prior to use verifying correct assembly/securement, pins are in "locked" position.
	4d. EXERTION: Muscle strain while moving/lifting materials.	4d. Employ buddy system or lifting-apparatus when lifting materials heavier than 50-lbs; Use proper lifting techniques including straight back, bent knees, load/weight near body, don't reach/extend/twist with load while handling components.
	4e. ENERGY SOURCE: Electrocution (if applicable)	4e. Verify that no energy sources (electric wires, cables) either contact scaffolding or come within OSHA/HASP specified distances of workers or scaffold. Use LO/TO to ensure that hazardous energy cannot be transmitted to the conductive scaffold framework prior to assembly.
5. Working on scaffolding.	**5a. CONTACT:** Struck-by objects falling from scaffolding / ladder.	5a. See JOB STEP 4a; Remove unnecessary tools/materials from scaffolding, returning them to designated staging areas. Inspect work zone for head-knocker and trip hazards.
	5b. FALL: Fall from elevation. Fall during scaffold collapse due to overloading. Slip/fall due to slick surfaces.	5b. See JOB STEP 4c; **CP** to conduct daily, pre-work, scaffold inspection; Workers climbing on scaffolding will use 3-points of contact; Ensure PFAS lanyards secured to approved anchor points (excluding the scaffold being worked from, or other scaffold-framework-struts). **CP** to review manufacturer's weight-loading specifications / restrictions for workers and materials, communicate limitations to the work crew, and periodically verify adherence to the specifications. **CP** and workers to inspect/assess for slick, wet, or iced (outdoor) surfaces continually during use due to changing conditions, mitigate hazards, and/or restrict access and post warnings.
6.Disassemble scaffolding.	**6a. CONTACT:** Struck-by falling tools / materials.	6a. Clear scaffolding of debris, tools, and materials prior to dismantling; Dismantle scaffolding by working backwards from the farthest point towards the access location; Plan/verify a route of egress prior to dismantling.
	6b. FALL: Slip/trip hazards resulting from inadequate house-keeping.	6b. Remove fall protection (mid-rail, top-rail) only after removing cross braces; Ensure that all personnel are aware that the particular tier of scaffolding is being dismantled; If fall protection anchor points have been removed, maintain safe distances from scaffolding platform edges, and only under a Supervisor's observation.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-019	DATE: 4/10/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Site Reconnaissance**	**Site Walk and Inspection**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Sara Barrientos	Project Geologist	Brian Hobbs	Corporate Health and Safety Director
Tim Unalp	SHSO	Joe Duminuco	Executive Vice President

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: ear plugs as necessary ☒ SAFETY SHOES: Steel or composite toed	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: High-visibility vest or high-vis outerwear	☒ GLOVES: Leather/cut-resistant/chemical resistant ☒ OTHER: Tyvek and rubber boots as necessary, dust mask as necessary

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Site map, emergency contact list, documentation of urgent care/hospital routes and / or guide familiar with Site, operating cell phone or walkie-talkie if Site allows, and bug spray.

Commitment to Safety – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

SITE SECURITY: Prior to site inspection verify appropriate method to address Site Security concerns as it relates to potential criminal activity, homeless population, and/or isolation concerns. Work with the Project Principal and/or Project Manager to address appropriately.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site contact.	**1a. CONTACT/EXPOSURE/FALL:** Personal injury caused by lack of awareness of site-specific hazards.	1a. Inquire about hazards and other activities taking place at the Site. 1a. Inform Site contact of work scope, timeline and location(s). 1a. Discuss emergency evacuation procedures and muster points with Site contact.
2. Traversing the Site	**2a. CONTACT:** Property damage and personal injury caused by obstructions/vehicles or unauthorized personnel at remote Sites.	2a. All equipment must be stowed and secured prior to moving. 2a. Maintain speed limit as posted on-site. 2a. When possible, drive on established roadways. 2a. Yield to all pedestrians. 2a. Use pull-through spots or back into parking spots. 2a. Don high visibility clothing/safety vest. If working at remote Site, add orange accessories during hunting season.
	2b. FALL: Uneven terrain and weather conditions. Overgrown shrubs and vines. Equipment in the work zone.	2b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 2b. When possible, use established pathways and walk on stable, secure ground. 2b. Communicate traversing hazards with others.
	2c. OVEREXERTION: Muscle strain while carrying equipment.	2c. When carrying equipment to/from work area, use proper lifting techniques; keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use the buddy system or mechanical means to maneuver items heavier than 50-lb. If necessary, make multiple trips to carry equipment.
	2d. EXPOSURE: Biological hazards – ticks; bees/wasps; poison ivy; insects; (Ticks are most active any time the temperature is above freezing, typically from March to November.)	2d. Inspect area to avoid contact with biological hazards. 2d. Ticks: • Treat outer clothing including pants, shirts, socks, boots and hats the evening before with Permethrin (allowing at least two hours before use). • Apply DEET to exposed skin before travelling to the Site and reapply after two hours. • Check for ticks during and after work. 2d. Bees: • Use bee spray as appropriate to deter/eliminate bees.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

	2e. EXPOSURE: Heat Stress & Cold Stress. Personal injury from working in inclement weather conditions.	• Protect exposed skin with insect repellent. 2d. Poison Ivy: • Identify areas of poison ivy and spray with weed killer. Don Tyvek and rubber boots while traversing poison ivy areas. • If skin contacts poison ivy, wash skin thoroughly with soap and water. 2e. Wear sunscreen with SPF 15 or greater on exposed skin whenever 30 minutes or more of sun exposure is expected. 2e. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). Take breaks as needed. 2e. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks as needed. 2e. Wear appropriate rain gear as needed. 2e. Take frequent breaks if tired, wet, or cold/hot. Drink water. 2e. If lightning is observed, wait 30 minutes after last thunder boom/lightning bolt in a sheltered location (car acceptable) before starting work again.
3. Walking near heavy equipment and machinery.	**3a. CONTACT:** Personal injury from Site and roadway traffic. Personal injury from flying debris **3b. OVEREXERTION:** Personal injury from lifting/moving/rotating equipment. **3c. EXPOSURE:** Hearing damage from noise generating equipment/processes. Inhalation/exposure to hazardous vapors and or dust. **3d. EXPOSURE:** Working in a remote area.	3a. See 2a. 3a. Maintain an exclusion zone of at least 10'-25' feet from all engaged equipment. 3a. Keep body parts out of the line-of-fire of pinch points. 3a. Wear appropriate PPE always. 3b. See 2c. 3c. Wear hearing protection if >85 dBA. (i.e. noise levels which require you to raise your voice to communicate) 3c. Always wear leather gloves when handling any tools or equipment. 3c. Always wear appropriate PPE based off chemicals present. 3d. Use the "buddy system" whenever possible. If working alone, contact PM upon arrival/departure, as well as during work activities prior to commencing work if applicable. 3d. Always carry a communication device (i.e., cell phone, walkie-talkie) or directional (i.e., map, compass, etc.) when traversing remote areas. 3d. If available, follow Lone Worker Protocol/Procedure.
4. Working in adverse weather conditions.	**4a. EXPOSURE:** Heat Stress & Cold Stress. Personal injury from working in inclement weather conditions.	4a. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). Take breaks as needed. 4a. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks as needed. 4a. Wear appropriate rain gear as needed. 4a. Take frequent breaks if tired, wet, or cold/hot. Drink water. 4a. If lightning is observed, wait 30 minutes after last thunder boom/lightning bolt in a sheltered location (car acceptable) before starting work again.
5. Departing Site.	**5a. EXPOSURE:** Exposure to unnecessary hazards should personnel believe Roux is on-Site during an emergency and conduct a search.	5a. Sign out or notify Site contact and Roux Project Manager of your departure.

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JOB SAFETYANALYSIS Ctrl. No. GEN-020	DATE: 04/11/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY: **GENERIC**	WORK TYPE: **Gauging & Sampling**	WORK ACTIVITY (Description): **Soil Sampling**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
MaryBeth Lyons	Project Scientist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES ☒ FLAME RESISTANT CLOTHING (as needed)	☐ GOGGLES ☐ FACE SHIELD: ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES: Composite-toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Recommended Equipment: 42" traffic cones, caution tape, trowel

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Secure location	**1a. CONTACT:** Personnel and vehicular traffic may enter the work area.	1a. If in an area with foot or vehicle traffic, delineate the work area with 42" traffic cones and/or caution tape to prevent exposure to traffic and inform others of work activity. 1a. Wear reflective vest and/or high visibility clothing. 1a. Face the direction of any vehicular traffic. Position vehicle to protect worker from traffic. 1a. Communicate work activity with adjacent work areas.
	1b. FALL: Tripping/falling due to uneven terrain or entry/exit from excavations.	1b. Inspect pathways and work area for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions. 1b. Use established pathways and walk on stable, secure ground. 1b. Stage equipment and tools in a convenient, stable, and orderly manner. Store equipment at lowest potential energy. 1b. Roux employees should stay 5 feet from in-progress excavations and trenches. Should entry to an excavation be required (when stabilization is complete), ladders must be employed for steep embankments, excavations, pits, and trenches.
	1c. EXPOSURE: Exposure to sun and excessive heat, possibly causing sunburn, heat exhaustion or heat stroke. Exposure to cold temperatures possibly causing cold stress. Skin burn as a result of fire, if applicable. Exposure to explosive vapors due to tank farm operations. Exposure to airborne dust due to high wind speeds. Biological hazards - ticks, bees/wasps, poison ivy, thorns, insects, etc.	1c. Wear sunscreen with an SPF 15 or greater whenever 30 minutes or more of exposure is expected. 1c. Use a tent to shade the work area from direct sunlight particularly when warm temperatures are expected. 1c. Be aware of the location of all Site personnel. 1c. Watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). 1c. Watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). 1c. Take breaks for rest and water as necessary. Move to an area that is well shaded or a climate controlled area (i.e., car, site trailer, etc.). 1c. No open flames/heat sources. 1c. Conduct air monitoring and ensure that harmul vapor concentrations are within the levels detailed in the Site Specific HASP. Follow procedures detailed in HASP for exceedances. 1c. Flame retardant clothing must be worn when specified by Site policy. 1c. Cell phones should be disabled when specified by Site policy. 1c. Pre-treat field clothing with Permethrin prior to site visit to kill ticks and insects. 1c. Wear long sleeved shirts and tuck in (or tape) pant legs into socks or boots to prevent ticks from reaching skin. 1c. Spray insect repellant containing DEET on exposed skin when working in overgrown areas of the Site. 1c. Inspect area to avoid contact with biological hazards. 1c. Wear cut-resistant gloves when handling branches, shrubs, etc. that may lie within the walking path. 1c. Wear spoggles if the average wind speeds are above 15 mph. 1c. Personnel shall examine themselves and co-worker's outer clothing for ticks periodically when onsite. 1c. If skin comes in contact with poison ivy, wash skin thoroughly with soap and water. If rash persists after washing, immediately notify your supervisor, the OM and OHSM for possible consultation with a physician at an approved Occupational Health Clinic.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
2. Collect Soil Sample	**2a. CONTACT:** Personal injury from pinch points, cuts, and abrasions from sampling equipment tools, and material within soil sample. Personal injury from contact with moving equipment while sampling. Personal injury from contact with glass sample jars.	2a. Wear cut-resistant (i.e., Kevlar) gloves under chemical-resistant (nitrile) disposable gloves when handling soil samples and sampling jars. 2a. Where possible, use trowel or equivalent tool to avoid contact with soil. 2a. If sampling from bucket of heavy equipment, ensure all equipment is off and operator utilizes the “show me your hands” policy. 2a. See 1a.
	2b. EXPOSURE: Exposure to contamination (impacted soil) and/or lab preservatives.	2b. Wear chemical-resistant (nitrile) disposable gloves over cut resistant gloves to protect hands when handling samples; use containment material or plastic sheeting to protect surrounding areas. 2b. Wear safety glasses to protect eyes from dust or air-borne contaminants that may results from disturbing the soil. 2b. Where possible, remain upgradient from sample location if collecting soil sample from stockpile, drill rig, etc. to avoid breathing contaminant vapors, if they are present. 2b. When collecting soil sample from hand auger, put large zip lock bag over entire auger to prevent spillage of soil on to the ground. 2b. Open sample jars slowly and fill carefully to avoid contact with preservatives.
	2c. EXERTION: Exertion due to repetitive motion and ergonomics.	2c. Utilize a table or raised surface for soil sampling if multiple soil samples are going to be taken to minimize repetitive bending motion.
3. Decontaminate equipment	**3a. EXPOSURE/CONTACT:** Contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated vapors and/or soil). **3b. EXPOSURE:** Chemicals in cleaning solution including ammonia.	3a. Wear chemical-resistant (nitrile) disposable gloves and safety glasses. 3a. Use an absorbent pad to clean spills. 3a. Properly dispose of used materials/PPE in provided drums in designated drum storage area. 3a. Remain upwind of sample and avoid breathing contaminant vapors, if they are present. 3b. Wear chemical-resistant (nitrile) disposable gloves and safety glasses. 3b. Work on the upwind side of decontamination area. 3b. Use an absorbent pad to clean spills. 3b. Properly dispose of used materials/PPE in provided drums in designated drum storage area. Ensure that all drums are properly labeled and secured.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-021	DATE: 4/10/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Gauging and Sampling**	**Soil Vapor Sampling (Permanent Monitoring Points)**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Jeff Wills	Principal Hydrogeologist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut-resistant & Nitriles
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Bug Spray, Sun Screen, Knee Pads or kneeling pad
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel-toe boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

9/16" Socket and Wrench, Non-Toxic Clay, Teflon-Lined Tubing, Masterflex Tubing, Air Pump with Low Flow, Dry Cal, Enclosure (Bucket with 2 holes), Helium Gas Canister, Summa Canisters and Flow Controllers, MultiRae Photo Ionization Detector (PID), Helium Detector, Tubing Cutter, 42-inch Safety Cones, Caution Tape or Retractable Cone Bars

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Work Zone (WZ): A 5-foot exclusion zone will be maintained for non-essential personnel.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Define and secure work area.	**1a. FALL:** Potential tripping hazards.	1a. Ensure work area is secure and inform others (third party) of work activity. 1a. Remove tripping hazards and inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment.
	1b. CONTACT: Potential contact with moving vehicles or pedestrians.	1b. If working alongside roads, look both ways before entering roadways, face traffic, and utilize work vehicle to protect employees. 1b. Delineate work area (including vehicles) with traffic safety cones and caution tape or retractable cone bars. 1b. Maintain a 5-foot exclusion zone. 1b. Wear high visibility clothing or reflective safety vest.
	1c. EXERTION: Muscle strain while lifting and carrying equipment.	1c. When carrying equipment to/from work area, keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced. Use the buddy system or mechanical means to maneuver loads heavier than 50-lbs. If necessary, make multiple trips to carry equipment.
2. Remove well cover / close well cover.	**2a. CONTACT/CAUGHT:** Pinch points and scrapes associated with hand tools and well covers.	2a. Keep hands away from pinch points. 2a. Use hand tools with extensions or magnet to remove and replace well covers. 2a. Wear cut-resistant gloves. 2a. Use knee pads or kneeling pad when repetitive kneeling on rough ground is anticipated.
	2b. FALL: Potential tripping hazards associated with installing bolts.	2b. Place security bolts in secure location so not to create tripping hazards. Replace security bolts so that they fit flush with monitoring well covers.
	2c. EXERTION: Physical exertion to remove bolts that were over torqued or stripped.	2c. Replace any security bolts that show signs of stripping. Do not over tighten. 2c. Use body positioning and bending techniques that minimize muscle strain; keep back straight, bend at the knees. 2c. See 2a.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Screen vapor point with PID.	**3a. FALL:** Potential tripping hazards associated with equipment. **3b. EXPOSURE:** Inhalation of soil vapor	3a. Place equipment in one area close to the sampling location. 3a. Identify area where equipment is to be stored within the work area (away from main walking path). 3a. Don't leave equipment on the ground. Return equipment to storage area between uses. 3b. Replace brass caps immediately upon completion to avoid soil vapors migrating to the surface through sample tubing. 3b. Stand upwind of sample point during screening activities.
4. Remove/replace brass caps at the end of the sample tubing.	**4a. CONTACT:** Pinch points associated with hand tools and brass caps. **4b. EXPOSURE:** Potential pathway for vapors to migrate to land surface.	4a. Use wrench to remove and replace brass caps. 4a. Wear cut-resistant gloves to protect against pinch points and scrapes. 4b. See 3b. 4b. Stand upwind of sample point location.
5. Set up soil vapor sampling equipment and calibration of meters.	**5a. FALL:** Potential tripping hazards associated with equipment and tubing.5b. **5b. CONTACT:** Pinch points associated with handling equipment. **5c. EXPOSURE:** Inhalation of calibration gas and helium.	5a. See 3a. 5a. Keep tubing slack to a minimum and locate the summa canister as close to the sampling location as possible. 5a. Avoid stepping over equipment and tubing. 5b. Do not place fingers/hands under sampling equipment. 5b. Make multiple trips when unloading equipment in work area. 5b. Wear cut-resistant gloves to protect against pinch points while handling sampling equipment. 5c. Review SDS for each type of calibration gas used before calibrating. 5c. Calibrate meters in a well-ventilated area and keep air flow regulator away from face. 5c. Close valve on canisters after use to avoid inhalation of excess helium or calibration gas. 5c. Stand up wind of bucket during helium tracer gas test.
6. Cleaning Work Area.	**6a. FALL:** Potential tripping hazards associated with equipment and tubing. **6b. CONTACT:** Storing and transport of equipment in car.	6a. See 3a. 6a. See 3b. 6b. Ensure that equipment is placed securely in the vehicle. Do not stack equipment on top of each other. Secure equipment so that it will not slide while being transported. 6b. Wear cut-resistant gloves while handling/loading equipment.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-022	DATE 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE:	WORK ACTIVITY (Description):
General	**Drilling**	**Rotosonic Soil Borings / Well Installation**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Ron Lombino	Senior Hydrogeologist	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION: (as needed) ☒ SAFETY SHOES steel or composite toe	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: fluorescent long sleeve shirt or long sleeve shirt and reflective safety vest.	☒ GLOVES: Leather, Nitrile and cut resistant ☒ OTHER: Insect Repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Truck-Mounted Sonic Drilling Rig or Mini Sonic Rig, Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Interface Probe, 20 lb. Type ABC Fire Extinguisher, 42" Cones & Flags, "Work Area" Signs, Water

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

"SHOW ME YOUR HANDS"
Driller and helper should show that hands are clear from controls and moving parts

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Mobilization of drilling rig (ensure the Subsurface Clearance Protocol and Drill Rig Checklist are completed). **See also Mobilization/Demobilization JSA.**	**1a. CONTACT/CRUSH:** Equipment/property damage during movement. Crush point between moving rig and other objects.	1a. The drill rig's tower/derrick will be lowered and secured prior to mobilization. 1a. A spotter should be utilized while moving the drill rig or backing operations. If personnel move into the path of the drill rig, the drill rig will be stopped until the path is again clear. 1a. Set-up the work area and position equipment in a manner that eliminates or reduces the need for backing of support trucks and trailers. 1a. When backing up truck rig with an attached trailer use a second spotter if there is tight clearance simultaneously on multiple sides of the equipment or if turning angles limit driver/spotter visibility. 1a. Inspect the driving path for uneven terrain. Level or avoid if needed. 1a. Drill rig should have a **minimum exclusion zone (i.e. greater than swing/tip radius of rig)** for non-essential personnel (i.e., geologist) when the rig is moving/in operation.
	1b. FALL: Slip/trip/fall hazards.	1b Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 1b. Use established pathways and walk on stable, secure ground.
2. Raising tower/derrick of drill rig.	**2a. CONTACT**: Overhead hazards.	2a. Prior to raising the tower/derrick, the area above the drilling rig will be inspected for overhead utilities, tree limbs, piping, or other structures, that could come in contact with the rig's tower and/or drilling rods or tools. 2a. Site requirements for raising a tower/derrick around overhead utilities must be reviewed prior to drilling. Maintain **a minimum distance of 10 feet** from overhead structures. 2a. The tower/derrick must not be raised beneath overhead power lines unless approved by both the Roux and Project PMs.
	2b. CONTACT: Amputation points when raising the rig and instability of rig.	2b. Inspect the equipment prior to use and avoid amputation points when engaging tower/derrick. 2b. Lower outriggers to ensure stability prior to raising rig tower/derrick. 2b. If the rig needs to be mounted, be sure to use three points of contact.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Advancement of soil boring and well installation. **See also Soil Sampling JSA.**		**If possible, operate drill rig using remote control to avoid potential hazards.**
	3a. CONTACT: Flying debris.	3a. Be aware of and avoid potential line-of-fire hazards and wear required PPE such as eye, ear, and hand protection.
	3b. EXPOSURE: Noise and dust.	3b. Wet borehole area with sprayer to minimize dust. 3b. Stand upwind and keep body away from rig. 3b. Dust mask should be worn if there is visible dust in the breathing zone. 3b. Wear hearing protection when the drill rig is in operation.
	3c. CAUGHT: Limb/extremity amputation points; abrasion/crushing.	3c. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 3c. Inspect the equipment prior to use for potential amputation points. Keep hands away from being between connections and use of tools is preferable compared to fingers and hands. 3c. Inspect drill head for worn surface or missing teeth; replace if damaged or blunt. 3c. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3c. All non-essential personnel should remain outside the heavy equipment exclusion zone that is at least as far as the boom is high (**minimum exclusion zone based on swing/tip radius**). 3c. Drillers and helpers will understand and use the “Show Me Your Hands” Policy. Operator and helpers will remain a **minimum of 3 feet** from augers/drill rods while in operation.
	3d. CONTACT/CRUSH: Crushed between equipment due to imbalance during advancement of drill equipment.	3d. Drillers will advance the borehole with caution to avoid causing the rig to become imbalanced and/or tip. 3d. The blocking and leveling devices used to secure the rig will be inspected by drillers and Roux personnel regularly to see if shifting has occurred. 3d. In addition, personnel and equipment that are non-essential to the advancement of the borehole will be positioned away from the rig at a distance that is at least as far as the boom is high (**minimum exclusion zone based on swing/tip radius**).
	3e. EXPOSURE: Inhalation of contamination/vapors.	3e. Air monitoring using a calibrated photoionization detector (PID) will be used to periodically monitor the breathing zone of the work area. 3e. If readings of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional precautions in accordance with the site-specific health and safety plan.
	3f. FALL: Slip/trip/fall hazards.	3f. Contain drill cuttings and drilling water to prevent slip/trip/fall hazards from developing in work area. 3f. See 1b.
	3g. EXERTION: Potential for muscle strain/injury while installing well casings and/or lifting sonic rods/casings.	3g. Keep back straight and bend at the knees. 3g. Utilize team lifting for objects over 50lbs. 3g. Use mechanical lifting device for odd shaped objects.
4. Decontaminate equipment.	**4a. EXPOSURE:** Contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, vapors, chemical in cleaning supplies).	4a. Wear chemical-resistant gloves and safety glasses. 4a. Contain decontamination water so that it does not spill. 4a. Use an absorbent pad to clean spills, if necessary. 4a. See 3b.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-023	DATE: 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
Generic	**Construction**	**Spotting Heavy Machinery**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Levi Curnutte	Senior Scientist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ Particulate Respirator	☒ GLOVES: Cut resistant / leather
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER:
☒ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-/Composite-toe boots/shoes		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Heavy Machinery (i.e. excavator, payloader, truck, forklift, etc.), two-way radios.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Prepare for machine activity.	**1a. CONTACT:** Obstructions in the work area may create contact hazards from machinery.	1a. Cordon off the work area with safety barrels/cones and a rigid barrier (snow fence, traffic bar, etc.). Communicate that only necessary personnel should be in the work area. Spotter and equipment operator shall enforce the **EZ.** Operator will not operate but shall remain in the hands-off mode while personnel are within the exclusion zone.
	1b. Fall : Slip/Trip/Fall	1b. Ensure that work area is flat, level and clear of any obstructions or debris before setting up work zone.
2. Spotting.	**2a. CONTACT:** Machine or load contact with personnel, property, or machinery.	2a. Discuss the specifics of the work with the operator and be clear about any hand signals that will be used. Clearly discuss the limits of the assigned work area and the machine's Exclusion Zone. Maintain Exclusion Zone. The Exclusion Zone shall be delineated by using 42-inch traffic cones/barrels and a fixed rigid barrier. 2a. The Minimum Heavy Equipment Exclusion zone is greater than the swing/tip radius of equipment. 2a. Both the spotter and equipment operators shall have 2-way radios/cellular devices on their persons to ensure audible communication in the event any changes or new hazards may arise. 2a. All workers should stay outside of the Exclusion Zone of all equipment unless operator is stopped and in "Hands Off" mode. **(This includes the spotter unless an exception has been established in the Site-specific JSA).** If the Exclusion Zone must be reduced due to work area restrictions, then the spotter and operator shall enforce the reduced Exclusion Zone. 2a. Spotters must make eye contact with the machine operator or all movement ceases until visual contact can be reestablished. 2a. Spotter shall keep an eye out for any issues with the machine the operator may not see and communicate with other work crews and spotters on behalf of the operator. 2a. If the spotter needs to take a break, he must find a replacement before leaving or have the machine stop operations. **No heavy equipment shall operate without a spotter under any circumstances.** 2a. Wear fluorescent clothing/safety vest. 2a. **Do not multitask. Only perform Spotting**

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
	2b. FALL: Slip/Trip/Fall	2b. Look where walking to identify and avoid slip/trip/fall hazards. Avoid icy and/or wet surfaces. Remove obstacles if possible. 2b. Use designated walkways during spotting whenever possible. 2b. **Do not walk backwards. Always face the direction you are walking towards.**
	2c. CAUGHT: Caught between machinery and nearby objects.	2c. **Maintain Exclusion Zone.** Do not stand between large, loose or fixed objects or structures and the machinery while it is in motion. Keep in sight of operator at all times while being aware of surrounding structures.
	2d. EXPOSURE: Inhalation of exhaust from machinery.	2d. The spotter will position him/herself upwind of the working machinery, when possible. Spotter will also inform others working within the vicinity of the EZ of proper positioning, if applicable.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-024	DATE: 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
GENERIC	**Site Maintenance**	**Tree/Brush/Overgrowth/Lawn Maintenance**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Robert Chimchirian	Principal Engineer	Brian Hobbs	CHSD
Scott Wright	Senior Geologist		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES: spoggles when using chain saw	☐ GOGGLES ☐ FACE SHIELD ☒ HEARING PROTECTION ☒ SAFETY SHOES: Steel Toed Boots (Composite Toe are not acceptable for use with chainsaws) ☐ KNEE PADS	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: High visibility long- sleeved shirt/Fluorescent reflective vest with long-sleeved shirt	☒ GLOVES: Cut-Resistant ANSI Level 2 work gloves ☒ OTHER: Insect Repellant (DEET/permethrin), sunscreen (as needed), logging helmet, safety glasses, Tyvek (as needed).

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Brush Hog, Wood Chipper, Lawn Mower, Hand Grabber, Blower, Line Trimmers, Pruning Shears, Chain Saw, Hand Tools,42" Safety Cones, Wheel Chocks, A-Frame ladder.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Inspect all equipment prior to use.	**1a. FALL:** Uneven terrain and other debris.	1a. Use designated walk areas. Remove slip, trip and fall hazards from walk areas.
	1b. EXPOSURE: Biological hazards, and bloodborne pathogens (i.e., insects, poison ivy, snakes, used syringes, contaminated trash, bed bugs, etc.) and sun exposure.	1b. Equipment inspections should take place in a parking lot or cleared area to avoid exposure to biological hazards (e.g. paved parking lot, stone paved area, etc.).
2. Prune Brush/Overgrowth Maintenance.	**2a. FALL:** Uneven terrain and other debris.	2a. Use designated walk areas. Remove slip, trip and fall hazards from walk areas.
	2b. EXPOSURE: Biological hazards, and bloodborne pathogens (i.e., insects, poison ivy, animals, used syringes, contaminated trash, bed bugs, etc.) and sun exposure.	2b. Survey work area: Identify biohazards (i.e., bees nest, toxic vegetation, animals). 2b. Use bee sprays to remove nests. 2b. Avoid contact with toxic vegetation (i.e., poison ivy). If contact cannot be avoided, wear protective gloves or coveralls when handling toxic vegetation. If skin comes in contact with poison ivy, wash skin thoroughly with soap and water. 2b. Wear light-colored clothing.. 2b. Pre-treat field clothing with Permethrin prior to site visit to kill/repel ticks and insects. [Note: clothing treated with Permethrin should be allowed 2 to 4 hours to dry prior to being worn.] 2b. Wear long-sleeved shirts and tuck in (or tape) pant legs into socks or boots to prevent ticks from reaching skin. 2b. Spray insect repellant containing DEET on exposed skin when working in overgrown areas of the Site. 2b. Wear cut resistant gloves when handling branches, shrubs, etc. that may lie within the walking path. 2b. Have Tyvek suits onsite in case tick populations in work areas warrant additional PPE. 2b. Personnel shall examine themselves and co-worker's outer clothing for ticks periodically when onsite. 2b. Wear sunscreen with an SPF of at least 15 whenever 30 minutes or more of exposure is expected. 2b. Use grabber to pick up trash and sharp objects. 2b. Place sharps (syringes) in a hard shelled container and dispose of at a designated facility. 2b. Use mechanical methods when possible to lift and load abandoned mattresses and sofas to avoid contact with bed bugs.
	2c. CONTACT: Falling debris or overhead hazards. Contaminated soils. Personal injury from contact with hand tools/equipment.	2c. Wear safety glasses and hardhat. 2c. Prune in a manner so that cuttings are propelled away from the operator and bystanders. 2c. Stay clear from line-of-fire of overhead branches when cutting, as well as check branches for tension prior to pruning. 2c. Wear coveralls and nitrile gloves over cut-resistant gloves to protect against exposure to potentially contaminated soils. 2c. Check handle of chainsaw for proper position (tool should be balanced at handle) adjust and tighten as needed. 2c. Check integrity of blade edge; sharpen as necessary to avoid slippage while cutting.
	2d. FALL: Pruned branches.	2d. Place in back of truck branches cut from shrubs and trees to minimize trip hazards and to make it easier to identify any additional trip hazards (i.e., branches, roots, depressions).

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Branch/Tree Removal using chain saw.	**3a. OVEREXERTION**: Back strain when cutting, lifting and reaching.	3a. Use correct body positioning while handling saw, bend at the knees, keep back straight and saw forward and away from body. Be aware of foot and leg placement in relation to saw blade. 3a. Use an A-Frame ladder to cut hard-to-reach branches. 3a. Use a buddy to stabilize ladder if the terrain is uneven. 3a. Use the buddy system to lift branches that are heavier than 50 lbs.
	3b. CONTACT: Deep cut and amputation hazard while operating chainsaw.	3b. Ensure chain guard is on chain saw. 3b. Cut away from body. 3b. Turn off chain saw when it is not in use. 3b. Wear protective chaps over legs.
	3c. FALL: Uneven terrain and debris.	3c. Use three points of contact when exiting/entering truck. 3c. Inspect walking path for uneven terrain, weather-related hazards (i.e., tree debris, puddles, ice, etc.), and obstructions prior to accessing work area. 3c. Use established pathways and walk on stable, secure ground. 3c. Place tools and equipment in designated area and maintain good housekeeping. 3c. Wear boots with a minimum of ¼" treads and steel toes.
	3d. EXPOSURE: Biological hazards, animals, and loud noise from equipment.	3d. See 2b. 3d. Survey your surroundings for potential hazards. 3d. Wear logging helmet equipped with hearing protection to prevent exposure to loud engine noise. 3d. Inspect area for insect nests and toxic vegetation and remove as necessary, or stay away until sprayed. 3d. Wear hearing protection while using the chain saw.
	3e. CONTACT: Flying debris. Potential contact with chainsaw blade or hot surface and fence.	3e. Determine areas where tree or branches are to be felled (cut so branches fall away) and plan escape route accordingly; delineate area and identify obstructions. 3e. Wear logging helmet equipped with screen and always wear spoggles. 3e. Provide advanced warning when tree will be coming down. 3e. Other personnel should maintain a distance of 100 feet away from large tree cutting activities.
4. Branch/Tree Consolidation.	**4a. CONTACT:** Downed branches and tree. Loading of debris from tree into truck.	4a. Wear cut-resistant gloves and ensure arms are fully covered by long sleeve shirt while handling trees. 4a. Do not stand under branches that are being cut.
	4b. OVEREXERTION: Back strain when cutting, lifting, consolidating.	4b. See 3a. above. 4b. Cut downed trees into pieces that are less than 50 lbs. Use assistance for loads heavier than 50 pounds.
	4c. EXPOSURE: Biological hazards, animals and noise.	4c. See 3b. above.
5. Cut Lawn Area/ and sweep/blow away grass cuttings.	**5a. CONTACT:** Obstacles and large debris. Flying debris.	5a. Inspect work area and identify hazards before starting the work. Remove small obstacles when possible and avoid large obstacles that cannot be removed.
	5b. EXPOSURE: Loud noise from the mower and dust while blowing.	5b. **Maintain 10' exclusion zone** around mower and a **30' exclusion zone** around mower discharge. 5b. Wear hearing protection while using the mower. 5b. Wear dust masks and blow downwind when possible.
6. Load Equipment and Leave work site.	**6a. CONTACT:** Sharp edges of equipment. Faulty equipment.	6a. Inspect tools before loading them. 6a. Carry equipment by the handles. Check handle for proper position (tool should be balanced at handle), adjust and tighten as needed. Keep working end of tool facing away from body to prevent contact. 6a. Wear leather gloves.
	6b. EXPOSURE: Biological hazards.	6b. Conduct tick check. Inspect any areas of body that were exposed, all clothing and other potential entry points such as the ankle and neck areas should be examined closely. 6b. Wash any areas of exposed skin.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-025	DATE: 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 1

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**General**	**Trucking**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Lauren Dolginko	Project Geologist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☐ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility long sleeved clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-toe boots		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Heavy equipment (i.e. trucks)

COMMITMENT TO SAFETY- All personnel onsite will actively participate in Hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Set up work zone.	**1a. CONTACT:** Personal injury/property damage caused by obstruction/vehicle.	1a. Establish work zone for manifesting/paperwork by communicating with workers before task begins. Maintain a minimum **Exclusion Zone (EZ)** around all heavy equipment.
2. Loading of truck.	**2a. CONTACT:** Rolling Vehicle could cause bodily harm.	2a. All commercial vehicles without an operator must have their engines off and wheels chocked. Truck and loading area should be on level and stable ground.
	2b. CONTACT: Machine or load may crush personnel, property or machinery.	2b. All machines (Excavator, Lull, Backhoe) must have a spotter. Spotter must communicate contact hazards such as other personnel in the work area, objects in the machine's blind spot, and overhead lines to the operator. Spotter and operator should have 2-way radios or established hand signals to communicate when needed. 2b. Loads must not be swung over other vehicles or personnel. 2b. Maintain **EZ** around all equipment.
	2c. CONTACT: Load shifting during travel.	2c. Secure all loads prior to moving the truck with chains or straps or cribbing. 2c. Any loose soil or debris should be cleaned off truck sides prior to truck mobilization. 2c. All truck beds must be secured prior to traveling.
3. Dumping loads.	**3a. CONTACT:** Truck may flip sideways or backwards.	3a. All workers must stay behind and away from the side of trucks that are dumping to avoid contact with flying debris and the truck potentially tipping sideways or backwards. EZ must be maintained equal to the height of bed while lifted.
4. Exchanging paperwork with truck driver.	**4a. CONTACT/CAUGHT:** Broken bones from contact by vehicle.	4a. Truck driver should exit truck with proper PPE, using the three-point stance, and enter the established work zone to complete paperwork. If Site-specific safety prohibits drivers from exiting the truck, wait until truck is finished loading, with engine turned off, before approaching truck. 4a. Always establish eye contact with driver prior to approaching truck. 4a. Confirm sides of truck have been cleaned/brushed off prior to approaching truck.
	4b. FALL: Slip, Trip or Fall may cause muscle strains or tears, abrasions or lacerations, or broken bones.	4b. Survey walking route to identify slip/trip/fall hazards. Avoid icy/wet surfaces. Remove slip/trip/fall hazards if present. 4b. Communicate with driver and spotter prior to approaching truck. Maintain **EZ** around all heavy equipment.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-026	DATE: 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**O&M**	**Vac Truck Product Pump Out of ASTs and Drums**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Alfredo Fernandez	Staff Scientist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut Restant / Leather / Nitrile / Chemical resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☒ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: High Visibility clothing, Tyvek suit (if needed), fire retardant suit	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel or composite toed		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: vac hoses, 5-gas meter (multi-gas meter), 20 lb. Type ABC fire extinguishers, safety cones, rigid barriers
Recommended: sunscreen/bug repellent (as needed)

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Calibrate multi-gas meter	**1a. EXPOSURE:** Calibration gas.	1a. Outside of work area calibrate the multi-gas meter while wearing nitrile gloves and safety glasses. 1a. Ensure calibration gas is contained. Avoid inhalation of the gas.
2. Perform Vac Truck Inspection	**2b. CONTACT:** With personnel and structures	2a. Don appropriate PPE including high visibility clothing. 2a. Prior to moving truck, perform a visual check of the critical parts with the driver and complete appropriate checklist.
3. Setup Vac Truck and Work area	**3a. CONTACT:** With personnel and structures.	3a. Don high visibility clothing. 3a. Prior to moving truck, review where truck is to be positioned and secure work area with 42" traffic cones and rigid barrier/snow fence. 3a. Review hand signals with driver prior to backing and use a spotter at all times while moving the vehicle. 3a. Chock wheels once in place.
	3b. CAUGHT: In the line of fire of vac truck while backing. Caught in pinch points while making hose connections.	3b. Back up spotter must position self to "leave an out". Stay out of the line-of-fire of the truck. 3b. Keep hands clear of potential pinch points while making hose connections (i.e., cam fittings); wear cut-resistant gloves.
	3c. SLIP/TRIP/FALL: Hazards from any debris in the immediate area.	3c. Inspect work area for slip, trip or fall hazards and remove or delineate. Designate a walking path free of debris. 3c. Stage tools and equipment out of walking surfaces to prevent slip/trip/falls. Maintain good housekeeping. 3c. Minimize vac hose/bond wire lengths and setup outside of walking paths.
	3d. EXPOSURE: Biological hazards. Contaminants in or on vac hose Loud noise from truck.	3d. Inspect work area for signs of biological inhabitation (insect nests or activity, animal signs). 3d. Use permethrin and DEET when working in grassy locations to prevent tick and insect exposure. 3d. Wear light clothing when possible and conduct a tick/insect check routinely. 3d. Wear nitrile gloves and keep hose clean with absorbent pads. 3d. Minimize duration or work around loud equipment if possible. Don hearing protection when noise levels exceed 85 dBA.
	3e. ERGONOMICS: From setting up work area and vac hoses.	3e. Utilize correct body positioning (i.e., knees bent, back straight, shoulders square). 3e. Do not reach more than an arm's length away to obtain an item. 3e. Use the buddy system to maneuver loads heavier than 50lbs.
	3f. ENERGY: Static electricity.	3f. Verify truck is bonded to vessel that is being vacuumed and that the truck is grounded.

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Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
4. Perform Vac Activities.	**4a. SLIP/TRIP/FALL:** Hazards from any debris in the immediate area.	4a. Maintain distance of 10 feet from vac hose/truck while operating. 4a. Ensure vac truck wheels are chocked.
	4b. CAUGHT: In crush/pinch points associated with vac truck valve handles.	4b. Keep hands clear of potential pinch points while making hose connections (i.e., cam fittings); wear cut-resistant gloves.
	4c. TRIP/SLIP/FALL: Hazards from any debris in the immediate area.	4c. See 3c.
	4d. EXPOSURE: Liquids, noise, and vapors.	4d. Secure hose connections prior to beginning vac activities (cam-lock couplings fully latched and locking pins in place). 4d. Upon completing vac activities, wipe down equipment with absorbent pads, as necessary. 4d. Don nitrile gloves while handling impacted equipment. 4d. Monitor breathing zone with multi-gas meter. 4d. Minimize duration or work around loud equipment if possible. Don hearing protection if noise exceeds 85 dBA.
4. Obtain tank level measurement / Pack truck for departure.	**5a. SLIP/TRIP/FALL:** From tools and equipment in the work area. Climbing fixed ladder to gauge truck.	5a. See 3c. 5a. Prior to ascending truck ladder, verify that it is secure and in good condition (i.e., all steps intact, no signs of rot, no missing hardware). Use three points of contact at all times. 5a. If vac truck is equipped with a catwalk and guardrails, verify that they are structurally sound. 5a. Don harness and attach lanyard to anchor point if truck is not equipped with catwalk around hatch of truck. Inspect harness and lanyard for tears prior to use.
	5b. ERGONOMICS: Opening vac truck hatch.	5b. See 3e.
	5c. EXPOSURE: Petroleum-impacted materials.	5c. Wipe down gauge stick over hatch so as not to drip liquids on truck or ground. 5c. See 4d.
	5d. CAUGHT: Pinch points when closing hatch, storage boxes.	5d. See 4b.

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JOB SAFETY ANALYSIS	Cntrl. No. GEN-027	DATE: 04/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Drilling**	**Pre-Drilling Clearance, Vactron and Air Knife**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Courtney Rempfer	Project Scientist	Joseph Midwig	Senior Engineer
Sara Redding	Senior Hydrogeologist	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☒ FACE SHIELD (While Air Knifing) ☒ HEARING PROTECTION (As needed) ☒ SAFETY SHOES: Composite toe or steel toe boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing; long-sleeve shirt	☒ GLOVES: Leather, Nitrile, cut-resistant ☒ OTHER: Dusk mask, insect repellant, sunscreen (as needed)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Vac-Truck or Vac Drum, Compressor, Jack Hammer, Air Knife. Circular Saw, Hand Tools, Dust Mask, Photoionization Detector, Multi Gas Meter, 42 inch safety cones and flags, Retractable Cone Bars, Caution Tape, 20 lb. Fire Extinguisher, "Work Area" Signs, Pressurized Water Sprayer

Commitment to Safety – All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE: All non-essential personnel will maintain a distance of 10 feet from drilling equipment while equipment is moving/engaged

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Verify pre-clearance protocol	**1a. CONTACT:** Underground utility damage; property damage; personal injury.	1a. Confirm that (if applicable) "Call Before You Dig" and local utility companies were contacted prior to starting work in order to confirm utility mark outs. Must have a case # before digging. 1a Walk the Site to evaluate utility markings and review maps (see Site Walk Inspection JSA - GEN-019). Utilities are not always properly marked out, ensure use of observational skills through the pre-clearing checklist. 1a. Review pre-clearing checklist form and sub-surface clearance form. Pre-clearing protocol indicates that clearance must be conducted to a minimum of 5 vertical feet below ground surface or 10 vertical feet below ground surface in the critical zone using hand tools.
	1b. ENERGY SOURCE/CONTACT: Property damage; Pressurized water mains may cause lacerations or broken bones. Pressurized gas mains may explode causing serious injury, or death. Underground electric may cause severe burns, shock, or death.	1b. Pre-clearing of each soil boring/monitoring well location must be conducted to a minimum of 5 vertical feet below the ground surface (10 feet minimum for Critical Zone) using hand tools (shovel and non-metallic dig bar and hand auger) prior to drilling. Supervisor should be contacted to discuss appropriate pre-clearing depth. 1b. MUST Complete subsurface clearance checklist prior to pre-clearance.
	1c. FALL: Slip, Trip or Fall may cause muscle strains or tears, abrasions, lacerations, or broken bones.	1c. Be aware of the conditions when walking or loading equipment and working. Walk within established pathway avoiding uneven surfaces. Remove potential slip/trip/fall hazards.
2. Mobilize/demobilize and establish work area	**2a. SEE MOBILIZATION / DEMOBILIZATION JSA – GEN-015**	2a. See Mobilization / Demobilization JSA.
3. Concrete saw cutting, jack hammer and hand clearance with hand tools, air knife	**3a. CONTACT:** Flying debris striking face or body	3a Maintain 10' minimum exclusion zone. Use the required PPE (i.e., leather/cut proof gloves, safety glasses/face shield). 3a. Use anti-whip devices on compressor hoses. Ensure hose couplings are secure. 3a Wear a face shield to protect face from flying debris when using air knife. 3a. Utilize a traffic cone, cage or physical barriers over the hole during air knife activities to keep flying debris close to ground.
	3b. EXPOSURE: Inhalation/exposure to hazardous vapors and/or concrete dust, noise exposure	3b. Monitor breathing zone with a calibrated PID and/or multi-gas meter. If meters sustain readings greater than recommeneded in the HASP for the specific contaminant of concerns (COCs) the Roux field personnel must temporarily cease work, instruct all Site personnel to step away from the area of elevated readings. Contact PM. 3b. Wet concrete while using saw to minimize dust and wear dust mask to prevent inhalation. 3b. Stand upwind and keep body behind saw. Observers and helpers should avoid line-of-fire for saw blade. Always cut away from body. 3b. No open flames/heat sources.

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	3c. ENERGYSOURCE/CONTACT: Property damage; Pressurized water mains may cause lacerations or broken bones. Pressurized gas mains may explode causing serious injury, or death. Underground electric may cause severe burns, shock, or death.	3b. Wear hearing protection when saw, jackhammer or air compressor are in operation. Otherwise, if sound levels exceed 85 dbA, put on hearing protection. 3c. For air knifing, ensure extention/lance tip reaches the full 5 feet bgs. Air knife should be advanced **AT A MINIMUM** in all four corners of the expected boring location to find any possible arrangement of utilities. 3c. Ensure diameter of soil preclearance hole is at a **MINIMUM 2x** the diameter of any drilling or hard dig equipment that will be entering the hole. 3c. See Complete subsurface clearance protocol for information provided above.
	3d. ERGONOMICS/EXERTION: Muscle strain due to poor body positioning when handling equipment and materials	3d. Use body positioning and lifting techniques that minimizes muscle strain; keep back straight, lift with legs, keep load close to body, and never reach with a load. 3d. Ensure that loads are balanced to reduce the potential for muscle strain. 3d. Two people or a mechanical lifting aid are required when lifting objects over 50 lbs. or when the shape makes the object difficult to lift.
	3e. FALL: Tripping/falling due to uneven terrain, weather conditions, and materials/equipment stored at the Site	3e. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. Mob/Demob JSA. 3e. Do not climb over stored materials/equipment; walk around. Practice good housekeeping. 3e. Use established pathways and walk on stable, secure ground. 3e. Equipment and tools will be stored at the lowest point of potential energy and out of the walkway and immediate work area (i.e. tools should not be propped against walls or nearby equipment or vehicles). 3e. Equipment and tools that are not anticipated to be used will be returned to a storage area that is out of the immediate work area. 3e. Ensure power cords and compressed air lines are grouped when used within the work area. 3e. Pre-cleared location will be finished flush to grade as to prevent a slip/trip hazard or coned and taped off.
	3f. CAUGHT: Amputation points associated with the equipment and vacuum hose	3f. Always wear leather gloves when making connections and using hand tools; wear cut-resistant (i.e., Kevlar) gloves when handling cutting tools. 3f. Inspect the equipment prior to use for potential pinch points. 3f. Test all emergency shutdown devices prior to using equipment. 3f. Inspect saw blade for worn surface or missing teeth; switch blade if damaged or blunt. 3f. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. 3f. All non-essential personnel shall maintain a 10 foot exclusion zone; position body out of the line-of-fire of equipment. 3f. Drillers and helpers will understand and use the “Show Me Your Hands Policy”.
4. Move drum to staging area using drum cart	**4a. EXPOSURE/CONTACT:** Contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, soil)	4a. Wear Nitrile chemical-resistant gloves under leather or cut proof gloves. 4a. Do not overfill drums. Ensure that the drum lids are attached securely. 4a. All drums will be staged in the designated storage area.
	4b. EXERTION: Muscle strain while maneuvering drums with drum cart/lift gate	4b. See 3d. Do not overfill drums. Use lift gate on back of truck to load and unload drums. Use drum dolly to move drum.
	4c. CAUGHT: Pinch points associated with handling drum lid	4c. Ensure that fingers are not placed under the lid of the drum. Wear leather gloves or cut proof gloves. Use appropriate ratchet while sealing drum lid.
5. Decontaminate equipment.	**5a. EXPOSURE/CONTACT**: To contamination (e.g., Separate Phase Hydrocarbons (SPH), contaminated groundwater, vapors).	5a. Wear chemical-resistant disposable gloves and safety glasses. 5a. Contain decontamination water so that it does not spill. 5a. Use an absorbent pad to clean spills, if necessary. 5a. Spray equipment from side angle, not straight on, to avoid backsplash. 5a. See 3b.
	5b. EXPOSURE: To chemicals in cleaning solution.	5b. See 4a. Review SDS to ensure appropriate precautions are taken and understood.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-028	DATE: 04/11/2023	☐NEW ☒REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
GENERIC	**Wetland Delineation**	**Wetland Delineation**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Kristy Northrup	Project Scientist	Brian Hobbs	CHSD
Tim Unalp	SHSO		

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☐ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☐ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION: ear plugs as necessary ☒ SAFETY SHOES: Steel or composite toed muck boots	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: High-visibility vest or high-vis outerwear	☒ GLOVES: Leather/cut-resistant/chemical resistant as necessary ☒ OTHER: Tyvek and rubber boots as necessary

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Required Equipment: Site map, emergency contact list, documentation of urgent care/hospital routes and/or guide familiar with Site, operating cell phone or walkie-talkie if Site allows.

Commitment to Safety – All personnel onsite will actively participate in SPSA performance by verbalizing SPSAs throughout the day.

SITE SECURITY: Prior to the delineation, verify appropriate method to address Site Security concerns as it relates to potential criminal activity, homeless population, and/or isolation concerns. Work with the Project Principal and/or Project Manager to address appropriately.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Check in with Site contact.	**1a. CONTACT/EXPOSURE/FALL:** Personal injury caused by lack of knowledge of site-specific hazards.	1a. Inquire about hazards and other activities taking place at the Site. 1a. Inform Site contact of work scope, timeline and location(s). 1a. Discuss emergency evacuation procedures and muster points with Site contact. 1a. Follow Lone Worker Protocol/Procedure if applicable.
2. Traversing the Site and inspecting vegetation	**2a. CONTACT:** Property damage and personal injury caused by obstructions/vehicles or unauthorized personnel at remote Sites.	2a. All equipment must be stowed and secured prior to moving. 2a. Maintain speed limit as posted on-site. 2a. When possible drive on established roadways. 2a. Yield to all pedestrians. 2a. Use pull-through spots or back into parking spots. 2a. Don high visibility clothing/safety vest. If working at remote Site, add orange accessories during hunting season. 2a. Wear safety glasses if traversing through thick vegetation to protect eyes from incidental contact.
	2b. FALL: Uneven terrain and weather conditions. Overgrown shrubs and vines. Equipment in the work zone.	2b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilization. 2b. When possible, use established pathways and walk on stable, secure ground. 2b. Be aware of potential ponds/surface water bodies as they may be obscured by vegetation. Be sure of footing prior to stepping. 2b. Communicate traversing hazards with others. 2b. Remain a safe distance from steep stream banks. Consider use of personal floatation device.
	2c. OVEREXERTION: Muscle strain while carrying equipment.	2c. When carrying equipment to/from work area, use proper lifting techniques; keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use the buddy system, mechanical means or make multiple trips to carry equipment.
	2d. EXPOSURE: Biological hazards – ticks; bees/wasps; poison ivy; insects; (Ticks are most active any time the temperature is above freezing, typically from March to November.)	2d. Inspect area to avoid contact with biological hazards. 2d. Ticks: • Treat outer clothing including pants, shirts, socks, boots and hats the evening before with Permethrin (refer to application instructions). • Apply DEET to exposed skin before travelling to the Site and reapply after two hours. • Check for ticks during and after work.

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		2d. Bees: • Use bee spray as appropriate to deter/eliminate bees. • Protect exposed skin with insect repellent. 2d. Poison Ivy: • Identify areas of poison ivy and spray with weed killer if able. Don Tyvek and rubber boots while traversing poison ivy areas. • Apply barrier lotion/cream to exposed skin. • If skin contacts poison ivy, wash skin thoroughly with soap and water. • Appropriately clean tools and materials which come into contact with poison ivy.
	2e. EXPOSURE: Heat Stress & Cold Stress. Personal injury from working in inclement weather conditions.	2e. Wear sunscreen with SPF 15 or greater on exposed skin whenever 30 minutes or more of sun exposure is expected. 2e. During summer months, watch for heat stress symptoms (muscle cramping, exhaustion, dizziness, rapid and shallow breathing). Take breaks as needed. 2e. During winter months, watch for cold stress symptoms (severe shivering, slowing of body movement, weakness, stumbling or inability to walk, collapse). Take breaks as needed. 2e. Wear appropriate rain gear as needed. 2e. Take frequent breaks if tired, wet, or cold/hot. Drink water. 2e. If lightning is observed, wait 30 minutes after last thunder boom/lightning bolt in a sheltered location (car acceptable) before starting work again.
3. Collecting Soil Borings.	**3a. CONTACT:** Personal injury from pinch points, cuts, and abrasions from auger.	3a. Wear cut-resistant (i.e., Kevlar) gloves under chemical-resistant (nitrile) disposable gloves when handling soil and auger.
	3b. EXPOSURE: Exposure to poison ivy	See 2d. Poison Ivy
	3c. EXERTION/ERGONOMICS: Exertion due to repetitive motion and ergonomics.	3c. Stretch torso and arms before, during, and after the delineation. Take breaks when needed. 3c. Bend at the knees and keep back straight when collecting samples and advancing boring.
4. Departing Site.	**4a. EXPOSURE:** Exposure to hazards should personnel believe Roux is still on-site during an emergency, resulting in an unnecessary rescue search.	4a. Sign out or notify Site contact and Roux Project Manager of your departure.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

JOB SAFETY ANALYSIS	Ctrl. No. GEN-029	DATE: 4/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
GENERIC	**Preclearing/Sampling**	**Hand Augering**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Sean Owens	Senior Health & Safety Specialist	Brian Hobbs	Corporate Health & Safety Director

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Cut Resistant / Leather / Nitrile / Chemical resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☐ LIFELINE / BODY HARNESS	☐ HEARING PROTECTION	☒ PPE CLOTHING: Long sleeve high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel or composite toed		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Hand Auger Tools (buckets, rods), 5-gallon buckets, hand tools (hammer, etc)

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Drive/walk to hand clearing/hand augering location	**1a. CONTACT:** Property damage and personal injury caused by obstructions/vehicles	1a. Maintain speed limit on-site. 1a. All equipment must be stowed and secured prior to moving. 1a. Drive on established roadways. 1a. Do not back up vehicle without spotter where visibility is limited; use pull-through spots or back into parking spots; use an audible signal (horn/back-up alarm) when backing up vehicles.1c.
	1b. FALL: Personal injury from tripping/falling due to uneven terrain, weather conditions, and materials/equipment stored at portions of the Site	1b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Use established pathways and walk on stable, secure ground. 1b. Use established ramp when descending into/ascending from impoundment areas. 1b. Keep tools and equipment in a designated area. When not in use, tools and equipment must be returned to their proper storage location. Keep work area clear of obstructions.
	1c. EXERTION: Muscle strain/exhaustion while carrying equipment (i.e., hand auger, post-hole digger, shovel, pry bar)	1c. When carrying equipment to/from work area, use proper lifting techniques; keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use mechanical assistance or make multiple trips to carry equipment.
	1d. EXPOSURE: Exposure to sun, possibly causing sunburn Biological hazards - bees/wasps, poison oak, thorns, insects, etc.	1d. Wear sunscreen with an SPF of at least 15 whenever 30 minutes or more of exposure is expected. 1d. Inspect area to avoid contact with biological hazards. 1d. Wear cut resistant gloves when handling branches, shrubs, etc. that may lie within the walking path. 1d. Avoid any areas onsite that have poison oak.
2. Secure location	**2a. CONTACT:** Personnel and vehicular traffic may enter the work area.	2a. Delineate the work area with traffic cones and/or caution tape to prevent exposure to traffic and inform others of work activity. 2a. Wear reflective vest and/or fluorescent clothing. 2a. Face the direction of vehicular traffic. Position vehicle to protect worker from traffic. 2a. Communicate work activity with adjacent work areas.
	2b. FALL: Tripping/falling due to uneven terrain, and materials /equipment stored within the work area	2b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment to the impoundments. 2b. Equipment and tools will be staged in a convenient, stable, and orderly manner. 2b. Equipment and tools will be stored at the lowest point of potential energy and out of the walkway and immediate work area (i.e. tools should not be propped against walls or nearby equipment or vehicles). 2b. Equipment and tools that are not anticipated to be used will be returned to an appropriate storage area that is out of the immediate work area.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift." Avoid general statements such as, "be careful."

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Verify pre-clearance protocol; review completed Subsurface Utility Checklist and utility verification site walkthrough.	**3a. ENERGY SOURCE:** Underground utility damage; property damage; personal injury	3a. Confirm that "Call Before You Dig" and local utility companies were contacted prior to hand augering. 3a. Walk the Site to evaluate utility markings and review maps.
4. Augering/advancing borehole	**4a. EXPOSURE:** Contaminated soil/water/vapor **4b. EXERTION:** Muscle strain from lifting, bending, repetitive motion. **4c. CAUGHT:** Personal injury as a result of jewelry/loose clothing caught on equipment, well covers, machinery, hand auger, pry bar etc.. **4d. CONTACT/CAUGHT:** Pinch points, abrasions	4a. Monitor breathing zone with a PID when VOCs area concern. If vapors sustain > 5 ppm, upgrade PPE as per HASP. 4a. Wear chemical-resistant disposable gloves and safety glasses when handling impacted materials. 4a. Place excavated soil on plastic sheeting and store soil waste in designated area. 4a. Work on the upwind side of the boring. 4b. Body positioning and rotating with the auger to reduce strain. Don't twist back. 4c. No form of jewelry should be worn while on-site. 4c. Clothing must be appropriately sized so it is not loose fitting. 4d. Keep head and upper body clear when lifting hand auger, pry bar/post-hole digger. Ensure to not be overly aggressive when using pry bar. 4d. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body.
5. Lithologic observation and soil sampling	**5a. EXPOSURE:** Contact with contamination (impacted soil and/or lab preservatives)	5a. Wear chemical-resistant disposable gloves to protect hands when handling samples; wear safety glasses when handling any preservatives; use containment material or plastic sheeting to protect surrounding areas. 5a. When collecting soil sample from hand auger, put large zip lock bag over entire auger to prevent spillage of soil on to the ground. 5a. Open sample jars slowly and fill carefully to avoid contact with preservatives.
6. Decontaminate equipment	**6a. EXPOSURE:** Contact with contamination (impacted soil and/or lab preservatives, decontamination solution) **6b. CONTACT/CAUGHT:** pinch points and cuts/abrasions	6a. Wear chemical-resistant disposable gloves and safety glasses. 6a. Use an absorbent pad to clean spills. 6a. Properly dispose of used materials/PPE trash bags. 6b. Keep fingers/hands out of pinch points when dis-assembling hand auger during decontamination.

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JOB SAFETY ANALYSIS	**Ctrl. No. GEN-030**	DATE 4/11/2023	☐ NEW ☒ REVISED	PAGE 1 of 2
JSA TYPE CATEGORY **Generic**	WORK TYPE: **Remediation**	WORK ACTIVITY (Description): **In-Situ Chemical Injection**		

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Connor Moore	Staff Scientist	Sean Owens	Senior Health and Safety Specialist
April McGuire	Project Engineer/PM	Brian Hobbs	CHSD

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST ☒ HARD HAT ☐ LIFELINE / BODY HARNESS ☒ SAFETY GLASSES	☒ GOGGLES ☐ FACE SHIELD ☐ HEARING PROTECTION ☒ SAFETY SHOES: Composite-toe or steel toe boots/shoes	☐ AIR PURIFYING RESPIRATOR ☐ SUPPLIED RESPIRATOR ☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	☒ GLOVES: Leather, Nitrile and cut resistant (as needed) ☒ OTHER: sunscreen (as needed), face covering (COVID-19)

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Limited-Access Geoprobe or Dolly-Mounted Direct Push Drill Rig, Ventilation Equipment (Ducts, Fans), Hand Tools, Photoionization Detector, Multi-Gas Meter (or equivalent), Macrocore liners, Liner Opening Tool, 20 lb. Type ABC Fire Extinguisher, 42" Cones & Flags, Signage, Water

COMMITMENT TO SAFETY – All personnel on-site will actively participate in hazard recognition throughout the day by verbalizing SPSAs.

EXCLUSION ZONE (EZ) – Maintain Minimum Heavy Equipment Exclusion Zone around equipment and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during injection activities.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Verify pre-clearance protocol and mobilize/demobilize	**1a. CONTACT:** Property damage, personal injury, or underground utilities.	1a. Check in with Site contact, if applicable. 1a. Confirm that local utility companies were contacted prior to pre-clearance, drilling and injections. Obtain completed One Call Tickets **1a. Walk the Site to evaluate utility markings and review maps and complete subsurface clearance form.**
	1b. CONTACT: With traffic (including any unintended movement of the work truck or drill rig), contact / interference with other site activities.	1b. Identify potential traffic hazards. 1b. Don high visibility clothing. 1b. Use a spotter while moving work vehicles; plan ahead to avoid backing up when unnecessary. Use additional spotters if necessary. 1b. Ensure that truck and trailer (if applicable) has wheel chocks in place when parked and equipment (e.g. compressor) is chocked if detached from truck. 1b. Yield right of way to traffic where appropriate. Use traffic signals. 1b. Delineate work area with cones, flags, caution tape, and/or other barriers. Construct pedestrian walkway, if needed. Use truck to barricade if possible. 1b. Maintain a minimum exclusion zone based on equipment. 1b. Face traffic, maintain eye contact with oncoming vehicles, use a spotter, and establish a safe exit route; wear bright colored clothing/safety vest. 1b. Stay focused on walking path to avoid slip, trip and fall hazards. 1b. Where possible, avoid traversing uneven terrain.
	1c. EXERTION/ERGONOMICS: Potential for muscle strain/injury when lifting equipment and injection materials	1c. Personnel shall limit how much they carry at one time when traversing the Site. If needed use a dolly or portable wagon to transport equipment. 1c. Keep back straight and bend at the knees. 1c. Utilize team lifting for objects over 50lbs. 1c. Use mechanical lifting device for odd shaped objects.
2. Advancement of drilling equipment.	**2.** See GEN-006 Direct Push Soil Boring/Well Installation JSA	2. See GEN-006 Direct Push Soil Boring/Well Installation JSA
3. Handling and injection of ISCR chemicals into injection points	**3a. EXPOSURE:** Ground water/Chemicals on body/clothing, inhalation	3a. Refer to manufacturer's safety data sheet for chemicals used during ISCR injections and don appropriate task specific PPE (e.g. Tyvek suit, chemically resistant gloves, goggles/safety glasses, faceshield, respiratory protection) 3a. Do not place your face near areas where chemicals are being poured or mixed. 3a. If there is wind present always stand on the up wind side of your equipment. 3a. Maintain exclusion zone around injection equipment.

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	3b. EXERTION/ERGONOMICS: Potential for muscle strain/injury when lifting equipment and injection materials	3b. See 1c.
	3c. ENERGY/CONTACT: Pressurized lines/Electrical, Pressurized well plugs and/or well packer assemblies	3c. Follow recommended maintenance procedure for equipment prior to event. Maintanence involves inspecting and replacing worn components. Checking hose connections ensuring whip checks in place. Maintain pressure below maximum operating pressure of equipment. 3c. A minimum exclusion zone of 10 feet will be kept around any active injection points in case of back pressure buildup causing projection of injection media. Elevated operating pressures may require a larger exclusion zone. 3c. Keep electrical components (cords, generator, mixer and pump) dry. 3c. Use power source with ground-fault circuit inturruptor (GFCI) outlet. 3c. If well packers are used, they must be secured to well casing or other permanent structure to ensure no projectile incidents due to pressure build up from injections. Prior to starting injections each day, well plugs on all wells within 50 feet of injections shall be loosened to relieve any possible pressure build up behind plug.
	3d. EXPOSURE: Ground water/Chemicals "Daylighting"	3d. Monitor wellhead pressure, daylighting, and injection lines. Stop pumping if any leaks or pressures above equipment action levels.
	3e. EXPOSURE: Noise from equipment	3e. Wear hearing protection when air compressor/injection equipment is in operation if noise is in excess of 85 dBA.
	3f. CONTACT/CAUGHT: Heavy equipment and hand tools	3f. Steel toe boots, leather gloves, long pants, high visibility clothing and safety glasses will be worn by on-Site personnel during injection activity to mitigate the potential for pinches, cuts, abrasions, etc. to limbs or extremities from equipment or hand tools. 3f. Keep hands out of the line of fire and pinch points when making hose connections. Use whip-checks and secure all hose couplings.
	3g. FALLS: Slips, trips and falls from hoses and potential daylighting	3g. Work area will be clean and free of any debris to remove slip, trip and fall hazards. All tools and hoses will be kept in designated areas. Ensure work area is well illuminated. 3g. Hoses connecting fire hydrant/mixing tank/geoprobe/wells will be delineated with cones and/or caution tape. 3g. Immediately clean up any wet areas with appropriate absorbent. 3g. Designate a walking path which avoids walking directly over hoses.
4. Disconnect/Move Injection Hose	**4a. EXPOSURE:** Injection chemicals	4a. Wear appropriate PPE as specified by manufacturer's SDS. See 3a. 4a. Double check valves before detaching components. (e.g. Before disconnecting line, check that corresponding manifold outlet valve is closed and pressure in line relieved.) 4a. Relieve pressure in system before detaching hose components. 4a. Drain hoses into approved container away from personnel. Secure caps on end of hoses to ensure additional contents are contained. 4a. Utilize appropriate absorbents to clean up spills.
	4b. CONTACT/CAUGHT: Heavy equipment, hand tools, and injection hoses	4b. See 3f.
	4c. FALLS Slips, trips and falls from hoses and potential daylighting	4c. See 3g.
	4d. EXPOSURE Loud noises associated with heavy machinery	4d. See 3e.
5. Secure/leave site.	**5a. FALL:** Slip/trip/fall	5a. See 3g. 5a. Be aware of the conditions when walking.
	5b. EXPOSURE: Poor communication can create Site Risk	5b. Notify site manager and project manager when leaving Site. 5b. Make sure to lock any gates/doors/wells that have been opened during injections. 5b. Return keys to site manager.

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JOB SAFETY ANALYSIS	Ctrl. No. LA-017	DATE: 04/11/2023	☒ NEW ☐ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)
Generic	**Construction**	**Lifting Storm Drain Grate with a Crowbar**

DEVELOPMENT TEAM	POSITION / TITLE	REVIEWED BY:	POSITION / TITLE
Johanan Knight	Staff Engineer	Brian Hobbs	CHSD
Sean Owens	OHSM	Ray Greenidge	Sr. Compliance Manager

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☒ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather or cut-resistant
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER
☒ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: High visibility long sleeved clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-toe boots		
☒ SAFETY GLASSES			

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Crowbar

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Drive/walk to storm drain grate location	**1a. CONTACT:** Property damage and personal injury caused by obstructions/vehicles	1a. Maintain speed limit on-site. 1a. All equipment must be stowed and secured prior to moving. 1a. Drive on established roadways. 1a. Do not back up vehicle without spotter where visibility is limited; use pull-through spots or back into parking spots; use an audible signal (horn/back-up alarm) when backing up vehicles.
	1b. FALL: Personal injury from tripping/falling due to uneven terrain, weather conditions, and materials/equipment stored at portions of the Site	1b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment. 1b. Do not climb over stored materials/equipment; walk around. Use established pathways and walk on stable, secure ground. 1b. Use established ramp when descending into/ascending from impoundment areas. 1b. Keep tools and equipment in a designated area. When not in use, tools and equipment must be returned to their proper storage location. Keep work area clear of obstructions.
	1c. EXERTION: Muscle strain/exhaustion while carrying equipment (i.e., hand auger, post-hole digger, shovel, pry bar)	1c. When carrying equipment to/from work area, use proper lifting techniques; keep back straight, lift with legs, keep load close to body, never reach with a load. Ensure that loads are balanced to reduce the potential for muscle strain. Use mechanical assistance or make multiple trips to carry equipment. 1c. Use team lift or mechanical means to lift objects heavier than 50 lbs.
2. Secure location	**2a. CONTACT:** Personnel and vehicular traffic may enter the work area.	2a. Delineate the work area with traffic cones and/or caution tape to prevent exposure to traffic and inform others of work activity. 2a. Wear high visibility clothing (adhere to site-specific PFAS-free restrictions, if appliable). 2a. Face the direction of vehicular traffic. Position vehicle to protect worker from traffic. 2a. Communicate work activity with adjacent work areas.
	2b. FALL: Tripping/falling due to uneven terrain, and materials /equipment stored within the work area	2b. Inspect walking path for uneven terrain, weather-related hazards (i.e., ice, puddles, snow, etc.), and obstructions prior to mobilizing equipment to the impoundments. 2b. Equipment and tools (crowbar) will be staged in a convenient, stable, and orderly manner. 2b. Equipment and tools (crowbar) will be stored at the lowest point of potential energy and out of the walkway and immediate work area (i.e. tools should not be propped against walls or nearby equipment or vehicles). 2b. Equipment and tools that are not anticipated to be used will be returned to an appropriate storage area that is out of the immediate work area.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Lifting/replacing storm drain grate with crowbar (up to 2' x 2' grate)	**3a. EXERTION:** Muscle strain from lifting, bending, repetitive motion.	3a. Place crowbar in between grate and ground and push from a stable position on the ground. Try to reduce strain on arms and back. Push using your legs as your source of energy when possible, rather than isolated muscles in your back or arms.
	3b. CAUGHT: Personal injury as a result of jewelry/loose clothing caught on crowbar or storm drains	3b. No form of jewelry should be worn while on-site. 3b. Clothing must be appropriately sized so it is not loose fitting.
	3c. CONTACT/CAUGHT: Pinch points, abrasions	3c. Keep head and upper body clear when lifting the grate using the crowbar. Ensure to not be overly aggressive when using crowbar. 3c. Ensure all jewelry is removed, loose clothing is secured, and PPE is secured close to the body. Make sure safety-toed boots are worn and to keep feet out of landing area if the grate were to slip out from the crowbar. Keep fingers/hands out of pinch points when moving grate after using the crowbar. Wear cut-resistant gloves.
	3c. EXPOSURE: Harmful vapors in storm drain	3d. Air monitoring using a calibrated 5-gas multi-gas meter (O_2, H_2S, CO, LEL%, PID) to periodically monitor the breathing zone of the work area. 3d. The Action Level for breathing zone air is five parts per million (sustained) as detected by the PID. 3d. If a reading of >5ppm is recorded, the Roux field personnel must temporarily cease work, instruct all personnel to step away from the area of elevated readings and inform the Roux PM of the condition. The Roux PM will then recommend additional appropriate precautions in accordance with the site-specific health and safety plan.

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JOB SAFETY ANALYSIS	Ctrl. No. GEN-032	DATE: 04/11/2023	☒ NEW ☐ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY	WORK TYPE	WORK ACTIVITY (Description)	
Generic	**Construction**	**Spotting Third-Party Traffic**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Douglas Ferraiolo	Project Geologist	Brian Hobbs	CHSD
Jerry Tolosko	VP Principal Hydrogeologist	Rafhael Gandolff	Sr. H&S Specialist

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ Particulate Respirator	☒ GLOVES: Cut resistant / leather
☒ HARD HAT	☐ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☐ OTHER:
☒ LONG SLEEVED SHIRT	☐ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective clothing	
☐ LIFELINE / BODY HARNESS	☒ SAFETY SHOES: Steel-/Composite-toe boots/shoes		
☒ SAFETY GLASSES			

REQUIRED EQUIPMENT

Handheld fluorescent warning flags (1 per spotter), two-way radios.

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs

EXCLUSION ZONE (EZ): Maintain Minimum Heavy Equipment Exclusion Zone around equipment, active operations (e.g., excavation, truck loading ,etc.) and loads while it is in motion. The HEEZ must be greater than the swing zone of any moving part of the equipment, tip zone of the equipment, fall zone of the equipment and contents, distance that debris may travel during demolition activities and/or foot print of a structure to be demolished. The HEEZ should not be compromised in any way by third party traffic.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Prepare for heavy equipment operations and/or job activity which require traffic stoppage.	**1a. CONTACT:** Third-party traffic in and/or adjacent to the work area may create contact hazards with machinery and site personnel. **1b. Fall :** Slip/Trip/Fall	1a. Cordon off the work area with safety barrels/cones and a rigid barrier (snow fence, traffic bar, etc.). Communicate that only necessary personnel should be in the work area. Spotter and equipment operator shall enforce the **EZ.** Operator will not operate but shall remain in the hands-off mode while personnel are within the exclusion zone. • Spotters must agree on communication via voice and hand signals before the activity begins. • Spotters must be visible and maintain contact with other spotters. • If contact is lost with either spotter, work operations should stop until communication has been re-established. • Spotters should never have additional duties while they are spotting. 1a. Spotters must analyze traffic patterns adjacent to the site to assess which traffic direction will need to be re-directed and what issues must be resolved prior to spotting traffic. 1a. The “Traffic Control Point” is a specific location where the spotter is positioned to direct traffic. 1a. **Spotters should select an appropriate Traffic Control Point where visibility, directions and personal safety will be maximized.** 1b. Ensure that the Traffic Control Point is flat, level and clear of any obstructions or debris before beginning spotting operations.

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[2] A hazard is a potential danger. Break hazards into six types: Contact - victim is struck by or strikes an object; Caught - victim is caught on, caught in or caught between objects; Fall - victim falls to ground or lower level (includes slips and trips); Exertion - excessive strain or stress / ergonomics / lifting techniques; Exposure - inhalation/skin hazards; Energy Source – electricity, pressure, compression/tension.
[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
2. Spotting third-party traffic during site operations.	**2a. CONTACT:** Machine or load contact with third party traffic.	2a. Discuss the specifics of the work, limits of the assigned work area, and the machine's Exclusion Zone. Maintain the Exclusion Zone while spotting third-party traffic. 2a. **Spotters and equipment operators shall have 2-way radios/cellular devices on their persons** to ensure audible communication in the event any changes or new hazards may arise. 2a. Spotters must make eye contact with the machine operations and third-party traffic, or all movement ceases until visual contact can be reestablished. 2a. Spotter shall keep an eye out for any traffic issues the operator may not see and communicate with other work crews and spotters accordingly. 2a. If the spotter needs to take a break, he must find a replacement before leaving or stop operations. **Operations which may contact third-party traffic shall not be performed without a spotter under any circumstances.** 2a. Wear fluorescent clothing/safety vest. **Handheld fluorescent warning flags (1 per spotter) are required for spotting third party traffic.** 2a. Establish traffic control by performing all signals / movements with precision and ensuring drivers obey signals. • Break traffic at natural gaps whenever possible to direct opposite sides of traffic • Maintain consistency in the time you allow each direction of traffic to travel. Prioritize major routes over secondary routes. • If breaks do not occur, allow traffic to accumulate on opposite sides of the road before directing it to move. • Allow right turns whenever they do not interfere with traffic and pedestrians. • Make sure opposite lanes are stopped before allowing left turns to be made. 2a. **Do not multitask. Only perform Spotting.**
	2b. FALL: Slip/Trip/Fall	2b. Look where walking to identify and avoid slip/trip/fall hazards. Avoid icy and/or wet surfaces. Remove obstacles if possible. 2b. Use designated walkways during spotting whenever possible. 2b. **Do not walk backwards. Always face the direction you are walking towards.**
	2c. CAUGHT: Caught between machinery and nearby objects.	2c. **Maintain Exclusion Zone.** Do not stand between large, loose or fixed objects or structures and the machinery while it is in motion. Keep in sight of operator at all times while being aware of surrounding structures.
	2d. EXPOSURE: Inhalation of exhaust from machinery.	2d. The spotter will position him/herself upwind of the working machinery, when possible. Spotter will also inform others working within the vicinity of the EZ of proper positioning, if applicable.

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JOB SAFETY ANALYSIS	Ctrl. No. Gen-033	DATE: 03/31/2023	☐ NEW ☒ REVISED	PAGE 1 of 2

JSA TYPE CATEGORY:	WORK TYPE	WORK ACTIVITY (Description)	
GENERIC	**Installation and Sampling**	**Sub-Slab Vapor Pin Installation & Sampling**	
DEVELOPMENT TEAM	**POSITION / TITLE**	**REVIEWED BY:**	**POSITION / TITLE**
Sean Owens	OHSM	Rafhael Gandolff	OHSM
		Mikhail Fradkin	Senior Industrial Hygienist

REQUIRED AND / OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT

☐ LIFE VEST	☐ GOGGLES	☐ AIR PURIFYING RESPIRATOR	☒ GLOVES: Leather, Cut-resistant & Nitriles
☒ HARD HAT	☒ FACE SHIELD	☐ SUPPLIED RESPIRATOR	☒ OTHER: Knee Pads or kneeling pad
☐ LIFELINE / BODY HARNESS	☒ HEARING PROTECTION	☒ PPE CLOTHING: Fluorescent reflective vest or high visibility clothing	
☒ SAFETY GLASSES	☒ SAFETY SHOES: Steel-toe boots		

REQUIRED AND / OR RECOMMENDED EQUIPMENT

Rotary Hammer Drill, HEPA Dust Extractor for Rotary Hammer Drill, Drilling Dust Shroud & HEPA Vacuum, Portable Generator (as needed), Soil Vapor Pin Mallet/Screwdriver, Silicone Tubing, Flush Seal, Summa Canisters and Flow Controllers, Photo Ionization Detector (PID), Tubing Cutter, Safety Cones, Caution Tape or Retractable Cone Bars

COMMITMENT TO SAFETY- All personnel onsite will actively participate in hazard recognition and mitigation throughout the day by verbalizing SPSAs.

Work Zone (WZ): A 10-foot exclusion zone will be maintained and delineated for non-essential personnel.

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
1. Define and secure work area.	**1. Refer to Mobilization/Demobilization JSA Gen-015** **1a. EXPOSURE:** Carbon monoxide exposure associated with portable generator operation. 1b. Contact: Energized utilities	**1. Refer to Mobilization/Demobilization JSA Gen-015** 1a. When staging portable generator (if applicable), an outdoor location adjacent to the work area will be selected and appropriate extension cords will be used to provide energy to equipment. Portable generators shall not be used indoors. 1a. Place the generator at least 20 feet from the entrance to the building, with exhaust pointing away from the building. 1a. If there is potential for CO re-entrainment use a multi-gas meter to screen work zone for CO. **1b. Follow procedures outlined in the Subsurface Utility Clearance Management Program**
2. Core through the concrete floor slab using a rotary hammer drill.	**2a. CONTACT:** Contact with the drill bit and spinning rotary hammer drill. **2b. FALL:** Potential tripping hazards associated with electrical power cord. **2c. ERGONOMICS:** Physical strain of coring through concrete. **2d. EXPOSURE:** Silica and particulate matter generated by coring concrete and quartz-containing materials. Potential of exposure due to contact with subsurface utilities. Loud noises from drilling through slabs. **2e. ENERGY SOURCE:** Avoid electrical shock when operating the Rotary Hammer Drill.	2a. Keep hands away from the rotary hammer drill bit and only operate from the handle. Drill can spin around and make contact with personnel, utilize a firm grip. 2a. Wear cut-resistant gloves, face shield and safety glasses. 2b. Place cones or delineators around the power cord to demarcate potential tripping hazards. Keep cords out of walking paths. 2c. Use body positioning and bending techniques that minimize muscle strain; keep back straight, bend at the knees. 2c. Utilize knee pads or kneeling pads while using the rotary hammer drill. 2d. Always use drill equipped with a dust shroud and HEPA vacuum/dust collection system during drilling as an engineering control for silica exposure 2d. See 1b. 2d. Use hearing protection (i.e. earplugs/earmuffs) when operating the Rotary Hammer Drill. 2e. Always use rotary hammer drill with appropriate extension cords and only plug into ground fault circuit interrupter (GFCI) outlets. 2e. Do not run cords through puddles or water. 2e. Inspect equipment lines and chords for visible damage and fraying prior to operation of drill. Remove drill from operation if damaged.

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[3] Using the first two columns as a guide, decide what actions or procedures are necessary to eliminate or minimize the risk. List the recommended safe operating procedures. Say exactly what needs to be done - such as "use two persons to lift". Avoid general statements such as, "be careful".

Assess [1]JOB STEPS	Analyze [2]POTENTIAL HAZARDS	Act [3]CRITICAL ACTIONS
3. Install sub-slab pin fitted with silicone sleeve.	**3a. CAUGHT/CRUSHED:** Potential for getting hand caught between top of pin and flush mounted cap, and underneath soil pin mallet. **3b. ERGONOMICS:** Physical strain related to working on the ground. Repetitive motions. **3c. EXPOSURE:** Loud sounds associated with hammering metal objects together. **3d. CONTACT:** Potential contact with broken concrete fragments	3a. Wear cut-resistant gloves 3a. Keep eye on hammering surface at all times to avoid striking nearby objects unintentionally. 3b. See 2c. 3b. Take breaks and stretch after conducting a task multiple times throughout the day. 3b. Switch out staff conducting the sampling activities. Take turns so that repetitive motions do not cause aching or muscle strain. 3c. Use hearing protection (i.e. earplugs) when hammer drill is in operation. 3d. Use HEPA vacuum to clean area and clear concrete pieces. Keep safety glasses on during installation.
4. Conduct leak testing	**4a. ERGONOMICS:** Physical strain related to working close to the ground. **4b. FALLS:** S/T/F hazards associated with equipment staged on floor. **4c. EXPOSURE:** Leak check compound (eg. 1,1 – DFA).	4a. See 3b. 4b. Watch step when moving around work area and ensure work area is free of unused tools on the ground. Place tools in a bucket. 4b. Maintain good housekeeping within work area. 4b. If any liquids or slippery substance spills in the work area, clean it up immediately. 4c. Review SDS for any chemical used. Don nitrile gloves when handling. Ensure proper ventilation exists and site personnel is not near the work area.
5. Set up soil vapor sampling equipment.	**5a. FALL:** Tripping hazards associated with equipment and tubing. **5b. CONTACT:** Pinch points associated with handling equipment. **5c. ERGONOMICS:** Physical strain related to working close to the ground.	5a. See 4b. 5a. Keep tubing slack to a minimum and locate the summa canister as close to the sampling location as possible. 5a. Avoid stepping over equipment and tubing. Maintain proper housekeeping to avoid S/T/F. 5b. Wear cut-resistant gloves, keep hands out of potential pinch points. 5c. See 2C.
6. Cleaning Work Area.	**6a. FALL:** Tripping hazards associated with equipment and tubing. **6b. CONTACT:** Storing and transport of equipment in car. **6b. Ergonomics:** Muscle strain during demobilization.	6a. See 4b. 6b. Ensure that equipment is placed securely in the vehicle. Do not stack equipment on top of each other. Secure equipment so that it will not slide while being transported. 6b. Wear cut-resistant gloves while handling/loading equipment. 6a. See 2C.

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HOT WORK PERMIT

PART 1 - INFORMATION

Issue Date:	
Date Work to be Performed: Start:	Finish (permit terminated):
Performed By:	
Work Area:	
Object to be Worked On:	

PART 2 - APPROVAL

(for 1, 2 or 3: mark Yes, No or NA)*

Will working be on or in:	Finish (permit terminated):	
1. Metal partition, wall, ceiling covered by combustible material?	yes	no
2. Pipes, in contact with combustible material?	yes	no
3. Explosive area?	yes	no

* = If any of these conditions exist (marked "yes"), a permit will not be issued without being reviewed and approved by Thomas H. Forbes (Corporate Health and Safety Director). Required Signature below.

PART 3 - REQUIRED CONDITIONS**

(Check all conditions that must be met)

	PROTECTIVE ACTION		PROTECTIVE EQUIPMENT
	Specific Risk Assessment Required		Goggles/visor/welding screen
	Fire or spark barrier		Apron/fireproof clothing
	Cover hot surfaces		Welding gloves/gauntlets/other:
	Move movable fire hazards, specifically		Wellintons/Knee pads
	Erect screen on barrier		Ear protection: Ear muffs/Ear plugs
	Restrict Access		B.A.: SCBA/Long Breather
	Wet the ground		Respirator: Type:
	Ensure adequate ventilation		Cartridge:
	Provide adequate supports		Local Exhaust Ventilation
	Cover exposed drain/floor or wall cracks		Extinguisher/Fire blanket
	Fire watch (must remain on duty during duration of permit)		Personal flammable gas monitor
	Issue additional permit(s):		

Other precautions:

** Permit will not be issued until these conditions are met.

SIGNATURES

Orginating Employee:	Date:
Project Manager:	Date:
Part 2 Approval:	Date:

APPENDIX B

SDSs for Chemicals Used

4 GAS

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: METHANE (0- 2.5%), CARBON MONOXIDE (0.0005- 1.0%), HYDROGEN SULFIDE (0.001- 0.025%, OXYGEN (0.0015- 23.5%), BALANCE NITROGEN

MSDS NO: 401 **Version:3** **Date: January, 2006**

1. Chemical Product and Company Identification

Gasco Affiliates, LLC
1933 Whitfield Park Loop
Sarasota, FL 34243

TELEPHONE NUMBER: (941) 755-8806 **24-HOUR EMERGENCY NUMBER: 1-800-424-9300**
FAX NUMBER: (941) 755-8920
E-MAIL: info@gascogas.com

PRODUCT NAME: MULTI-MIX
CHEMICAL NAME: Methane, Carbon Monoxide, Hydrogen Sulfide, Oxygen in Nitrogen
COMMON NAMES/ SYNONYMS: None
TDG (Canada) CLASSIFICATION: 2.2
WHIMIS CLASSIFICATION: A

2. COMPOSITION/ INFORMATION ON INGREDIENTS

INGREDIENT	%VOLUME	PEL-OSHA	TLV-ACGIH	LD_{50} or LC_{50} Route/Species
Methane FORMULA: CH_4	0 to 2.5%	Simple Asphixiate	Simple Asphixiate	N/A
Carbon Monoxide FORMULA: CO	0.0005 to 1.0%	50 ppm	25 ppm	1811 ppm/ 4 hours (rat)
Hydrogen Sulfide FORMULA: H_2S	0.001 to 0.025%	20 ppm	10 ppm	444 ppm (rat)
Oxygen FORMULA: O_2	0.0015 to 23.5%	N/A	N/A	N/A
Nitrogen FORMULA: N_2	Balance	Simple Asphyxiate	Simple Asphyxiate	N/A

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

This product is a colorless gas, which has a rotten-egg odor. The odor cannot be relied on as an adequate warning of the presence of this product, because olfactory fatigue occurs after over-exposure to hydrogen sulfide. Hydrogen sulfide and carbon monoxide are toxic to humans in relatively low concentrations. Over-exposure can cause skin or eye irritation, nausea, dizziness, headaches, collapse, unconsciousness, coma, and death.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	No

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization	Reproductive Hazard	Mutagen
Yes	Yes	No	Yes	No

Carcinogenicity: --NTP: No IARC: No OSHA: No

EYE EFFECTS:
Hydrogen sulfide can cause eyes to become scratchy, irritated and even teary. Above 50 ppm of hydrogen sulfide, there is an intense tearing blurring of vision, and pain when looking at light.

SKIN EFFECTS:
Over-exposure to carbon monoxide can be indicated by the lips and fingernails turning bright red. High concentrations of hydrogen sulfide may also be irritating to the skin.

INGESTION EFFECTS:
Ingestion unlikely. Gas at room temperature.

INHALATION EFFECTS:
Due to the small size of this cylinder, no unusual heath effects from over-exposure are anticipated under routine circumstances of use. Over-exposure to hydrogen sulfide can cause dizziness, headache, and nausea. At 12- 16% Oxygen, breathing and pulse rate is increased, muscular coordination is slightly disturbed.

NFPA HAZARD CODES		HMIS HAZARD CODES		RATING SYSTEM
Health:	4	Health:	4	0= No Hazard
Flammability:	0	Flammability:	0	1= Slight Hazard
Reactivity:	0	Reactivity:	0	2= Moderate Hazard
				3= Serious Hazard
				4= Severe Hazard

4. FIRST AID MEASURES

EYES:
PERSONS WITH POTENTIAL EXPOSURE SHOULD NOT WEAR CONTACT LENSES. Flush contaminated eyes with copious quantities of water. Part eyelids to assure complete flushing. Continue for a minimum of 15 minutes. Seek immediate medical attention.

SKIN:
Remove contaminated clothing as rapidly as possible. Flush affected area with copious quantities of water. Seek immediate medical attention.

INGESTION:
Not required

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASED OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED THE SELF-CONTAINED BREATHING APPARATUS. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. If breathing has stopped administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: METHANE (0- 2.5%), CARBON MONOXIDE (0.0005- 1.0%), HYDROGEN SULFIDE (0.001- 0.025%, OXYGEN (0.0015- 23.5%), BALANCE NITROGEN

5. FIRE-FIGHTING MEASURES

These containers hold gas under pressure, with no liquid phase. If involved in a major fire, they should be sprayed with water to avoid pressure increases, otherwise pressures will rise and ultimately they may distort or burst to release the contents. The gases will not add significantly to the fire, but containers or fragments may be projected considerable distances - thereby hampering fire fighting efforts.

6. ACCIDENTAL RELEASE MEASURES

In terms of weight, these containers hold very little contents, such that any accidental release by puncturing etc. will be of no practical concern.

7. HANDLING AND STORAGE

Suck back of water into the container must be prevented. Do not allow backfeed into the container. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Use only in well-ventilated areas. Do not heat cylinder by any means to increase rate of product from the cylinder. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Use adequate ventilation for extended use of gas.

9. PHYSICAL AND CHEMICAL PROPERTIES

PARAMETER:	VALUE:
Physical state	: Gas
Evaporation point	: N/A
pH	: N/A
Odor and appearance	: Colorless gas with a rotten-egg odor

10. STABILITY AND REACTIVITY

Stable under normal conditions. Expected shelf life 12 months.

11. TOXICOLOGICAL INFORMATION

This gas mixture contains components that may cause embryotoxic effects in humans; however, due to the small size of the cylinder no toxicological damage is anticipated.

12. ECOLOGICAL INFORMATION

No ecological damage caused by this product.

13. DISPOSAL INFORMATION

Do not discharge into any place where its accumulation could be dangerous. Used containers are acceptable for disposal in the normal waste stream as long as the cylinder is empty and valve removed or cylinder wall is punctured; but GASCO encourages the consumer to return cylinders.

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14. TRANSPORT INFORMATION

	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Compressed Gas N.O.S. (Hydrogen Sulfide, Nitrogen)	Compressed Gas N.O.S. (Hydrogen Sulfide, Nitrogen)
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN1956	UN1956
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. REGULATORY INFORMATION

The components of this product are listed under the accident prevention provisions of section 112(r) of the Clean Air Act (CAA) with a threshold quantity (TQ) of 10,000 pounds each.

16. OTHER INFORMATION

This MSDS has been prepared in accordance with the Chemicals (Hazard Information and Packaging for Supply (Amendment) Regulation 1996. The information is based on the best knowledge of GASCO, and its advisors and is given in good faith, but we cannot guarantee its accuracy, reliability or completeness and therefore disclaim any liability for loss or damage arising out of use of this data. Since conditions of use are outside the control of the Company and its advisors we disclaim any liability for loss or damage when the product is used for other purposes than it is intended.

MSDS/S010/401/January, 2006

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	No

HEALTH EFFECTS:

Exposure Limits	Irritant	Sensitization	Reproductive Hazard	Mutagen
Yes	Yes	No	Yes	No

Carcinogenicity: --NTP: No IARC: No OSHA: No

EYE EFFECTS:
Hydrogen sulfide can cause eyes to become scratchy, irritated and even teary. Above 50 ppm of hydrogen sulfide, there is an intense tearing blurring of vision, and pain when looking at light.

SKIN EFFECTS:
Over-exposure to carbon monoxide can be indicated by the lips and fingernails turning bright red. High concentrations of hydrogen sulfide may also be irritating to the skin.

INGESTION EFFECTS:
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SKIN:
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INGESTION:
Not required

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASED OF OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED THE SELF-CONTAINED BREATHING APPARATUS. Victims should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. If breathing has stopped administer artificial resuscitation and supplemental oxygen. Further treatment should be symptomatic and supportive.

GASCO

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CHEMICAL NAME: Methane, Carbon Monoxide, Hydrogen Sulfide, Oxygen in Nitrogen
COMMON NAMES/ SYNONYMS: None
TDG (Canada) CLASSIFICATION: 2.2
WHIMIS CLASSIFICATION: A

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INGREDIENT	%VOLUME	PEL-OSHA	TLV-ACGIH	LD_{50} or LC_{50} Route/Species
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5. FIRE-FIGHTING MEASURES

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6. ACCIDENTAL RELEASE MEASURES

In terms of weight, these containers hold very little contents, such that any accidental release by puncturing etc. will be of no practical concern.

7. HANDLING AND STORAGE

Suck back of water into the container must be prevented. Do not allow backfeed into the container. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Use only in well-ventilated areas. Do not heat cylinder by any means to increase rate of product from the cylinder. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C).

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Use adequate ventilation for extended use of gas.

9. PHYSICAL AND CHEMICAL PROPERTIES

PARAMETER:	VALUE:
Physical state	: Gas
Evaporation point	: N/A
pH	: N/A
Odor and appearance	: Colorless gas with a rotten-egg odor

10. STABILITY AND REACTIVITY

Stable under normal conditions. Expected shelf life 12 months.

11. TOXICOLOGICAL INFORMATION

This gas mixture contains components that may cause embryotoxic effects in humans; however, due to the small size of the cylinder no toxicological damage is anticipated.

12. ECOLOGICAL INFORMATION

No ecological damage caused by this product.

13. DISPOSAL INFORMATION

Do not discharge into any place where its accumulation could be dangerous. Used containers are acceptable for disposal in the normal waste stream as long as the cylinder is empty and valve removed or cylinder wall is punctured; but GASCO encourages the consumer to return cylinders.

GASCO

MATERIAL SAFETY DATA SHEET - CALIBRATION CHECK GAS

PRODUCT NAME: METHANE (0- 2.5%), CARBON MONOXIDE (0.0005- 1.0%), HYDROGEN SULFIDE (0.001- 0.025%, OXYGEN (0.0015- 23.5%), BALANCE NITROGEN

14. TRANSPORT INFORMATION

	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Compressed Gas N.O.S. (Hydrogen Sulfide, Nitrogen)	Compressed Gas N.O.S. (Hydrogen Sulfide, Nitrogen)
HAZARD CLASS:	2.2	2.2
IDENTIFICATION NUMBER:	UN1956	UN1956
SHIPPING LABEL:	NONFLAMMABLE GAS	NONFLAMMABLE GAS

15. REGULATORY INFORMATION

The components of this product are listed under the accident prevention provisions of section 112(r) of the Clean Air Act (CAA) with a threshold quantity (TQ) of 10,000 pounds each.

16. OTHER INFORMATION

This MSDS has been prepared in accordance with the Chemicals (Hazard Information and Packaging for Supply (Amendment) Regulation 1996. The information is based on the best knowledge of GASCO, and its advisors and is given in good faith, but we cannot guarantee its accuracy, reliability or completeness and therefore disclaim any liability for loss or damage arising out of use of this data. Since conditions of use are outside the control of the Company and its advisors we disclaim any liability for loss or damage when the product is used for other purposes than it is intended.

MSDS/S010/401/January, 2006

STL
PRESERVATIVES

SEVERN TRENT STL

STL Buffalo

Pre-preserved Bottle Inventory

Bottle Type	Size	Preservative	Preservative Volume (ml)	Typical Usage
poly	16 oz.	~~1:1~~ Nitric Acid 20%	3	Metals
poly	8 oz.	~~1:1~~ Nitric Acid 20%	1.5	Hardness or Metals (reduced list)
poly	8 oz.	1:1 Sodium Hydroxide	2	Cyanide
poly	8 oz.	1:1 NaOH/Zinc Acetate	2	Sulfide
poly	32 oz.	~~1:1~~ Nitric Acid 20%	4	Radiochemistry
poly	16 oz.	1:1 Sulfuric Acid	2	TKN, Ammonia, Phosphorous, etc.
poly	8 oz.	1:1 Sulfuric Acid	1	same as above (limited parameters)
amber glass - septa	8 oz.	1:1 Sulfuric Acid	1	TOX
amber glass -narrow	32 oz.	1:1 Sulfuric Acid	4	8015 DRO
clear glass - wide	32 oz.	1:1 Sulfuric Acid	4	Oil & Grease
amber glass	8 oz.	1:1 Sulfuric Acid	1	Phenol

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS | J.T.Baker

24 Hour Emergency Telephone
CHEMTREC:

National Response in Canada
CANUTEC:

Outside U.S. and Canada
Chemtrec:

NOTE: EMERGENCY CHEMTREC and National Emergency Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800 582 2537) for assistance.

NITRIC ACID, 50-70%

MSDS Number: N3660 — *Effective Date: 07/13/00*

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%
CAS No.: 7697-37-2
Molecular Weight: 63.01
Chemical Formula: HNO3
Product Codes:
J.T. Baker: 411D, 412D, 5371, 5555, 5801, 5826, 5876, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9616, 9617
Mallinckrodt: 1409, 2703, 2704, 412D, 6623, H988, H993, H998, V069, V077, V336, V561, V633, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Yellow (Reactive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Water spray may be used to keep fire exposed containers cool. Do not get water inside container.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB(R) or TEAM(R) 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:

MSDS Number: H3880 * * * * * Effective Date: 05/07/03 * * * * * Supercedes: 05/10/01

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS

J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC®: 1-800-424-9300
National Response in Canada
CANUTEC: 613-996-6666
Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

HYDROCHLORIC ACID, 33 - 40%

1. Product Identification

Synonyms: Muriatic acid; hydrogen chloride, aqueous
CAS No.: 7647-01-0
Molecular Weight: 36.46
Chemical Formula: HCl
Product Codes:
J.T. Baker: 5367, 5537, 5575, 5800, 5814, 5839, 5894, 5994, 6900, 7831, 9529, 9530, 9534, 9535, 9536, 9537, 9538, 9539, 9540, 9544, 9548
Mallinckrodt: 2062, 2612, 2624, 2626, 5587, H611, H613, H987, H992, H999, V078, V628

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hydrogen Chloride	7647-01-0	33 - 40%	Yes
Water	7732-18-5	60 - 67%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 3 - Severe (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.
Ingestion:
Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea. Swallowing may be fatal.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never

give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Extreme heat or contact with metals can release flammable hydrogen gas.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
If involved in a fire, use water spray. Neutralize with soda ash or slaked lime.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and

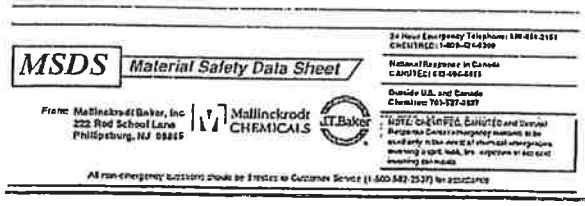
incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Hydrochloric acid:
- OSHA Permissible Exposure Limit (PEL):
5 ppm (Ceiling)
- ACGIH Threshold Limit Value (TLV):
2 ppm (Ceiling), A4 Not classifiable as a human carcinogen
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a full facepiece respirator with an acid gas cartridge may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless, fuming liquid.
Odor:
Pungent odor of hydrogen chloride.
Solubility:
Infinite in water with slight evolution of heat.
Density:
1.18



SODIUM HYDROXIDE SOLUTIONS (MORE THAN 10% NaOH)

MSDS Number: S4037 — *Effective Date: 08/20/98*

1. Product Identification

Synonyms: Caustic soda solution; lye solution; sodium hydroxide liquid; sodium hydrate solution,Sodium Hydroxide Concentrate Solution StandARd(R), Sodium Hydroxide, DILUT-IT(R) Analytical Concentrates, sodium hydroxide volumetric solutions
CAS No.: 1310-73-2
Molecular Weight: 40.00
Chemical Formula: NaOH in water
Product Codes:
J.T. Baker: 0337, 3719, 3725, 3727, 3729, 4689, 4690, 5000, 5661, 5666, 5668, 5669, 5671, 5672, 5674, 5676
Mallinckrodt: 6290, 7701, 7703, 7705, 7706, 7775, H369, H382, H385, V038, V039, V264

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Hydroxide	1310-73-2	10 - 60%	Yes
Water	7732-18-5	40 - 90%	No

3. Hazards Identification

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician, immediately. Wash clothing before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Perform endoscopy in all cases of suspected sodium hydroxide ingestion. In cases of severe esophageal corrosion, the use of therapeutic doses of steroids should be considered. General supportive measures with continual monitoring of gas exchange, acid-base balance, electrolytes, and fluid intake are also required.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Hot or molten material can react violently with water. Can react with certain metals, such as aluminum, to generate flammable hydrogen gas.
Explosion:
May cause fire and explosions when in contact with incompatible materials.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Adding water to caustic solution generates large amounts of heat.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Contain and recover liquid when possible. Do not flush caustic residues to the sewer. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulfuric. Absorb neutralized caustic residue on clay, vermiculite or other inert substance and package in a suitable container for disposal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRACIT(R)-2 or BuCAM(R) caustic neutralizers are recommended for spills of this product.

Emergency Overview

POISON! DANGER! CORROSIVE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES BURNS TO ANY AREA OF CONTACT. REACTS WITH WATER, ACIDS AND OTHER MATERIALS.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

Inhalation:
Severe irritant. Effects from inhalation of mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may occur.
Ingestion:
Corrosive! Swallowing may cause severe burns of mouth, throat, and stomach. Severe scarring of tissue and death may result. Symptoms may include bleeding, vomiting, diarrhea, fall in blood pressure. Damage may appears days after exposure.
Skin Contact:
Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.
Eye Contact:
Corrosive! Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Chronic Exposure:
Prolonged contact with dilute solutions or dust has a destructive effect upon tissue.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:

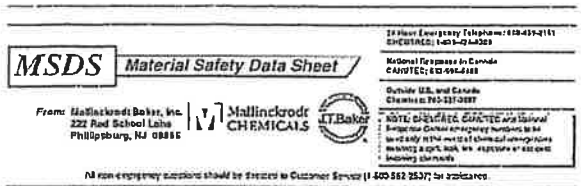
7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Store above 16C (60F) to prevent freezing. Always add the caustic to water while stirring; never the reverse. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Do not store with aluminum or magnesium. Do not mix with acids or organic materials.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
2 mg/m3 Ceiling
- ACGIH Threshold Limit Value (TLV):
2 mg/m3 Ceiling
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator.
WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties



ZINC ACETATE

MSDS Number: Z1140 — *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Acetic acid, zinc salt, dihydrate; zinc diacetate; zinc acetate dihydrate
CAS No.: 557-34-6 (Anhydrous)
Molecular Weight: 219.50
Chemical Formula: (CH3COO)2Zn 2H2O
Product Codes:
J.T. Baker: 4296, 4297, 4304, 5658
Mallinckrodt: 8740

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Zinc Acetate	557-34-6	98 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.

Health Rating: 1 - Slight
Flammability Rating: 1 - Slight
Reactivity Rating: 0 - None
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath.
Ingestion:
Irritation of the mucous membranes due to hydrolysis and formation of acid in the stomach can occur. Large amounts can produce stomach cramps, stricture of the esophagus, nausea, and vomiting.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

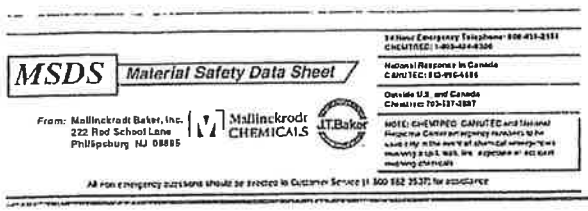
9. Physical and Chemical Properties

Appearance:
White crystals or powder.
Odor:
Slight acetic acid (vinegar) odor.
Solubility:
43g in 100g water.
Density:
1.74
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
Decomposes.
Melting Point:
237C (459F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Loses water of hydration above 100C.

Hazardous Decomposition Products:
Freshly-formed zinc oxide or zinc oxide fumes at high temperatures (over 800C).
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No incompatibility data found. Oxidizing agents, zinc salts in general, alkalis and their carbonates, oxalates, phosphates, sulfides.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.



SULFURIC ACID, 52 - 100 %

MSDS Number: S8234 — *Effective Date: 09/14/00*

1. Product Identification

Synonyms: Oil of vitriol; Babcock acid; sulphuric acid
CAS No.: 7664-93-9
Molecular Weight: 98.08
Chemical Formula: H2SO4 in H2O
Product Codes:
J.T. Baker: 5030, 5137, 5374, 5802, 5815, 5889, 5960, 5961, 5971, 6902, 9673, 9674, 9675, 9676, 9679, 9680, 9681, 9682, 9684, 9687, 9691, 9693, 9694
Mallinckrodt: 2468, 2876, 2878, 2900, 2904, 3780, 4222, 5524, 5557, H644, H976, H996, V344, V651

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfuric Acid	7664-93-9	52 - 100%	Yes
Water	7732-18-5	0 - 48%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR

give oxygen. Call a physician immediately.
Ingestion:
DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Excess acid on skin can be neutralized with a 2% solution of bicarbonate of soda. Call a physician immediately.
Eye Contact:
Immediately flush eyes with gentle but large stream of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Call a physician immediately.

5. Fire Fighting Measures

Fire:
Concentrated material is a strong dehydrating agent. Reacts with organic materials and may cause ignition of finely divided materials on contact.
Explosion:
Contact with most metals causes formation of flammable and explosive hydrogen gas.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Do not use water on material. However, water spray may be used to keep fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving this material. Stay away from sealed containers.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB(R) or TEAM(R) 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Water Reactive)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. May cause lung edema, a medical emergency.
Ingestion:
Corrosive. Swallowing can cause severe burns of the mouth, throat, and stomach, leading to death. Can cause sore throat, vomiting, diarrhea. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death.
Skin Contact:
Corrosive. Symptoms of redness, pain, and severe burn can occur. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow skin contact or ingestion. Circulatory shock is often the immediate cause of death.

Eye Contact:
Corrosive. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Chronic Exposure:
Long-term exposure to mist or vapors may cause damage to teeth. Chronic exposure to mists containing sulfuric acid is a cancer hazard.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult,

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, always add the acid to water; never add water to the acid. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Sulfuric Acid:
- OSHA Permissible Exposure Limit (PEL) -
1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -
1 mg/m3(TWA), 3 mg/m3 (STEL), A2 - suspected human carcinogen for sulfuric acid contained in strong inorganic acid mists.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece respirator with an acid gas cartridge and particulate filter (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P particulate filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

SULFURIC ACID

MSDS Number: **S8234** * * * * * *Effective Date:* ***11/04/04*** * * * * * *Supercedes:* ***02/18/02***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SULFURIC ACID, 52 - 100 %

1. Product Identification

Synonyms: Oil of vitriol; Babcock acid; sulphuric acid
CAS No.: 7664-93-9
Molecular Weight: 98.08
Chemical Formula: H2SO4 in H2O
Product Codes:
J.T. Baker: 5030, 5137, 5374, 5802, 5815, 5858, 5859, 5868, 5889, 5897, 5961, 5971, 5997, 6902, 9671, 9673, 9674, 9675, 9676, 9679, 9680, 9681, 9682, 9684, 9687, 9691, 9693, 9694
Mallinckrodt: 21201, 2468, 2876, 2878, 2900, 2904, 3780, 4222, 5524, 5557, H644, H850, H976, H996, V651, XL003

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfuric Acid	7664-93-9	52 - 100%	Yes
Water	7732-18-5	0 - 48%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. May cause lung edema, a medical emergency.
Ingestion:
Corrosive. Swallowing can cause severe burns of the mouth, throat, and stomach, leading to death. Can cause sore throat, vomiting, diarrhea. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death.
Skin Contact:
Corrosive. Symptoms of redness, pain, and severe burn can occur. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow skin contact or ingestion. Circulatory shock is often the immediate cause of death.
Eye Contact:
Corrosive. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Chronic Exposure:
Long-term exposure to mist or vapors may cause damage to teeth. Chronic exposure to mists containing sulfuric acid is a cancer hazard.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.
Ingestion:
DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Excess acid on skin can be neutralized with a 2% solution of bicarbonate of soda. Call a physician immediately.
Eye Contact:
Immediately flush eyes with gentle but large stream of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Call a physician immediately.

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5. Fire Fighting Measures

Fire:
Concentrated material is a strong dehydrating agent. Reacts with organic materials and may cause ignition of finely divided materials on contact.
Explosion:
Contact with most metals causes formation of flammable and explosive hydrogen gas.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Do not use water on material. However, water spray may be used to keep fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving this material. Stay away from sealed containers.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

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7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, always add the acid to water; never add water to the acid. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Sulfuric Acid:
- OSHA Permissible Exposure Limit (PEL) -
1 mg/m3 (TWA)
- ACGIH Threshold Limit Value (TLV) -
1 mg/m3(TWA), 3 mg/m3 (STEL), A2 - suspected human carcinogen for sulfuric acid contained in strong inorganic acid mists.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a full facepiece respirator with an acid gas cartridge and particulate filter (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P particulate filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres. Where respirators are required, you must have a written program covering the basic requirements in the OSHA respirator standard. These include training, fit testing, medical approval, cleaning, maintenance, cartridge change schedules, etc. See 29CFR1910.134 for details.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear oily liquid.
Odor:
Odorless.
Solubility:
Miscible with water, liberates much heat.
Specific Gravity:
1.84 (98%), 1.40 (50%), 1.07 (10%)
pH:
1 N solution (ca. 5% w/w) = 0.3; 0.1 N solution (ca. 0.5% w/w) = 1.2; 0.01 N solution (ca. 0.05% w/w) = 2.1.
% Volatiles by volume @ 21C (70F):
No information found.
Boiling Point:
ca. 290C (ca. 554F) (decomposes at 340C)
Melting Point:
3C (100%), -32C (93%), -38C (78%), -64C (65%).
Vapor Density (Air=1):
3.4
Vapor Pressure (mm Hg):
1 @ 145.8C (295F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Concentrated solutions react violently with water, spattering and liberating heat.
Hazardous Decomposition Products:
Toxic fumes of oxides of sulfur when heated to decomposition. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas, and with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Water, potassium chlorate, potassium perchlorate, potassium permanganate, sodium, lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals (yields hydrogen gas), strong oxidizing and reducing agents and many other reactive substances.
Conditions to Avoid:
Heat, moisture, incompatibles.

11. Toxicological Information

Toxicological Data:
Oral rat LD50: 2140 mg/kg; inhalation rat LC50: 510 mg/m3/2H; standard Draize, eye rabbit, 250 ug (severe); investigated as a tumorigen, mutagen, reproductive effector.
Carcinogenicity:
Cancer Status: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mists containing sulfuric acid" as a known human carcinogen, (IARC category 1). This classification applies only to mists containing sulfuric acid and not to sulfuric acid or sulfuric acid solutions.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Sulfuric Acid (7664-93-9)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
When released into the soil, this material may leach into groundwater. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition. When released into the air, this material may be removed from the atmosphere to a moderate extent by dry deposition.
Environmental Toxicity:
LC50 Flounder 100 to 330 mg/l/48 hr aerated water/Conditions of bioassay not specified; LC50 Shrimp 80 to 90 mg/l/48 hr aerated water /Conditions of bioassay not specified; LC50 Prawn 42.5 ppm/48 hr salt water /Conditions of bioassay not specified.
This material may be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

International (Water, I.M.O.)

Proper Shipping Name: SULFURIC ACID (WITH MORE THAN 51% ACID)
Hazard Class: 8
UN/NA: UN1830
Packing Group: II
Information reported for product/size: 440LB

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Sulfuric Acid (7664-93-9)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Sulfuric Acid (7664-93-9)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Sulfuric Acid (7664-93-9)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sulfuric Acid (7664-93-9)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: Yes
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: Yes (Pure / Liquid)

Australian Hazchem Code: 2P

Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **2** Other: **Water reactive**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR CONTACTED WITH SKIN. HARMFUL IF INHALED. AFFECTS TEETH. WATER REACTIVE. CANCER HAZARD. STRONG INORGANIC ACID MISTS CONTAINING SULFURIC ACID CAN CAUSE CANCER. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Do not contact with water.
Label First Aid:
In all cases call a physician immediately. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before re-use. Excess acid on skin can be neutralized with a 2% bicarbonate of soda solution. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING

FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

NITRIC ACID

MSDS Number: **N3660** * * * * * *Effective Date:* ***07/02/02*** * * * * * *Supercedes:* ***07/13/00***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

NITRIC ACID, 50-70%

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%
CAS No.: 7697-37-2
Molecular Weight: 63.01
Chemical Formula: HNO3
Product Codes:
J.T. Baker: 411D, 412D, 5371, 5796, 5801, 5826, 5856, 5876, 5896, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9608, 9610, 9616, 9617, 9670
Mallinckrodt: 1409, 2704, 2716, 6623, H862, H993, H998, V077, V633, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

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4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give

oxygen. Call a physician.

Ingestion:

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:

Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.

Explosion:

Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.

Fire Extinguishing Media:

Water spray may be used to keep fire exposed containers cool. Do not get water inside container.

Special Information:

Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® or TEAM® 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:
Suffocating, acrid.

Solubility:
Infinitely soluble.
Specific Gravity:
1.41
pH:
1.0 (0.1M solution)
% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
122C (252F)
Melting Point:
-42C (-44F)
Vapor Density (Air=1):
2-3
Vapor Pressure (mm Hg):
48 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Light and heat.

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11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Nitric Acid (7697-37-2)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 150LB

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 150LB

International (Air, I.C.A.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8
UN/NA: UN2031

Packing Group: II
Information reported for product/size: 150LB

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Nitric Acid (7697-37-2)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Nitric Acid (7697-37-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Nitric Acid (7697-37-2)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL

MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

Label Precautions:

Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

SODIUM HYDROXIDE

MSDS Number: **S4034** * * * * * *Effective Date:* ***07/07/04*** * * * * * *Supercedes:* ***05/11/04***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SODIUM HYDROXIDE

1. Product Identification

Synonyms: Caustic soda; lye; sodium hydroxide solid; sodium hydrate
CAS No.: 1310-73-2
Molecular Weight: 40.00
Chemical Formula: NaOH
Product Codes:
J.T. Baker: 3717, 3718, 3721, 3722, 3723, 3728, 3734, 3736, 5045, 5565
Mallinckrodt: 7001, 7680, 7708, 7712, 7772, 7798

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Hydroxide	1310-73-2	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES BURNS TO ANY AREA OF CONTACT. REACTS WITH WATER, ACIDS AND OTHER MATERIALS.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

Inhalation:
Severe irritant. Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat or runny nose. Severe pneumonitis may occur.
Ingestion:
Corrosive! Swallowing may cause severe burns of mouth, throat, and stomach. Severe scarring of tissue and death may result. Symptoms may include bleeding, vomiting, diarrhea, fall in blood pressure. Damage may appears days after exposure.
Skin Contact:
Corrosive! Contact with skin can cause irritation or severe burns and scarring with greater exposures.
Eye Contact:
Corrosive! Causes irritation of eyes, and with greater exposures it can cause burns that may result in permanent impairment of vision, even blindness.
Chronic Exposure:
Prolonged contact with dilute solutions or dust has a destructive effect upon tissue.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing

contaminated clothing and shoes. Call a physician, immediately. Wash clothing before reuse.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Perform endoscopy in all cases of suspected sodium hydroxide ingestion. In cases of severe esophageal corrosion, the use of therapeutic doses of steroids should be considered. General supportive measures with continual monitoring of gas exchange, acid-base balance, electrolytes, and fluid intake are also required.

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5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Hot or molten material can react violently with water. Can react with certain metals, such as aluminum, to generate flammable hydrogen gas.

Explosion:
Not considered to be an explosion hazard.

Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Adding water to caustic solution generates large amounts of heat.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. Do not flush caustic residues to the sewer. Residues from spills can be diluted with water, neutralized with dilute acid such as acetic, hydrochloric or sulfuric. Absorb neutralized caustic residue on clay, vermiculite or other inert substance and package in a suitable container for disposal.
US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry, ventilated area away from sources of heat, moisture and incompatibilities. Always add the caustic to water while stirring; never the reverse. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product. Do not store with aluminum or magnesium. Do not mix with acids or organic materials.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
- OSHA Permissible Exposure Limit (PEL):
2 mg/m3 Ceiling
- ACGIH Threshold Limit Value (TLV):
2 mg/m3 Ceiling

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half facepiece particulate respirator (NIOSH type N95 or better filters) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.. A full-face piece particulate respirator (NIOSH type N100 filters) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
White, deliquescent pellets or flakes.

Odor:
Odorless.

Solubility:

111 g/100 g of water.
Specific Gravity:
2.13
pH:
13 - 14 (0.5% soln.)
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1390C (2534F)
Melting Point:
318C (604F)
Vapor Density (Air=1):
> 1.0
Vapor Pressure (mm Hg):
Negligible.
Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Very hygroscopic. Can slowly pick up moisture from air and react with carbon dioxide from air to form sodium carbonate.
Hazardous Decomposition Products:
Sodium oxide. Decomposition by reaction with certain metals releases flammable and explosive hydrogen gas.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Sodium hydroxide in contact with acids and organic halogen compounds, especially trichloroethylene, may causes violent reactions. Contact with nitromethane and other similar nitro compounds causes formation of shock-sensitive salts. Contact with metals such as aluminum, magnesium, tin, and zinc cause formation of flammable hydrogen gas. Sodium hydroxide, even in fairly dilute solution, reacts readily with various sugars to produce carbon monoxide. Precautions should be taken including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.
Conditions to Avoid:
Moisture, dusting and incompatibles.

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11. Toxicological Information

Irritation data: skin, rabbit: 500 mg/24H severe; eye rabbit: 50 ug/24H severe; investigated as a mutagen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Sodium Hydroxide (1310-73-2)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SODIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1823
Packing Group: II
Information reported for product/size: 300LB

International (Water, I.M.O.)

Proper Shipping Name: SODIUM HYDROXIDE, SOLID
Hazard Class: 8
UN/NA: UN1823
Packing Group: II
Information reported for product/size: 300LB

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Sodium Hydroxide (1310-73-2)	Yes	Yes	Yes	Yes

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Sodium Hydroxide (1310-73-2)	Yes	Yes	No	Yes

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Sodium Hydroxide (1310-73-2)	No	No	No	No

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sodium Hydroxide (1310-73-2)	1000	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: Yes (Pure / Solid)

Australian Hazchem Code: 2R
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **1**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES BURNS TO ANY AREA OF CONTACT. REACTS WITH WATER, ACIDS AND OTHER MATERIALS.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and

shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:
Laboratory Reagent.

Revision Information:
MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

SAFETY DATA SHEET

1. Identification

Product identifier **DIESEL FUELS**

Other means of identification

SDS number 102-GHS

Synonyms Diesel Fuels All Grades, Diesel Fuel No.2, Fuel Oil No.2, High Sulfur Diesel Fuel, Low Sulfur Diesel Fuel, Ultra Low Sulfur Diesel Fuel, CARB (California Air Resource Board) Diesel Fuel, Off-Road Diesel Fuel, Dyed Diesel Fuel, X Grade Diesel Fuel, X-1 Diesel Fuel, R5 ULSD, B5 ULS D See section 16 for complete information.

Recommended use Motor Fuel
Refinery feedstock.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer/Supplier Valero Marketing & Supply Company and Affiliates
One Valero Way
San Antonio, TX 78269-6000

General Assistance 210-345-4593

E-Mail CorpHSE@valero.com

Contact Person Industrial Hygienist

Emergency Telephone 24 Hour Emergency 866-565-5220
1-800-424-9300 (CHEMTREC USA)

2. Hazard(s) identification

Physical hazards	Flammable liquids	Category 3
Health hazards	Acute toxicity, inhalation	Category 4
	Skin corrosion/irritation	Category 2
	Carcinogenicity	Category 2
	Reproductive toxicity	Category 2
	Specific target organ toxicity, repeated exposure	Category 2
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, long-term hazard	Category 2

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement Flammable liquid and vapor. Harmful if inhaled. Causes skin irritation. Suspected of causing cancer. Suspected of damaging fertility or the unborn child. May cause damage to organs (blood, thymus, liver) through prolonged or repeated exposure. May be fatal if swallowed and enters airways.

Precautionary statement

Prevention Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting equipment. Use only non-sparking tools. Take precautionary measures against static discharges. Do not breathe mist/vapors/spray. Wash thoroughly after handling. Wear protective gloves/protective clothing/eye protection/face protection. Use only outdoors or in a well-ventilated area.

Response	If skin irritation occurs: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If exposed or concerned: Get medical advice/attention. If swallowed: Immediately call a poison center/doctor. Take off contaminated clothing and wash before reuse. In case of fire: Use foam, carbon dioxide, dry powder or water fog for extinction.
Storage	Store locked up. Store in a well-ventilated place. Keep cool.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Fuels, diesel, no. 2	68476-34-6	85 - 100
Biodiesel - Fatty acid methyl esters	67762-38-3	0 - 10
Fuels, diesel, C9-18-alkane branched and linear	1159170-26-9	0 - 5
n-Nonane	111-84-2	1 - 3
Octane (All isomers)	111-65-9	1 - 2
Hexane (Other isomers)	96-14-0	0 - 1
Naphthalene	91-20-3	0 - 1
n-Heptane	142-82-5	0 - 1
n-Hexane	110-54-3	0 - 1

4. First-aid measures

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
Skin contact	Remove contaminated clothing and shoes. Wash off immediately with soap and plenty of water. Get medical attention if irritation develops or persists. Wash clothing separately before reuse. Destroy or thoroughly clean contaminated shoes. If high pressure injection under the skin occurs, always seek medical attention.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention.
Ingestion	Rinse mouth thoroughly. Do not induce vomiting without advice from poison control center. Do not give mouth-to-mouth resuscitation. If vomiting occurs, keep head low so that stomach content does not get into the lungs. Never give anything by mouth to a victim who is unconscious or is having convulsions. Get medical attention immediately.
Most important symptoms/effects, acute and delayed	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash. The toxicological properties of this product have not been thoroughly investigated. Use appropriate precautions. Hydrogen sulfide, a highly toxic gas, may be present. Signs and symptoms of overexposure to hydrogen sulfide include respiratory and eye irritation, dizziness, nausea, coughing, a sensation of dryness and pain in the nose, and loss of consciousness. Odor does not provide a reliable indicator of the presence of hazardous levels in the atmosphere.
Indication of immediate medical attention and special treatment needed	In case of shortness of breath, give oxygen. Keep victim warm. Keep victim under observation. Symptoms may be delayed. The toxicological properties of this material have not been fully investigated.
General information	If exposed or concerned: get medical attention/advice. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before re-use.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media	Do not use a solid water stream as it may scatter and spread fire.
Specific hazards arising from the chemical	The product is flammable, and heating may generate vapors which may form explosive vapor/air mixtures. Thermal decomposition or combustion may liberate toxic gases or fumes.
Special protective equipment and precautions for firefighters	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask.
Fire-fighting equipment/instructions	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask. Withdraw immediately in case of rising sound from venting safety devices or any discoloration of tanks due to fire. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Move containers from fire area if you can do it without risk. In the event of fire, cool tanks with water spray. Cool containers exposed to flames with water until well after the fire is out. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Water runoff can cause environmental damage. Use compatible foam to minimize vapor generation as needed.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Local authorities should be advised if significant spills cannot be contained. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. See Section 8 of the SDS for Personal Protective Equipment.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Local authorities should be advised if significant spillages cannot be contained. Stop leak if you can do so without risk. This material is a water pollutant and should be prevented from contaminating soil or from entering sewage and drainage systems and bodies of water. Dike the spilled material, where this is possible. Prevent entry into waterways, sewers, basements or confined areas. Use non-sparking tools and explosion-proof equipment. Small Spills: Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. This material and its container must be disposed of as hazardous waste. Large Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent product from entering drains. Do not allow material to contaminate ground water system. Should not be released into the environment. Clean up in accordance with all applicable regulations.
Environmental precautions	If facility or operation has an "oil or hazardous substance contingency plan", activate its procedures. Stay upwind and away from spill. Wear appropriate protective equipment including respiratory protection as conditions warrant. Do not enter or stay in area unless monitoring indicates that it is safe to do so. Isolate hazard area and restrict entry to emergency crew. Flammable. Review Firefighting Measures, Section 5, before proceeding with clean up. Keep all sources of ignition (flames, smoking, flares, etc.) and hot surfaces away from release. Contain spill in smallest possible area. Recover as much product as possible (e.g. by vacuuming). Stop leak if it can be done without risk. Use water spray to disperse vapors. Use compatible foam to minimize vapor generation as needed. Spilled material may be absorbed by an appropriate absorbent, and then handled in accordance with environmental regulations. Prevent spilled material from entering sewers, storm drains, other unauthorized treatment or drainage systems and natural waterways. Contact fire authorities and appropriate federal, state and local agencies. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, contact the National Response Center at 1-800-424-8802. For highway or railways spills, contact Chemtrec at 1-800-424-9300.

7. Handling and storage

Precautions for safe handling	Eliminate sources of ignition. Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity. Wear personal protective equipment. Avoid breathing mist/vapors/spray. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. Avoid prolonged exposure. Use only with adequate ventilation. Wash thoroughly after handling. The product is combustible, and heating may generate vapors which may form explosive vapor/air mixtures. DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. When using, do not eat, drink or smoke. Avoid release to the environment.

Conditions for safe storage, including any incompatibilities	Flammable liquid storage. Do not handle or store near an open flame, heat or other sources of ignition. This material can accumulate static charge which may cause spark and become an ignition source. The pressure in sealed containers can increase under the influence of heat. Keep container tightly closed in a cool, well-ventilated place. Keep away from food, drink and animal feedingstuffs. Keep out of the reach of children.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Naphthalene (CAS 91-20-3)	PEL	50 mg/m3
		10 ppm
n-Heptane (CAS 142-82-5)	PEL	2000 mg/m3
		500 ppm
n-Hexane (CAS 110-54-3)	PEL	1800 mg/m3
		500 ppm
Octane (All isomers) (CAS 111-65-9)	PEL	2350 mg/m3
		500 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Fuels, diesel, no. 2 (CAS 68476-34-6)	TWA	100 mg/m3	Inhalable fraction and vapor.
Hexane (Other isomers) (CAS 96-14-0)	STEL	1000 ppm	
	TWA	500 ppm	
Naphthalene (CAS 91-20-3)	STEL	15 ppm	
	TWA	10 ppm	
n-Heptane (CAS 142-82-5)	STEL	500 ppm	
	TWA	400 ppm	
n-Hexane (CAS 110-54-3)	TWA	50 ppm	
n-Nonane (CAS 111-84-2)	TWA	200 ppm	
Octane (All isomers) (CAS 111-65-9)	TWA	300 ppm	

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Hexane (Other isomers) (CAS 96-14-0)	Ceiling	1800 mg/m3
		510 ppm
	TWA	350 mg/m3
		100 ppm
Naphthalene (CAS 91-20-3)	STEL	75 mg/m3
		15 ppm
	TWA	50 mg/m3
		10 ppm
n-Heptane (CAS 142-82-5)	Ceiling	1800 mg/m3
		440 ppm
	TWA	350 mg/m3
		85 ppm
n-Hexane (CAS 110-54-3)	TWA	180 mg/m3
		50 ppm
n-Nonane (CAS 111-84-2)	TWA	1050 mg/m3
		200 ppm
Octane (All isomers) (CAS 111-65-9)	Ceiling	1800 mg/m3
		385 ppm
	TWA	350 mg/m3
		75 ppm

Biological limit values

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
n-Hexane (CAS 110-54-3)	0.4 mg/l	2,5-Hexanedion, without hydrolysis	Urine	*
	0.4 mg/l	2,5-Hexanedi - on, without hydrolysis		*

* - For sampling details, please see the source document.

Exposure guidelines

US - California OELs: Skin designation

n-Hexane (CAS 110-54-3) Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Fuels, diesel, no. 2 (CAS 68476-34-6) Can be absorbed through the skin.
Naphthalene (CAS 91-20-3) Can be absorbed through the skin.
n-Hexane (CAS 110-54-3) Can be absorbed through the skin.

Appropriate engineering controls Provide adequate general and local exhaust ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof equipment.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear safety glasses. If splash potential exists, wear full face shield or chemical goggles.

Skin protection

Hand protection Wear chemical-resistant, impervious gloves. Suitable gloves can be recommended by the glove supplier. Be aware that the liquid may penetrate the gloves. Frequent change is advisable.

Other Full body suit and boots are recommended when handling large volumes or in emergency situations. Flame retardant protective clothing is recommended.

Respiratory protection Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. If workplace exposure limits for product or components are exceeded, NIOSH approved equipment should be worn. Proper respirator selection should be determined by adequately trained personnel, based on the contaminants, the degree of potential exposure and published respiratory protection factors. This equipment should be available for nonroutine and emergency use.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Consult supervisor for special handling instructions. Avoid contact with eyes. Avoid contact with skin. Keep away from food and drink. Wash hands before breaks and immediately after handling the product. Provide eyewash station and safety shower. Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance Liquid (may be dyed red).

Physical state Liquid.

Form Liquid.

Color Clear. Straw.

Odor Kerosene (strong).

Odor threshold Not available.

pH Not available.

Melting point/freezing point -60.07 °F (-51.15 °C) Estimated

Initial boiling point and boiling range 325 - 700 °F (162.78 - 371.11 °C)

Flash point > 100.0 °F (> 37.8 °C) Closed Cup

Evaporation rate 0.02

Flammability (solid, gas) Not available.

Upper/lower flammability or explosive limits

Flammability limit - lower (%)	0.4 %
Flammability limit - upper (%)	8 %
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	< 1 mm Hg (20°C)
Vapor density	3 (Air = 1)
Relative density	0.82 - 0.87
Relative density temperature	60 °F (15.56 °C)
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	494.96 °F (257.2 °C)
Decomposition temperature	Not available.
Viscosity	2 - 4.5 mm²/s

10. Stability and reactivity

Reactivity	Stable at normal conditions.
Chemical stability	Stable under normal temperature conditions and recommended use.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Heat, flames and sparks. Ignition sources. Contact with incompatible materials. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Ingestion	May be fatal if swallowed and enters airways.
Inhalation	Harmful if inhaled. In high concentrations, vapors and spray mists are narcotic and may cause headache, fatigue, dizziness and nausea.
Skin contact	Causes skin irritation.
Eye contact	May cause eye irritation.
Symptoms related to the physical, chemical and toxicological characteristics	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash. The toxicological properties of this product have not been thoroughly investigated. Use appropriate precautions.

Information on toxicological effects

Acute toxicity	Harmful if inhaled. Harmful: may cause lung damage if swallowed. The toxicological properties of this material have not been fully investigated.

Components	**Species**	**Test Results**
Fuels, diesel, no. 2 (CAS 68476-34-6)		
Acute		
Inhalation		
LC50	Rat	4.1 mg/l, 4 hours

Components	Species	Test Results
Naphthalene (CAS 91-20-3)		
Acute		
Dermal		
LD50	Rabbit	> 2 g/kg
Oral		
LD50	Rat	490 mg/kg
n-Heptane (CAS 142-82-5)		
Acute		
Inhalation		
LC50	Rat	103 mg/l, 4 Hours
n-Hexane (CAS 110-54-3)		
Acute		
Oral		
LD50	Rat	28710 mg/kg
n-Nonane (CAS 111-84-2)		
Acute		
Inhalation		
LC50	Rat	3200 mg/l, 4 Hours
Octane (All isomers) (CAS 111-65-9)		
Acute		
Inhalation		
LC50	Rat	118 mg/l, 4 Hours

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Based on available data, the classification criteria are not met.

Respiratory or skin sensitization

Respiratory sensitization Based on available data, the classification criteria are not met.

Skin sensitization Based on available data, the classification criteria are not met.

Germ cell mutagenicity Based on available data, the classification criteria are not met.

Carcinogenicity Suspected of causing cancer.
International Agency for Research on Cancer (IARC): Whole diesel engine exhaust – IARC Group 1. Exposure may cause lung cancer and also noted a positive association with an increased risk of bladder cancer.
Diesel exhaust has been reported to be an occupational hazard due to NIOSH-reported potential carcinogenic properties.

IARC Monographs. Overall Evaluation of Carcinogenicity

Fuels, diesel, no. 2 (CAS 68476-34-6)	3 Not classifiable as to carcinogenicity to humans.
Naphthalene (CAS 91-20-3)	2B Possibly carcinogenic to humans.

NTP Report on Carcinogens

Naphthalene (CAS 91-20-3)	Reasonably Anticipated to be a Human Carcinogen.

Reproductive toxicity Suspected of damaging fertility or the unborn child.
Napthalene interferes with embryo development in experimental animals at dose levels that cause maternal toxicity. In humans, excessive exposure to this agent may cause hemolytic anemia in the mother and fetus.

Specific target organ toxicity - single exposure Based on available data, the classification criteria are not met.

Specific target organ toxicity - repeated exposure May cause damage to the following organs through prolonged or repeated exposure: Blood. Liver. Thymus.

Aspiration hazard May be fatal if swallowed and enters airways.

Chronic effects Contains organic solvents which in case of overexposure may depress the central nervous system causing dizziness and intoxication. Repeated exposure to naphthalene may cause cataracts, allergic skin rashes, destruction of red blood cells, and anemia, jaundice, kidney and liver damage. Danger of serious damage to health by prolonged exposure. Prolonged or repeated overexposure may cause central nervous system, kidney, liver, and lung damage.

Further information Symptoms may be delayed. Hydrogen sulfide, a highly toxic gas, may be present. Signs and symptoms of overexposure to hydrogen sulfide include respiratory and eye irritation, dizziness, nausea, coughing, a sensation of dryness and pain in the nose, and loss of consciousness. Odor does not provide a reliable indicator of the presence of hazardous levels in the atmosphere. Toxicological properties of this material have not been fully investigated.

12. Ecological information

Ecotoxicity Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Components		Species	Test Results
Fuels, diesel, no. 2 (CAS 68476-34-6)			
Aquatic			
Acute			
Crustacea	EL50	Daphnia magna	68 mg/l, 48 hours
Fish	LL50	Oncorhynchus mykiss	65 mg/l, 96 hours
Naphthalene (CAS 91-20-3)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	1.09 - 3.4 mg/l, 48 hours
Fish	LC50	Pink salmon (Oncorhynchus gorbuscha)	0.95 - 1.62 mg/l, 96 hours
n-Heptane (CAS 142-82-5)			
Aquatic			
Fish	LC50	Western mosquitofish (Gambusia affinis)	4924 mg/l, 96 hours
n-Hexane (CAS 110-54-3)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	2.101 - 2.981 mg/l, 96 hours

Persistence and degradability Not available.

Bioaccumulative potential Not available.

Partition coefficient n-octanol / water (log Kow)

Hexane (Other isomers) (CAS 96-14-0)	3.6
Octane (All isomers) (CAS 111-65-9)	5.18
n-Heptane (CAS 142-82-5)	4.66
n-Hexane (CAS 110-54-3)	3.9
n-Nonane (CAS 111-84-2)	5.46

Mobility in soil Not available.

Other adverse effects Not available.

13. Disposal considerations

Disposal instructions Dispose in accordance with all applicable regulations. This material and its container must be disposed of as hazardous waste. Dispose of this material and its container to hazardous or special waste collection point. Incinerate the material under controlled conditions in an approved incinerator. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container.

Hazardous waste code D001: Waste Flammable material with a flash point <140 °F

US RCRA Hazardous Waste U List: Reference

Naphthalene (CAS 91-20-3)	U165

Waste from residues / unused products Dispose of in accordance with local regulations.

Contaminated packaging Offer rinsed packaging material to local recycling facilities.

14. Transport information

DOT

UN number UN1202

UN proper shipping name Diesel fuel

Transport hazard class(es)

Class Combustible Liquid

Subsidiary risk -

Packing group III

Environmental hazards

Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	144, B1, IB3, T2, TP1
Packaging exceptions	150
Packaging non bulk	203
Packaging bulk	242

IATA

UN number	UN1202
UN proper shipping name	Diesel fuel
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	III
Environmental hazards	Yes
ERG Code	3L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1202
UN proper shipping name	DIESEL FUEL
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	III
Environmental hazards	
Marine pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. Regulatory information

US federal regulations

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

n-Nonane (CAS 111-84-2)	1.0 % One-Time Export Notification only.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Hexane (Other isomers) (CAS 96-14-0)	LISTED
Naphthalene (CAS 91-20-3)	LISTED
n-Heptane (CAS 142-82-5)	LISTED
n-Hexane (CAS 110-54-3)	LISTED
n-Nonane (CAS 111-84-2)	LISTED
Octane (All isomers) (CAS 111-65-9)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - No Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Naphthalene	91-20-3	0 - 1

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Naphthalene (CAS 91-20-3)
n-Hexane (CAS 110-54-3)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

US. Massachusetts RTK - Substance List

Hexane (Other isomers) (CAS 96-14-0)
Naphthalene (CAS 91-20-3)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
n-Nonane (CAS 111-84-2)
Octane (All isomers) (CAS 111-65-9)

US. New Jersey Worker and Community Right-to-Know Act

Fuels, diesel, no. 2 (CAS 68476-34-6)
Naphthalene (CAS 91-20-3)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
n-Nonane (CAS 111-84-2)
Octane (All isomers) (CAS 111-65-9)

US. Pennsylvania Worker and Community Right-to-Know Law

Fuels, diesel, no. 2 (CAS 68476-34-6)
Hexane (Other isomers) (CAS 96-14-0)
Naphthalene (CAS 91-20-3)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
n-Nonane (CAS 111-84-2)
Octane (All isomers) (CAS 111-65-9)

US. Rhode Island RTK

Naphthalene (CAS 91-20-3)
n-Hexane (CAS 110-54-3)

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Benzene (CAS 71-43-2)
Toluene (CAS 108-88-3)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	No
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No

Country(s) or region	Inventory name	On inventory (yes/no)*
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

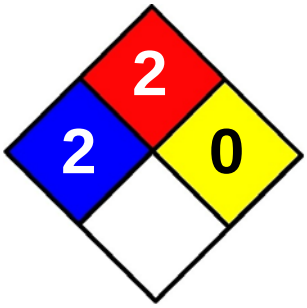
Issue date 13-May-2013

Revision date 23-May-2014

Version # 04

Further information HMIS® is a registered trade and service mark of the NPCA.

NFPA Ratings



Disclaimer This material Safety Data Sheet (SDS) was prepared in accordance with 29 CFR 1910.1200 by Valero Marketing & Supply Co., ("VALERO"). VALERO does not assume any liability arising out of product use by others. The information, recommendations, and suggestions presented in this SDS are based upon test results and data believed to be reliable. The end user of the product has the responsibility for evaluating the adequacy of the data under the conditions of use, determining the safety, toxicity and suitability of the product under these conditions, and obtaining additional or clarifying information where uncertainty exists. No guarantee expressed or implied is made as to the effects of such use , the results to be obtained, or the safety and toxicity of the product in any specific application. Furthermore, the information herein is not represented as absolutely complete, since it is not practicable to provide all the scientific and study information in the format of this document, plus additional information may be necessary under exceptional conditions of use, or because of applicable laws or government regulations.

SAFETY DATA SHEET

1. Identification

Product identifier **UNLEADED GASOLINE**

Other means of identification

SDS number 002-GHS

Synonyms Regular/Premium/Midgrade - Unleaded Gasoline, RFG - Reformulated Unleaded Gasoline, Conventional Unleaded Gasoline, Oxygenated Unleaded Gasoline, Non-Oxygenated Unleaded Gasoline, CARB (California Air Resource Board) Unleaded Gasoline, RBOB - Reformulated Blendstock for Oxygenate Blending, CBOB - Conventional Blendstock for Oxygenate Blending, Petrol, Motor Fuel.
See section 16 for complete information.

Recommended use Motor Fuel
Motor fuels.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer/Supplier Valero Marketing & Supply Company and Affiliates
One Valero Way
San Antonio, TX 78269-6000

General Assistance 210-345-4593

E-Mail CorpHSE@valero.com

Contact Person Industrial Hygienist

Emergency Telephone 24 Hour Emergency 866-565-5220
1-800-424-9300 (CHEMTREC USA)

2. Hazard(s) identification

Physical hazards	Flammable liquids	Category 1
Health hazards	Skin corrosion/irritation	Category 2
	Germ cell mutagenicity	Category 1B
	Carcinogenicity	Category 1B
	Reproductive toxicity	Category 2
	Specific target organ toxicity, single exposure	Category 3 narcotic effects
	Specific target organ toxicity, repeated exposure	Category 2
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, long-term hazard	Category 2

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement Extremely flammable liquid and vapor. Causes skin irritation. May cause genetic defects. May cause cancer. Suspected of damaging fertility or the unborn child. May cause drowsiness or dizziness. May cause damage to organs (blood, liver, kidney) through prolonged or repeated exposure. May be fatal if swallowed and enters airways. Toxic to aquatic life with long lasting effects.

Precautionary statement

Prevention	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting// equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Do not breathe gas/mist/vapors/spray. Wash thoroughly after handling. Wear protective gloves/protective clothing/eye protection/face protection. Use only outdoors or in a well-ventilated area. Avoid release to the environment.
Response	If exposed or concerned: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. If swallowed: Immediately call a poison center/doctor. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. In case of fire: Use alcohol-resistant foam, carbon dioxide, dry powder or water fog for extinction. Collect spillage.
Storage	Store locked up. Store in a well-ventilated place. Keep container tightly closed. Keep cool.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Gasoline	86290-81-5	80-100
Toluene	108-88-3	0-30
Hexane (Other Isomers)	96-14-0	5-25
Xylene (o, m, p isomers)	1330-20-7	0-25
Octane (All isomers)	111-65-9	0-18.5
Ethanol	64-17-5	0-10
1,2,4, Trimethylbenzene	95-63-6	0-6
n-Heptane	142-82-5	1-5
Pentane	109-66-0	1-5
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

4. First-aid measures

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
Skin contact	Remove contaminated clothing and shoes. Wash off immediately with soap and plenty of water. Get medical attention if irritation develops or persists. Wash clothing separately before reuse. Destroy or thoroughly clean contaminated shoes. If high pressure injection under the skin occurs, always seek medical attention.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention.
Ingestion	Rinse mouth thoroughly. Do not induce vomiting without advice from poison control center. Do not give mouth-to-mouth resuscitation. If vomiting occurs, keep head low so that stomach content does not get into the lungs. Never give anything by mouth to a victim who is unconscious or is having convulsions. Get medical attention immediately.
Most important symptoms/effects, acute and delayed	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

Indication of immediate medical attention and special treatment needed	In case of shortness of breath, give oxygen. Keep victim warm. Keep victim under observation. Symptoms may be delayed.
General information	If exposed or concerned: get medical attention/advice. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before re-use.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use a solid water stream as it may scatter and spread fire.
Specific hazards arising from the chemical	Vapor may cause flash fire. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.
Special protective equipment and precautions for firefighters	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask.
Fire-fighting equipment/instructions	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask. Withdraw immediately in case of rising sound from venting safety devices or any discoloration of tanks due to fire. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Move containers from fire area if you can do it without risk. In the event of fire, cool tanks with water spray. Cool containers exposed to flames with water until well after the fire is out. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors may form explosive air mixtures even at room temperature. Prevent buildup of vapors or gases to explosive concentrations. Some of these materials, if spilled, may evaporate leaving a flammable residue. Water runoff can cause environmental damage. Use compatible foam to minimize vapor generation as needed.
Specific methods	Use water spray to cool unopened containers.
General fire hazards	Extremely flammable liquid and vapor. Containers may explode when heated.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Local authorities should be advised if significant spills cannot be contained. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. See Section 8 of the SDS for Personal Protective Equipment.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Stop leak if you can do so without risk. This material is a water pollutant and should be prevented from contaminating soil or from entering sewage and drainage systems and bodies of water. Dike the spilled material, where this is possible. Prevent entry into waterways, sewers, basements or confined areas. Use non-sparking tools and explosion-proof equipment. Small Spills: Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. This material and its container must be disposed of as hazardous waste. Large Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent product from entering drains. Do not allow material to contaminate ground water system. Should not be released into the environment.
Environmental precautions	Gasoline may contain oxygenated blend products (Ethanol, etc.) that are soluble in water and therefore precautions should be taken to protect surface and groundwater sources from contamination. If facility or operation has an "oil or hazardous substance contingency plan", activate its procedures. Stay upwind and away from spill. Wear appropriate protective equipment including respiratory protection as conditions warrant. Do not enter or stay in area unless monitoring indicates that it is safe to do so. Isolate hazard area and restrict entry to emergency crew. Extremely flammable. Review Firefighting Measures, Section 5, before proceeding with clean up. Keep all sources of ignition (flames, smoking, flares, etc.) and hot surfaces away from release. Contain spill in smallest possible area. Recover as much product as possible (e.g. by vacuuming). Stop leak if it can be done without risk. Use water spray to disperse vapors. Use compatible foam to minimize vapor generation as needed. Spilled material may be absorbed by an appropriate absorbent, and then handled in accordance with environmental regulations. Prevent spilled material from entering sewers, storm drains, other unauthorized treatment or drainage systems and natural waterways. Contact fire authorities and appropriate federal, state and local agencies. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, contact the National Response Center at 1-800-424-8802.

7. Handling and storage

Precautions for safe handling

Eliminate sources of ignition. Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity.
Wear personal protective equipment. Do not breathe dust/fume/gas/mist/vapors/spray. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. Avoid prolonged exposure. Use only with adequate ventilation. Wash thoroughly after handling. The product is extremely flammable, and explosive vapor/air mixtures may be formed even at normal room temperatures. DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. When using, do not eat, drink or smoke. Avoid release to the environment.

Conditions for safe storage, including any incompatibilities

Flammable liquid storage. Do not handle or store near an open flame, heat or other sources of ignition. This material can accumulate static charge which may cause spark and become an ignition source. The pressure in sealed containers can increase under the influence of heat. Keep container tightly closed in a cool, well-ventilated place. Keep away from food, drink and animal feedingstuffs. Keep out of the reach of children.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Components	Type	Value
Benzene (CAS 71-43-2)	STEL	5 ppm
	TWA	1 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Cumene (CAS 98-82-8)	PEL	245 mg/m3
		50 ppm
Cyclohexane (CAS 110-82-7)	PEL	1050 mg/m3
		300 ppm
Ethanol (CAS 64-17-5)	PEL	1900 mg/m3
		1000 ppm
Ethylbenzene (CAS 100-41-4)	PEL	435 mg/m3
		100 ppm
n-Heptane (CAS 142-82-5)	PEL	2000 mg/m3
		500 ppm
n-Hexane (CAS 110-54-3)	PEL	1800 mg/m3
		500 ppm
Octane (All isomers) (CAS 111-65-9)	PEL	2350 mg/m3
		500 ppm
Pentane (CAS 109-66-0)	PEL	2950 mg/m3
		1000 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	PEL	435 mg/m3
		100 ppm

US. OSHA Table Z-2 (29 CFR 1910.1000)

Components	Type	Value
Benzene (CAS 71-43-2)	Ceiling	25 ppm
	TWA	10 ppm
Toluene (CAS 108-88-3)	Ceiling	300 ppm
	TWA	200 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	25 ppm
Benzene (CAS 71-43-2)	STEL	2.5 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
	TWA	0.5 ppm
Cumene (CAS 98-82-8)	TWA	50 ppm
Cyclohexane (CAS 110-82-7)	TWA	100 ppm
Ethanol (CAS 64-17-5)	STEL	1000 ppm
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm
Gasoline (CAS 86290-81-5)	STEL	500 ppm
	TWA	300 ppm
Hexane (Other Isomers) (CAS 96-14-0)	STEL	1000 ppm
	TWA	500 ppm
n-Heptane (CAS 142-82-5)	STEL	500 ppm
	TWA	400 ppm
n-Hexane (CAS 110-54-3)	TWA	50 ppm
Octane (All isomers) (CAS 111-65-9)	TWA	300 ppm
Pentane (CAS 109-66-0)	TWA	600 ppm
Toluene (CAS 108-88-3)	TWA	20 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	STEL	150 ppm
	TWA	100 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	125 mg/m3
		25 ppm
Benzene (CAS 71-43-2)	STEL	1 ppm
	TWA	0.1 ppm
Cumene (CAS 98-82-8)	TWA	245 mg/m3
		50 ppm
Cyclohexane (CAS 110-82-7)	TWA	1050 mg/m3
		300 ppm
Ethanol (CAS 64-17-5)	TWA	1900 mg/m3
		1000 ppm
Ethylbenzene (CAS 100-41-4)	STEL	545 mg/m3
		125 ppm
	TWA	435 mg/m3
		100 ppm
Hexane (Other Isomers) (CAS 96-14-0)	Ceiling	1800 mg/m3
		510 ppm
	TWA	350 mg/m3
		100 ppm
n-Heptane (CAS 142-82-5)	Ceiling	1800 mg/m3
		440 ppm
	TWA	350 mg/m3
		85 ppm
n-Hexane (CAS 110-54-3)	TWA	180 mg/m3
		50 ppm
Octane (All isomers) (CAS 111-65-9)	Ceiling	1800 mg/m3
		385 ppm
	TWA	350 mg/m3
		75 ppm
Pentane (CAS 109-66-0)	Ceiling	1800 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
		610 ppm
	TWA	350 mg/m3
		120 ppm
Toluene (CAS 108-88-3)	STEL	560 mg/m3
		150 ppm
	TWA	375 mg/m3
		100 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	STEL	655 mg/m3
		150 ppm
	TWA	435 mg/m3
		100 ppm

Biological limit values

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
Benzene (CAS 71-43-2)	25 µg/g	S-Phenylmercapturic acid	Creatinine in urine	*
Ethylbenzene (CAS 100-41-4)	0.7 g/g	Sum of mandelic acid and phenylglyoxylic acid	Creatinine in urine	*
n-Hexane (CAS 110-54-3)	0.4 mg/l	2,5-Hexanedi - on, without hydrolysis		*
	0.4 mg/l	2,5-Hexanedion, without hydrolysis	Urine	*
Toluene (CAS 108-88-3)	0.3 mg/g	o-Cresol, with hydrolysis	Creatinine in urine	*
	0.03 mg/l	Toluene	Urine	*
	0.02 mg/l	Toluene	Blood	*
Xylene (o, m, p isomers) (CAS 1330-20-7)	1.5 g/g	Methylhippuric acids	Creatinine in urine	*

* - For sampling details, please see the source document.

Exposure guidelines

US - California OELs: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
Cumene (CAS 98-82-8)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.
Toluene (CAS 108-88-3)	Can be absorbed through the skin.

US - Minnesota Haz Subs: Skin designation applies

Cumene (CAS 98-82-8)	Skin designation applies.
Toluene (CAS 108-88-3)	Skin designation applies.

US - Tennesse OELs: Skin designation

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.

US. NIOSH: Pocket Guide to Chemical Hazards

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

Appropriate engineering controls Provide adequate general and local exhaust ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof equipment.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses. If splash potential exists, wear full face shield or chemical goggles.
Skin protection	
Hand protection	Avoid exposure - obtain special instructions before use. Wear protective gloves. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier.
Other	Wear chemical-resistant, impervious gloves. Full body suit and boots are recommended when handling large volumes or in emergency situations. Flame retardant protective clothing is recommended.
Respiratory protection	Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. If workplace exposure limits for product or components are exceeded, NIOSH approved equipment should be worn. Proper respirator selection should be determined by adequately trained personnel, based on the contaminants, the degree of potential exposure and published respiratory protection factors. This equipment should be available for nonroutine and emergency use.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Consult supervisor for special handling instructions. Avoid contact with eyes. Avoid contact with skin. Keep away from food and drink. Wash hands before breaks and immediately after handling the product. Provide eyewash station and safety shower. Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance	Light straw to red clear liquid with characteristic strong odor of gasoline.
Physical state	Liquid.
Form	Liquid.
Color	Light straw to red clear.
Odor	Characteristic Gasoline Odor (Strong).
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	44.01 °F (6.67 °C) May start to solidify at this temperature. This is based on data for the following ingredient: Cyclohexane. Weighted average: -91.9 deg C (-133.4 deg F)
Initial boiling point and boiling range	80.06 - 440.06 °F (26.7 - 226.7 °C)
Flash point	-40.0 °F (-40.0 °C) (closed cup)
Evaporation rate	10 - 11 BuAc
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	1.3 %
Flammability limit - upper (%)	7.1 %
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	60.8 - 101.3 kPa (20°C)
Vapor density	3 - 4 (Air=1)
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Very slightly soluble.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	> 500 °F (> 260 °C)
Decomposition temperature	Not available.
Viscosity	Not available.

Other information

Flash point class	Flammable IA
VOC (Weight %)	100 %

10. Stability and reactivity

Reactivity	None known.
Chemical stability	Stable under normal temperature conditions and recommended use.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Heat, flames and sparks. Ignition sources. Contact with incompatible materials. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Ingestion	Swallowing or vomiting of the liquid may result in aspiration into the lungs.
Inhalation	In high concentrations, mists/vapors may irritate throat and respiratory system and cause coughing. May cause drowsiness or dizziness.
Skin contact	Causes skin irritation. Prolonged contact may cause dryness of the skin.
Eye contact	May cause eye irritation.
Symptoms related to the physical, chemical and toxicological characteristics	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Components	Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)		
Acute		
Dermal		
LD50	Rabbit	> 3160 mg/kg
Inhalation		
LC50	Rat	> 2000 mg/l, 48 Hours
Oral		
LD50	Rat	6 g/kg
Benzene (CAS 71-43-2)		
Acute		
Oral		
LD50	Rat	3306 mg/kg
Cumene (CAS 98-82-8)		
Acute		
Inhalation		
LC50	Mouse	2000 mg/l, 7 Hours
	Rat	8000 mg/l, 4 Hours
Oral		
LD50	Rat	1400 mg/kg
Cyclohexane (CAS 110-82-7)		
Acute		
Oral		
LD50	Rat	12705 mg/kg

Components	Species	Test Results
Ethanol (CAS 64-17-5)		
Acute		
Inhalation		
LC50	Rat	30000 mg/m3
Ethylbenzene (CAS 100-41-4)		
Acute		
Dermal		
LD50	Rabbit	> 5000 mg/kg
Oral		
LD50	Rat	5.46 g/kg
n-Heptane (CAS 142-82-5)		
Acute		
Inhalation		
LC50	Rat	103 mg/l, 4 Hours
n-Hexane (CAS 110-54-3)		
Acute		
Oral		
LD50	Rat	28710 mg/kg
Octane (All isomers) (CAS 111-65-9)		
Acute		
Inhalation		
LC50	Rat	118 mg/l, 4 Hours
Pentane (CAS 109-66-0)		
Acute		
Inhalation		
LC50	Rat	364 mg/l, 4 Hours
Toluene (CAS 108-88-3)		
Acute		
Dermal		
LD50	Rabbit	14.1 ml/kg
Inhalation		
LC50	Rat	8000 mg/l, 4 Hours
Oral		
LD50	Rat	2.6 g/kg
Xylene (o, m, p isomers) (CAS 1330-20-7)		
Acute		
Oral		
LD50	Rat	4300 mg/kg

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Based on available data, the classification criteria are not met.

Respiratory or skin sensitization

Respiratory sensitization Based on available data, the classification criteria are not met.

Skin sensitization Based on available data, the classification criteria are not met.
This substance may have a potential for sensitization which may provoke an allergic reaction among sensitive individuals.

Germ cell mutagenicity May cause genetic defects.
In in-vitro experiments, neither benzene, toluene nor xylene changed the number of sister-chromatid exchanges (SCEs) or the number of chromosomal aberrations in human lymphocytes. However, toluene and xylene caused a significant cell growth inhibition which was not observed with benzene in the same concentrations. In in-vivo experiments, toluene changed the number of sister-chromatid exchanges (SCEs) in human lymphocytes. Toluene may cause heritable genetic damage.

Carcinogenicity May cause cancer.

IARC Monographs. Overall Evaluation of Carcinogenicity

Benzene (CAS 71-43-2)	1 Carcinogenic to humans.
Cumene (CAS 98-82-8)	2B Possibly carcinogenic to humans.
Ethylbenzene (CAS 100-41-4)	2B Possibly carcinogenic to humans.
Gasoline (CAS 86290-81-5)	2B Possibly carcinogenic to humans.
Toluene (CAS 108-88-3)	3 Not classifiable as to carcinogenicity to humans.
Xylene (o, m, p isomers) (CAS 1330-20-7)	3 Not classifiable as to carcinogenicity to humans.

NTP Report on Carcinogens

Benzene (CAS 71-43-2)	Known To Be Human Carcinogen.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Reproductive toxicity Suspected of damaging fertility or the unborn child.
Benzene, xylene and toluene have demonstrated animal effects of reproductive toxicity. Animal studies of benzene have shown testicular effects, alterations in reproductive cycles, chromosomal aberrations and embryo/fetotoxicity. Ethanol has demonstrated human effects of reproductive toxicity. Can cause adverse reproductive effects - such as birth defects, miscarriages, or infertility. Avoid exposure to women during early pregnancy. Avoid contact during pregnancy/while nursing.

Specific target organ toxicity - single exposure May cause drowsiness or dizziness.

Specific target organ toxicity - repeated exposure May cause damage to the following organs through prolonged or repeated exposure: Blood. Kidneys. Liver.

Aspiration hazard May be fatal if swallowed and enters airways.

Chronic effects Repeated exposure of laboratory animals to high concentrations of gasoline vapors has caused kidney damage and cancer in rats and cancer in mice. Gasoline was evaluated for genetic activity in assays using microbial cells, cultured mammalian cells and rat bone marrow cells. The results were all negative so gasoline was considered nonmutagenic under these conditions. Overexposure to this product or its components has been suggested as a cause of liver abnormalities in laboratory animals and humans. Lifetime studies by the American Petroleum Institute have shown that kidney damage and kidney cancer can occur in male rats after prolonged inhalation exposures at elevated concentrations of total gasoline. Kidneys of mice and female rats were unaffected. The U.S. EPA Risk Assessment Forum has concluded that the male rat kidney tumor results are not relevant for humans. Total gasoline exposure also produced liver tumors in female mice only. The implication of these data for humans has not been determined.

Further information Symptoms may be delayed.

12. Ecological information

Ecotoxicity Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Components		Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	7.19 - 8.28 mg/l, 96 hours
Benzene (CAS 71-43-2)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	8.76 - 15.6 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	7.2 - 11.7 mg/l, 96 hours
Cumene (CAS 98-82-8)			
Aquatic			
Crustacea	EC50	Brine shrimp (Artemia sp.)	3.55 - 11.29 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	2.7 mg/l, 96 hours
Cyclohexane (CAS 110-82-7)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	3.961 - 5.181 mg/l, 96 hours
		Striped bass (Morone saxatilis)	8.3 mg/l, 96 hours

Components		Species	Test Results
Ethanol (CAS 64-17-5)			
Aquatic			
Algae	EC50	Freshwater algae	275 mg/l, 72 Hours
		Marine water algae	1970 mg/l
Fish	LC50	Fathead minnow (Pimephales promelas)	> 100 mg/l, 96 hours
		Freshwater fish	11200 mg/l, 96 Hours
Invertebrate	EC50	Freshwater invertebrate	5012 mg/l, 48 Hours
		Marine water invertebrate	857 mg/l, 48 Hours
Ethylbenzene (CAS 100-41-4)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	1 - 4 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4 mg/l, 96 hours
n-Heptane (CAS 142-82-5)			
Aquatic			
Fish	LC50	Western mosquitofish (Gambusia affinis)	4924 mg/l, 96 hours
n-Hexane (CAS 110-54-3)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	2.101 - 2.981 mg/l, 96 hours
Toluene (CAS 108-88-3)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	5.46 - 9.83 mg/l, 48 hours
Fish	LC50	Pink salmon (Oncorhynchus gorbuscha)	6.86 - 8.48 mg/l, 96 hours
Xylene (o, m, p isomers) (CAS 1330-20-7)			
Aquatic			
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	8 mg/l, 96 Hours

Persistence and degradability Not available.

Bioaccumulative potential Not available.

Partition coefficient n-octanol / water (log Kow)

Benzene (CAS 71-43-2)	2.13
Cumene (CAS 98-82-8)	3.66
Cyclohexane (CAS 110-82-7)	3.44
Ethanol (CAS 64-17-5)	-0.31
Ethylbenzene (CAS 100-41-4)	3.15
Hexane (Other Isomers) (CAS 96-14-0)	3.6
Octane (All isomers) (CAS 111-65-9)	5.18
Pentane (CAS 109-66-0)	3.39
Toluene (CAS 108-88-3)	2.73
Xylene (o, m, p isomers) (CAS 1330-20-7)	3.2
n-Heptane (CAS 142-82-5)	4.66
n-Hexane (CAS 110-54-3)	3.9

Mobility in soil Not available.

Other adverse effects Not available.

13. Disposal considerations

Disposal instructions Dispose in accordance with all applicable regulations. This material and its container must be disposed of as hazardous waste. Dispose of this material and its container to hazardous or special waste collection point. Incinerate the material under controlled conditions in an approved incinerator. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container.

Hazardous waste code D001: Waste Flammable material with a flash point <140 °F
D018: Waste Benzene

US RCRA Hazardous Waste U List: Reference

Benzene (CAS 71-43-2)	U019
Cumene (CAS 98-82-8)	U055
Cyclohexane (CAS 110-82-7)	U056
Toluene (CAS 108-88-3)	U220
Xylene (o, m, p isomers) (CAS 1330-20-7)	U239

Waste from residues / unused products Dispose of in accordance with local regulations.

Contaminated packaging Offer rinsed packaging material to local recycling facilities.

14. Transport information

DOT

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	139, B33, B101, T8
Packaging exceptions	150
Packaging non bulk	202
Packaging bulk	242

IATA

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	Yes
ERG Code	3H
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	
Marine pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Central nervous system
Blood
Aspiration
Skin
Eye
Respiratory tract irritation
Flammability

CERCLA Hazardous Substance List (40 CFR 302.4)

Benzene (CAS 71-43-2)	LISTED
Cumene (CAS 98-82-8)	LISTED
Cyclohexane (CAS 110-82-7)	LISTED
Ethanol (CAS 64-17-5)	LISTED
Ethylbenzene (CAS 100-41-4)	LISTED
Gasoline (CAS 86290-81-5)	LISTED
Hexane (Other Isomers) (CAS 96-14-0)	LISTED
n-Heptane (CAS 142-82-5)	LISTED
n-Hexane (CAS 110-54-3)	LISTED
Octane (All isomers) (CAS 111-65-9)	LISTED
Pentane (CAS 109-66-0)	LISTED
Toluene (CAS 108-88-3)	LISTED
Xylene (o, m, p isomers) (CAS 1330-20-7)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories
Immediate Hazard - No
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Toluene	108-88-3	0-30
Xylene (o, m, p isomers)	1330-20-7	0-25
1,2,4, Trimethylbenzene	95-63-6	0-6
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Pentane (CAS 109-66-0)

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

Toluene (CAS 108-88-3) 6594

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Toluene (CAS 108-88-3) 35 % weight/volumn

DEA Exempt Chemical Mixtures Code Number

Toluene (CAS 108-88-3) 594

US state regulations

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

US. Massachusetts RTK - Substance List

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. New Jersey Worker and Community Right-to-Know Act

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Pennsylvania Worker and Community Right-to-Know Law

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Gasoline (CAS 86290-81-5)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Rhode Island RTK

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
Toluene (CAS 108-88-3)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

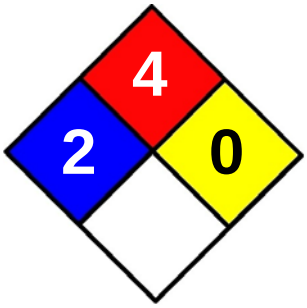
Issue date 13-May-2013

Revision date 23-May-2014

Version # 03

Further information HMIS® is a registered trade and service mark of the NPCA.

NFPA Ratings



References

ACGIH
EPA: AQUIRE database
NLM: Hazardous Substances Data Base
US. IARC Monographs on Occupational Exposures to Chemical Agents
HSDB® - Hazardous Substances Data Bank
IARC Monographs. Overall Evaluation of Carcinogenicity
National Toxicology Program (NTP) Report on Carcinogens
ACGIH Documentation of the Threshold Limit Values and Biological Exposure Indices

Disclaimer

This material Safety Data Sheet (SDS) was prepared in accordance with 29 CFR 1910.1200 by Valero Marketing & Supply Co., ("VALERO"). VALERO does not assume any liability arising out of product use by others. The information, recommendations, and suggestions presented in this SDS are based upon test results and data believed to be reliable. The end user of the product has the responsibility for evaluating the adequacy of the data under the conditions of use, determining the safety, toxicity and suitability of the product under these conditions, and obtaining additional or clarifying information where uncertainty exists. No guarantee expressed or implied is made as to the effects of such use , the results to be obtained, or the safety and toxicity of the product in any specific application. Furthermore, the information herein is not represented as absolutely complete, since it is not practicable to provide all the scientific and study information in the format of this document, plus additional information may be necessary under exceptional conditions of use, or because of applicable laws or government regulations.

MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: **Helium, compressed**
CHEMICAL NAME: Helium
FORMULA: He
SYNONYMS: Helium gas, Gaseous helium, Balloon gas

MANUFACTURER: **Air Products and Chemicals, Inc.**
7201 Hamilton Boulevard
Allentown, PA 18195-1501

PRODUCT INFORMATION: 1–800–752–1597

MSDS NUMBER: 1008 **REVISION:** 4

REVISION DATE: March 1994 **REVIEW DATE:** August 1997 **

SECTION 2. COMPOSITION / INFORMATION ON INGREDIENTS

Helium is sold as pure product > 99%.

CAS NUMBER: 7440-59-7

EXPOSURE LIMITS:

OSHA: Not established **ACGIH:** Simple asphyxiant **NIOSH:** Not established

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

Helium is a nontoxic, odorless, colorless, nonflammable gas stored in cylinders at high pressure. It can cause rapid suffocation when concentrations are sufficient to reduce oxygen levels below 19.5%. It is lighter than air and may collect in high points or along ceilings. Self-Contained Breathing Apparatus (SCBA) may be required by rescue workers.

EMERGENCY TELEPHONE NUMBERS

800 - 523 - 9374 Continental U.S., Canada and Puerto Rico

610 - 481 - 7711 other locations

POTENTIAL HEALTH EFFECTS:

INHALATION: Simple asphyxiant. Helium is nontoxic, but may cause suffocation by displacing the oxygen in air. Lack of sufficient oxygen can cause serious injury or death.

EYE CONTACT: No adverse effect.

SKIN CONTACT: No adverse effect.

EXPOSURE INFORMATION:

ROUTE OF ENTRY: Inhalation

TARGET ORGANS: None

EFFECT: Asphyxiation (suffocation)

SYMPTOMS: Exposure to an oxygen deficient atmosphere (less than 19.5%) may cause dizziness, drowsiness, nausea, vomiting, excess salivation, diminished mental alertness, loss of consciousness and death. Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help or protect themselves.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: None

CARCINOGENIC POTENTIAL: Helium is not listed as a carcinogen or potential carcinogen by NTP, IARC, or OSHA Subpart Z.

WARNING

The practice of intentionally inhaling helium for a voice altering effect is extremely dangerous and may result in serious injury or death!

SECTION 4. FIRST AID

INHALATION: Persons suffering from lack of oxygen should be moved to fresh air. If victim is not breathing, administer artificial respiration. If breathing is difficult, administer oxygen. Obtain prompt medical attention.

EYE / SKIN CONTACT: Not applicable

SECTION 5. FIRE AND EXPLOSION

FLASH POINT:	AUTOIGNITION:	FLAMMABLE LIMITS:
Not applicable	Nonflammable	Nonflammable

EXTINGUISHING MEDIA: Helium is nonflammable and does not support combustion. Use extinguishing media appropriate for the surrounding fire.

HAZARDOUS COMBUSTION PRODUCTS: None

SPECIAL FIRE FIGHTING INSTRUCTIONS: Helium is a simple asphyxiant. If possible, remove helium cylinders from fire area or cool with water. Self contained breathing apparatus may be required for rescue workers.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Upon exposure to intense heat or flame cylinder will vent rapidly and or rupture violently. Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a container can build up due to heat and it may rupture if pressure relief devices should fail to function.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Evacuate all personnel from affected area. Increase ventilation to release area and monitor oxygen level. Use appropriate protective equipment (SCBA). If leak is from container or it's valve, call the Air Products' emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

SECTION 7. STORAGE AND HANDLING

STORAGE: Cylinders should be stored upright in a well-ventilated, secure area, protected from the weather. Storage area temperatures should not exceed 125 °F (52 °C) and area should be free of

combustible materials. Storage should be away from heavily traveled areas and emergency exits. Avoid areas where salt or other corrosive materials are present. Valve protection caps and valve outlet seals should remain on cylinders not connected for use. Separate full from empty cylinders. Avoid excessive inventory and storage time. Use a first-in first-out system. Keep good inventory records.

HANDLING: Do not drag, roll, or slide cylinder. Use a suitable handtruck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure reducing regulator or separate control valve to safely discharge gas from cylinder. Use a check valve to prevent reverse flow into cylinder. Do not overheat cylinder to increase pressure or discharge rate. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve causing a leak to occur. Use an adjustable strap-wrench to remove over-tight or rusted caps.

Helium is compatible with all common materials of construction. Pressure requirements should be considered when selecting materials and designing systems.

SPECIAL REQUIREMENTS: Always store and handle compressed gases in accordance with Compressed Gas Association, Inc. (ph. 703-412-0900) pamphlet CGA P-1, ***Safe Handling of Compressed Gases in Containers.*** Local regulations may require specific equipment for storage or use.

CAUTION: Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a cylinder which has not been filled by the owner or with the owner's written consent is a violation of federal law.

SECTION 8. PERSONAL PROTECTION / EXPOSURE CONTROL

ENGINEERING CONTROLS: Provide good ventilation and/or local exhaust to prevent accumulation of high concentrations of gas. Oxygen levels in work area should be monitored to ensure they do not fall below 19.5%.

RESPIRATORY PROTECTION:

GENERAL USE: None required.

EMERGENCY: Use SCBA or positive pressure air line with mask and escape pack in areas where oxygen concentration is less than 19.5%. Air purifying respirators will not provide protection.

OTHER PROTECTIVE EQUIPMENT: Safety shoes are recommended when handling cylinders.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Colorless gas

ODOR: Odorless

MOLECULAR WEIGHT: 4.00

BOILING POINT (1 atm): -452.1 °F (-268.9 °C)

SPECIFIC GRAVITY (Air =1): 0.138

SPECIFIC VOLUME (at 70 °F (21.1 °C) and 1 atm): 96.71 ft^3/lb (6.037 m^3/kg)

FREEZING POINT/MELTING POINT: None

VAPOR PRESSURE (AT 70°F): Not applicable

GAS DENSITY (at 70 °F (21.1 °C) and 1 atm): 0.0103 lb/ft^3 (0.165 kg/m^3)

SOLUBILITY IN WATER (Vol./Vol. at 32 °F (0 °C)): 0.0094

SECTION 10. REACTIVITY / STABILITY

CHEMICAL STABILITY: Stable

CONDITIONS TO AVOID: None

INCOMPATIBILITY: None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

Helium is a simple asphyxiant.

SECTION 12. ECOLOGICAL INFORMATION

Helium is not toxic. No adverse ecological effects are expected. Helium does not contain any Class I or Class II ozone depleting chemicals. Helium is not listed as a marine pollutant by DOT (49 CFR 171).

SECTION 13. DISPOSAL

UNUSED PRODUCT / EMPTY CONTAINER: Return container and unused product to supplier. Do not attempt to dispose of residual or unused quantities.

DISPOSAL: For emergency disposal, secure the cylinder and slowly discharge gas to the atmosphere in a well ventilated area or outdoors.

SECTION 14. TRANSPORTATION

DOT HAZARD CLASS: 2.2

DOT SHIPPING LABEL: Nonflammable Gas

DOT SHIPPING NAME: Helium, Compressed

IDENTIFICATION NUMBER: UN1046

REPORTABLE QUANTITY (RQ): None

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure upright position in a well ventilated truck. Never transport in passenger compartment of a vehicle.

SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS:

EPA - ENVIRONMENTAL PROTECTION AGENCY

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 requires notification to the National Response Center of a release of quantities of hazardous substances equal to or greater than the reportable quantities (RQ) in 40 CFR 302.4.

CERCLA Reportable Quantity: None

SARA TITLE III: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT OF 1986

SECTION 302: Requires emergency planning based on threshold planning quantities (TPQ) and release reporting based on reportable quantities (RQ) of EPA's extremely hazardous substances (40 CFR 355).

Helium is not listed as an Extremely Hazardous Substance.

SECTIONS 311/312: Require submission of material safety data sheets (MSDSs) and chemical inventory reporting with identification of EPA defined hazard classes. The hazard classes for this product are:

IMMEDIATE HEALTH:	No	PRESSURE:	Yes
DELAYED HEALTH:	No	REACTIVITY:	No
		FIRE:	No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR 372. This information should be included in all MSDSs that are copied and distributed for this material.

Helium is not listed as a toxic chemical.

40 CFR PART 68: Risk Management for Chemical Accident Release Prevention. Requires the development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Helium is not listed as a regulated substance.

TSCA - TOXIC SUBSTANCE CONTROL ACT : Helium is listed on the TSCA inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals. Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Helium is not listed as a Highly Hazardous Chemical.

STATE REGULATIONS:

CALIFORNIA:

Proposition 65: This product does NOT contain any listed substances which the State of California requires warning under this statute.

SCAQMD Rule: VOC = Not applicable

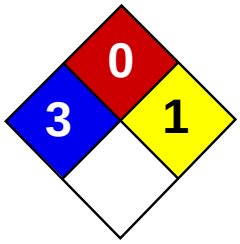
SECTION 16. SUPPLEMENTAL INFORMATION

HAZARD RATINGS:

NFPA RATINGS:		**HMIS RATINGS:**	
HEALTH:	0	HEALTH:	0
FLAMMABILITY:	0	FLAMMABILITY:	0
REACTIVITY:	0	REACTIVITY:	0
SPECIAL:	SA*		

*Compressed Gas Association recommendation to designate simple asphyxiant.

Documents with Effective Date of March 1994 and August 1997 are identical in content and either may be used.



Material Safety Data Sheet
Hydrochloric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Hydrochloric acid

Catalog Codes: SLH1462, SLH3154

CAS#: Mixture.

RTECS: MW4025000

TSCA: TSCA 8(b) inventory: Hydrochloric acid

CI#: Not applicable.

Synonym: Hydrochloric Acid; Muriatic Acid

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Hydrogen chloride	7647-01-0	20-38
Water	7732-18-5	62-80

Toxicological Data on Ingredients: Hydrogen chloride: GAS (LC50): Acute: 4701 ppm 0.5 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Non-corrosive for lungs. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth. Repeated or prolonged exposure to the substance can produce target

organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of metals

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Non combustible. Calcium carbide reacts with hydrogen chloride gas with incandescence. Uranium phosphide reacts with hydrochloric acid to release spontaneously flammable phosphine. Rubidium acetylene carbides burns with slightly warm hydrochloric acid. Lithium silicide in contact with hydrogen chloride becomes incandescent. When dilute hydrochloric acid is used, gas spontaneously flammable in air is evolved. Magnesium boride treated with concentrated hydrochloric acid produces spontaneously flammble gas. Cesium acetylene carbide burns hydrogen chloride gas. Cesium carbide ignites in contact with hydrochloric acid unless acid is dilute. Reacts with most metals to produce flammable Hydrodgen gas.

Special Remarks on Explosion Hazards:

Hydrogen chloride in contact with the following can cause an explosion, ignition on contact, or other violent/vigorous reaction: Acetic anhydride AgClO + CCl4 Alcohols + hydrogen cyanide, Aluminum Aluminum-titanium alloys (with HCl vapor), 2-Amino ethanol, Ammonium hydroxide, Calcium carbide Ca3P2 Chlorine + dinitroanilines (evolves gas), Chlorosulfonic acid Cesium carbide Cesium acetylene carbide, 1,1-Difluoroethylene Ethylene diamine Ethylene imine, Fluorine, HClO4 Hexalithium disilicide H2SO4 Metal acetylides or carbides, Magnesium boride, Mercuric sulfate, Oleum, Potassium permanganate, beta-Propiolactone Propylene oxide Rubidium carbide, Rubidium, acetylene carbide Sodium (with aqueous HCl), Sodium hydroxide Sodium tetraselenium, Sulfonic acid, Tetraselenium tetranitride, U3P4 , Vinyl acetate. Silver perchlorate with carbon tetrachloride in the presence of hydrochloric acid produces trichloromethyl perchlorate which detonates at 40 deg. C.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, organic materials, metals, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
CEIL: 5 (ppm) from OSHA (PEL) [United States] CEIL: 7 (mg/m3) from OSHA (PEL) [United States] CEIL: 5 from NIOSH CEIL: 7 (mg/m3) from NIOSH TWA: 1 STEL: 5 (ppm) [United Kingdom (UK)] TWA: 2 STEL: 8 (mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Pungent. Irritating (Strong.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light yellow.

pH (1% soln/water): Acidic.

Boiling Point:
108.58 C @ 760 mm Hg (for 20.22% HCl in water) 83 C @ 760 mm Hg (for 31% HCl in water) 50.5 C (for 37% HCl in water)

Melting Point:
-62.25°C (-80°F) (20.69% HCl in water) -46.2 C (31.24% HCl in water) -25.4 C (39.17% HCl in water)

Critical Temperature: Not available.

Specific Gravity:
1.1- 1.19 (Water = 1) 1.10 (20%and 22% HCl solutions) 1.12 (24% HCl solution) 1.15 (29.57% HCl solution) 1.16 (32% HCl solution) 1.19 (37% and 38%HCl solutions)

Vapor Pressure: 16 kPa (@ 20°C) average

Vapor Density: 1.267 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.25 to 10 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility: Soluble in cold water, hot water, diethyl ether.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, water

Incompatibility with various substances:
Highly reactive with metals. Reactive with oxidizing agents, organic materials, alkalis, water.

Corrosivity:
Extremely corrosive in presence of aluminum, of copper, of stainless steel(304), of stainless steel(316). Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Reacts with water especially when water is added to the product. Absorption of gaseous hydrogen chloride on mercuric sulfate becomes violent @ 125 deg. C. Sodium reacts very violently with gaseous hydrogen chloride. Calcium phosphide and hydrochloric acid undergo very energetic reaction. It reacts with oxidizers releasing chlorine gas. Incompatible with, alkali metals, carbides, borides, metal oxides, vinyl acetate, acetylides, sulphides, phosphides, cyanides, carbonates. Reacts with most metals to produce flammable Hydrogen gas. Reacts violently (moderate reaction with heat of evolution) with water especially when water is added to the product. Isolate hydrogen chloride from heat, direct sunlight, alkalies (reacts vigorously), organic materials, and oxidizers (especially nitric acid and chlorates), amines, metals, copper and alloys (e.g. brass), hydroxides, zinc (galvanized materials), lithium silicide (incandescence), sulfuric acid(increase in temperature and pressure) Hydrogen chloride gas is emitted when this product is in contact with sulfuric acid. Adsorption of Hydrochloric Acid onto silicon dioxide results in exothmeric reaction. Hydrogen chloride causes aldehydes and epoxides to violently polymerize. Hydrogen chloride or Hydrochloric Acid in contact with the folloiwng can cause explosion or ignition on contact or

Special Remarks on Corrosivity:

Highly corrosive. Incompatible with copper and copper alloys. It attacks nearly all metals (mercury, gold, platinium, tantalum, silver, and certain alloys are exceptions). It is one of the most corrosive of the nonoxidizing acids in contact with copper alloys. No corrosivity data on zinc, steel. Severe Corrosive effect on brass and bronze

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:
Acute oral toxicity (LD50): 900 mg/kg [Rabbit]. Acute toxicity of the vapor (LC50): 1108 ppm, 1 hours [Mouse]. Acute toxicity of the vapor (LC50): 3124 ppm, 1 hours [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 3 (Not classifiable for human.) by IARC [Hydrochloric acid]. May cause damage to the following organs: kidneys, liver, mucous membranes, upper respiratory tract, skin, eyes, Circulatory System, teeth.

Other Toxic Effects on Humans:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of ingestion, . Hazardous in case of eye contact (corrosive), of inhalation (lung corrosive).

Special Remarks on Toxicity to Animals:
Lowest Published Lethal Doses (LDL/LCL) LDL [Man] -Route: Oral; 2857 ug/kg LCL [Human] - Route: Inhalation; Dose: 1300 ppm/30M LCL [Rabbit] - Route: Inhalation; Dose: 4413 ppm/30M

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects (fetoxicity). May affect genetic material.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Corrosive. Causes severe skin irritation and burns. Eyes: Corrosive. Causes severe eye irritation/conjuntivitis, burns, corneal necrosis. Inhalation: May be fatal if inhaled. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract. Inhalation of hydrochloric acid fumes produces nose, throat, and larryngeal burning, and irritation, pain and inflammation, coughing, sneezing, choking sensation, hoarseness, laryngeal spasms, upper respiratory tract edema, chest pains, as well has headache, and palpitations. Inhalation of high concentrations can result in corrosive burns, necrosis of bronchial epithelium, constriction of the larynx and bronchi, nasospetal perforation, glottal closure, occur, particularly if exposure is prolonged. May affect the liver. Ingestion: May be fatal if swallowed. Causes irritation and burning, ulceration, or perforation of the gastrointestinal tract and resultant peritonitis, gastric hemorrhage and infection. Can also cause nausea, vomitting (with "coffee ground" emesis), diarrhea, thirst, difficulty swallowing, salivation, chills, fever, uneasiness, shock, strictures and stenosis (esophogeal, gastric, pyloric). May affect behavior (excitement), the cardiovascular system (weak rapid pulse, tachycardia), respiration (shallow respiration), and urinary system (kidneys- renal failure, nephritis). Acute exposure via inhalation or ingestion can also cause erosion of tooth enamel. Chronic Potential Health Effects: dyspnea, bronchitis. Chemical pneumonitis and pulmonary edema can also

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Hydrochloric acid, solution UNNA: 1789 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Connecticut hazardous material survey.: Hydrochloric acid Illinois toxic substances disclosure to employee act: Hydrochloric acid Illinois chemical safety act: Hydrochloric acid New York release reporting list: Hydrochloric acid Rhode Island RTK hazardous substances: Hydrochloric acid Pennsylvania RTK: Hydrochloric acid Minnesota: Hydrochloric acid Massachusetts RTK: Hydrochloric acid Massachusetts spill list: Hydrochloric acid New Jersey: Hydrochloric acid New Jersey spill list: Hydrochloric acid Louisiana RTK reporting list: Hydrochloric acid Louisiana spill reporting: Hydrochloric acid California Director's List of Hazardous Substances: Hydrochloric acid TSCA 8(b) inventory: Hydrochloric acid TSCA 4(a) proposed test rules: Hydrochloric acid SARA 302/304/311/312 extremely hazardous substances: Hydrochloric acid SARA 313 toxic chemical notification and release reporting: Hydrochloric acid CERCLA: Hazardous substances.: Hydrochloric acid: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):
R34- Causes burns. R37- Irritating to respiratory system. S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 1

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 1

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References:
-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. -Guide de la loi et du règlement sur le transport des marchandises dangeureuses au canada. Centre de conformité internatinal Ltée. 1986.

Other Special Considerations: Not available.

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Last Updated: 05/21/2013 12:00 PM

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BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: ISOBUTYLENE

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6

TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: ISOBUTYLENE
CHEMICAL NAME: Isobutylene
COMMON NAMES/SYNONYMS: 2-Methylpropene, Isobutene
TDG (Canada) CLASSIFICATION: 2.1
WHMIS CLASSIFICATION: A, B1, D2B

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD_{50} or LC_{50} Route/Species
Isobutylene FORMULA: C4H8 CAS: 115-11-7 RTECS #: UD0890000	99.0 to 99.8	Simple Asphyxiant	Simple Asphyxiant	LC_{50} 620 mg/m^3/3H (rat)

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)

[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW

This product does not contain oxygen and may cause asphyxia if released in a confined area. Simple hydrocarbons can cause irritation and central nervous system depression at high concentrations. flammable.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	No

HEALTH EFFECTS:

Exposure Limits No	Irritant Yes	Sensitization No
Teratogen No	Reproductive Hazard No	Mutagen No
Synergistic Effects None Reported		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
Irritation may occur.

SKIN EFFECTS:
None anticipated as product is a gas at room temperature.

INGESTION EFFECTS:
Ingestion is unlikely.

INHALATION EFFECTS:
Product is relatively nontoxic. Simple hydrocarbons can irritate the eyes, mucous membranes and respiratory system at high concentrations.

Inhalation of high concentrations may cause dizziness, disorientation, incoordination, narcosis, nausea or narcotic effects.

This product may displace oxygen if released in a confined space. Maintain oxygen levels above 19.5% at sea level to prevent asphyxiation.

Effects of oxygen deficiency resulting from simple asphyxiants may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

NFPA HAZARD CODES	HMIS HAZARD CODES	RATINGS SYSTEM
Health: 1	Health: 1	0 = No Hazard
Flammability: 4	Flammability: 4	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
		3 = Serious Hazard
		4 = Severe Hazard

4. First Aid Measures

EYES:
Never introduce oil or ointment into the eyes without medical advice! If pain is present, refer the victim to an ophthalmologist for further treatment and follow up.

SKIN:

Remove contaminated clothing and wash affected area with soap and water. If irritation persists, seek medical attention.

INGESTION:
Not normally required. Seek immediate medical attention.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO PRODUCT. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted (artificial) respiration and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. Fire Fighting Measures

Conditions of Flammability: Flammable liquid and vapor		
Flash point: -105 °F (-76 °C)	Method: Closed Cup	Autoignition Temperature: 869 °F (465 °C)
LEL(%): 1.8	UEL(%): 9.6	
Hazardous combustion products: Carbon monoxide, Carbon dioxide		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: Not Available		

FIRE AND EXPLOSION HAZARDS:
Isobutylene is heavier than air and may travel a considerable distance to an ignition source. Isobutylene is a flammable gas! Keep away from open flame and other sources of ignition. Do not allow smoking in storage areas or when handling.

EXTINGUISHING MEDIA:
Water, carbon dioxide, dry chemical.

FIRE FIGHTING INSTRUCTIONS:
If possible, stop the flow of gas with a remote valve. Use water spray to cool fire exposed containers. If fire is extinguished and flow of gas is continued, increase ventilation to prevent a build up of a flammable/ explosive atmosphere. Extinguish sources of ignition.

Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers. Direct 500 GPM water stream onto containers above the liquid level with remote monitors. Limit the number of personnel in proximity to the fire. Evacuate surrounding areas to at least 3000 feet in all directions.

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. Increase ventilation to prevent build up of a flammable/explosive atmosphere. Extinguish all sources of ignition! If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location

7. Handling and Storage

Earth bond and ground all lines and equipment associated with the product system. Electrical equipment should be non-sparking and explosion proof.

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure regulator when connecting cylinder to lower pressure (<250 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time.

Post "No Smoking" signs in storage or use areas.

For additional recommendations consult Compressed Gas Association Pamphlet P-1.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Isobuylene FORMULA: C4H8 CAS: 115-11-7 RTECS #: UD0890000	99.0 to 99.8	Simple Asphyxiant	Simple Asphyxiant	LC_{50} 620 mg/m^3/3H (rat)

[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.
[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)
[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

ENGINEERING CONTROLS:
Use local exhaust to prevent accumulation. Use general ventilation to prevent build up of flammable concentrations. May use hood with forced ventilation when handling small quantities. If product is handled routinely where the potential for leaks exists, all electrical equipment must be rated for use in potentially flammable atmospheres. Consult the National Electrical Code for details.

EYE/FACE PROTECTION:
Safety goggles or glasses.

SKIN PROTECTION:
Protective gloves made of plastic or rubber.

RESPIRATORY PROTECTION:
Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes, safety shower, eyewash.

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure at 70°F	: 39	psia
Vapor density at STP (Air = 1)	: 1.98	
Evaporation point	: Not Available	
Boiling point	: 19.5	°F
	: -6.9	°C
Freezing point	: -220.6	°F
	: -140.3	°C
pH	: Not Available	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Insoluble	
Odor threshold	: Not Available	
Odor and appearance	: A colorless gas with an unpleasant odor similar to that of burning coal.	

10. Stability and Reactivity

STABILITY:
Stable

CONDITIONS TO AVOID (STABILITY):
None

INCOMPATIBLE MATERIALS:
Oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS:
Carbon monoxide

11. Toxicological Information

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

No chronic effects data given in the Registry of Toxic Effects of Chemical Substances (RTECS) or Sax, Dangerous Properties of Industrial Materials, 7th ed.

12. Ecological Information

No data given.

13. Disposal Considerations

Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED, WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to BOC Gases or authorized distributor for proper disposal.

14. Transport Information

PARAMETER	United States DOT	Canada TDG
PROPER SHIPPING NAME:	Isobutylene	Isobutylene
HAZARD CLASS:	2.1	2.1
IDENTIFICATION NUMBER:	UN 1055	UN 1055
SHIPPING LABEL:	FLAMMABLE GAS	FLAMMABLE GAS

15. Regulatory Information

Isoutylene is listed under the accident prevention provisions of section 112(r) of the Clean Air Act (CAA) with a threshold quantity (TQ) of 10,000 pounds.

SARA TITLE III NOTIFICATIONS AND INFORMATION

SARA TITLE III - HAZARD CLASSES:
Acute Health Hazard
Fire Hazard
Sudden Release of Pressure Hazard

16. Other Information

Compressed gas cylinders shall not be refilled without the express written permission of the owner. Shipment of a compressed gas cylinder which has not been filled by the owner or with his/her (written) consent is a violation of transportation regulations.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

SAFETY DATA SHEET

SECTION I – PRODUCT AND SUPPLIER INFORMATION

Supplier: **Target Products Ltd,**
1080 Bradner Road
Abbotsford, BC
V4X 1H8
Telephone: 1.604.856.7976

24-Hour Emergency Response Telephone for Transport Emergencies ONLY: **+1 (613) 996-6666**

PRODUCT **99932599 GRANULAR ACTIVATED CARBON**

SDS Identifier: Activated Carbon

Product Use: Water purification

SECTION II - HAZARD IDENTIFICATION

Hazard-determining components of labeling
Classification of the substance or mixture
Eye Corrosion – Category 2
Specific Target Organ Toxicity Repeat Exposure – Category 2

Signal word Warning

Hazard Statements
H319 – Causes serious eye irritation.
H373 – May cause damage to organs through prolonged or repeated exposure.

Pictograms

Precautionary statements
P264 – Wash hands thoroughly after handling.
P280 – Wear eye protection and face protection.
P305 + P351 + P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313 – If eye irritation persists: Get medical advice/attention.
P260 – Do not breathe dust.

Immediately seek medical advice or attention if symptoms are significant or persist.

Store in a well-ventilated place. Keep container tightly closed.
Dispose of contents/containers in accordance with all regulations.

Additional
HNOC – Hazards not otherwise classified: Not applicable

Unknown Acute Toxicity: None

SECTION III - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Hazardous Components	CAS No.	% by Weight
Activated Carbon	7440-44-0	100%

SECTION IV – FIRST AID MEASURES

Inhalation	Remove victim to fresh air. Give artificial respiration only if breathing has stopped. If breathing is difficult, give oxygen. Seek immediate medical attention.
Skin Contact / Absorption	Remove contaminated clothing. Wash affected area with soap and water.
Eye Contact	Contact lenses should never be worn when working with this product. Flush immediately with water for at least 15 minutes. Forcibly hold eyelids apart to ensure complete irrigation of eye tissue. Seek medical attention.
Ingestion	No known health effects. Seek medical attention if any problems are experienced.
Additional Information	Not Available

SECTION V - FIRE FIGHTING MEASURES

Suitable Extinguishing Media	Small fires: Carbon dioxide dry chemical powder, sand. Large fires: regular foam.
Unsuitable Extinguishing Media	NOTE: Violent steam generation and frothing may occur on direct application of water stream.
Specific Hazards Arising From Chemical	During a fire, toxic gases are generated.
Special Protective Equipment for Fire-Fighters	Wear NIOSH-approved self-contained breathing apparatus and protective clothing.
Further Information	Wet activated carbon removes oxygen from air and can lower the concentration of oxygen inside vessels containing carbon and other confined spaces. During a fire, toxic gases are generated.

SECTION VI – ACCIDENTAL RELEASE MEASURES

Personal Precautions/ Protective Equipment/ Emergency Procedures	Wear appropriate personal protective equipment. Ventilate area. Only enter area with PPE. Stop or reduce leak if safe to do so. Prevent material from entering sewers. Flush with water to remove any residue.
Environmental Precautions	Prevent materials from entering sewers.
Methods For Cleaning Up	Vacuum or shovel spilled material and place in closed container for proper disposal.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND STORAGE

Precautions for Safe Handling	Use proper equipment for lifting and transporting all containers. Use sensible industrial hygiene and housekeeping practices. Wash thoroughly after handling. Avoid all situations that could lead to harmful exposure. Minimize airborne spreading of dust.
Conditions for Safe Storage	Store in a clean, well-ventilated area away from oxidizers, acids, ignition sources, heat, and combustible materials.
Incompatibilities	Strong oxidizers such as ozone, liquid oxygen, chlorine, potassium permanganate. Strong acids, Acetone, Alkali metals.

SECTION VIII – EXPOSURE CONTROL MEASURES / PERSONAL PROTECTION

Components with limit values that require monitoring at the workplace:

Hazardous Components	CAS No.	PEL (OSHA) mg/M^3	TLV (ACGIH) mg/M^3
Activated Carbon	7440-44-0	Not established	Not established

Engineering Control(s)

Ventilation Requirements	Mechanical ventilation (dilution or local exhaust), process or personnel enclosure and control of process conditions must be provided in accordance with all fire codes and regulatory requirements. Supply sufficient replacement air to make up for air removed by exhaust systems.
Other	Emergency shower and eyewash must be available and tested in accordance with regulations and be in close proximity.

Protective Equipment

Eyes/Face	Chemical goggles, full-face shield, or a full-face respirator is to be worn at all times when product is handled. Contact lenses should not be worn; they may contribute to severe eye injury.
Hand Protection	Impervious gloves of chemically resistant material (rubber or PVC) should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse.
Skin and Body Protection	Body suite, aprons, and/or coveralls of chemical resistant material should be worn at all times. Wash contaminated clothing and dry thoroughly before reuse. No special footwear is required other than what is mandated at place of work.
Respiratory Protection	Respiratory protection is not normally required. If use creates dust formations, then a NIOSH-approved respirator with a dust cartridge is recommended. Wet activated carbon removes oxygen from air causing a severe hazard to workers inside confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken (such as wearing a self-contained breathing apparatus).
Thermal Hazards	Not Available

SECTION IX - PHYSICAL/CHEMICAL CHARACTERISTICS

General Information	
Physical State	Particulate solid, pellet or powder
Colour	Black
Odour	Odourless
Odour Threshold	Not Applicable
pH	Not applicable. Activated carbon bearing inorganic and chemically active groups on its surface may alter the pH of liquids to which it is added.
Melting Point/Freezing Point	>3500°C
Initial Boiling Point and Boiling Range	Maximum 4000°C
Flash Point	Not Applicable
Evaporation Rate	Not Applicable
Flammability	Not Applicable
Upper Flammable Limit	Not Applicable
Lower Flammable Limit	Not Applicable
Vapour Pressure (mm Hg, 20°C)	Not Applicable
Vapour Density (Air=1)	Not Applicable
Relative Density	Not Available
Solubility(ies)	Insoluble in water
Partition Coefficient (n-octanol/water)	Not Applicable
Auto-ignition Temperature	~ 300°C [Depends on particle size and physical form.]
Decomposition Temperature	Not Available
Viscosity	Not Applicable
Explosive Properties	Airborne dust may create an explosion hazard.
Specific Gravity (Water=1)	0.25 – 0.60
% Volatiles by Volume	0%
IUPAC Formula	C
Molecular Weight	12.011

SECTION X – STABILITY AND REACTIVITY

Reactivity	Not Available
Chemical Stability	Stable under normal conditions.
Possibility of Hazardous Reactions	Self-heats due to slow oxidation by air. Presence of moisture accelerates self-heating.
Conditions to Avoid	High temperatures, sparks, open flames and all other sources of ignition. Minimize airborne spreading of dust. High concentrations of organics in air will cause temperature rise due to heat of adsorption. At very high concentration levels this may cause a bed fire. High concentrations of Ketones and Aldehydes may cause a bed temperature rise due to adsorption and oxidation.
Incompatible Materials	Strong oxidizers such as ozone, liquid oxygen, chlorine, potassium permanganate. Strong acids, Acetone, Alkali metals.
Hazardous Decomposition Products	Carbon monoxide may be generated in the event of a fire (especially with incomplete combustion in an enclosed space).

SECTION XI – TOXICOLOGICAL INFORMATION

Acute Toxicity

Component	**Oral LD50**	**Dermal LD50**	**LC50**
Activated Carbon	>10,000 mg/kg	Not Available	>64.4mg/L (rat, inhalation)

Chronic Toxicity – Carcinogenicity

Component	**IARC**
Activated Carbon	Not considered to be carcinogenic as per IARC, NTP, and OSHA.

Skin Corrosion/Irritation	Dust may cause mechanical irritation.
Ingestion	Non-toxic though ingestion
Inhalation	Non-toxic though inhalation
Serious Eye Damage/Irritation	Causes slight to mild irritation of the eyes.
Respiratory or Skin Sensitization	None known.
Germ Cell Mutagenicity	No adverse mutagenic effects are anticipated.

Reproductive Toxicity	No adverse reproductive effects are anticipated.
STOT-Single Exposure	May cause respiratory tract irritation
STOT-Repeated Exposure	May cause damage to organs through prolonged or repeated exposure.
Aspiration Hazard	Not Available
Synergistic Materials	None known

SECTION XII – ECOLOGICAL INFORMATION

Ecotoxicity

Component	Toxicity to Algae	Toxicity to Fish	Toxicity to Daphnia and Other Aquatic Invertebrates
Carbon	Not Available	Not Available	Not Available

Persistence and degradability	No further relevant information available.
Bioaccumulative potential	No evidence of bioaccumulation or tainting of seafood.
Mobility in soil	No further relevant information available.
Other Adverse Effects	No further relevant information available.

SECTION XIII – DISPOSAL CONSIDERATIONS

Waste Disposal Method
The packaging and material may be land filled; however, material should be covered to minimize generation of airborne dust. This product is not classified as a hazardous waste under the authority of the RCRA (40CFR 261) or CERCLA (40CFR 117&302). Disposal must be made in accordance with local, state and federal regulations including the Canadian Environmental Protection Act..

Contaminated Packaging
Disposal must be made in accordance with local, state and federal regulations including the Canadian Environmental Protection Act.

SECTION XIV – TRANSPORT INFORMATION

	DOT (U.S.)	TDG (Canada)
UN-Number	Not Regulated	Not Regulated
UN proper shipping name	Not Regulated	Not Regulated
Transport Hazard Class(es)	Not Regulated	Not Regulated
Packing Group (if applicable)	Not Regulated	Not Regulated

Environmental hazards:
Not Available

Transport in bulk according to Annex II of Marpol 73/78 and the IBC Code
Not available

Special precautions for user
Do not handle until all safety precautions have been read and understood.

TDG PRODUCT CLASSIFICATION: This product has been classified on the preparation date specified at section 14 of this MSDS / SDS, for transportation in accordance with the requirements of part 2 of the Transportation of Dangerous Goods Regulations. If applicable, testing and/or published test data regarding the classification of this product are listed in the references at section 16 of this MSDS / SDS.

SECTION XV – OTHER REGULATORY INFORMATION

NOTE: THE PRODUCT LISTED ON THIS SDS HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CANADIAN CONTROLLED PRODUCTS REGULATIONS. THIS SDS CONTAINS ALL INFORMATION REQUIRED BY THOSE REGULATIONS.

SECTION XVI – OTHER INFORMATION

Last Updated: March 21, 2022

NOTE: The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind, express or implied, is made with respect to the information contained herein. We accept no responsibility and disclaim all liability for any harmful effects which may be caused by exposure to silica contained in our products.
Prepared by Target Products, Ltd. - Phone 1.604.856.7976

www.TargetProducts.com

End of SDS

TURBIDITY STANDARDS

The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2659405	2660501	Hach Company	OSHA	English	1
2659405	2684701	Hach Company	OSHA	English	1
2659405	2684801	Hach Company	OSHA	English	1
2659405	2684901	Hach Company	OSHA	English	1

Total Enclosures: 4

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01401

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 800 NTU
Catalog Number: 2660501

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01401
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 11
Month: October
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable

Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, milky suspension
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat

Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Turbid, milky suspension
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.36
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit
Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01393

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN SOLUTION <0.1 NTU
Catalog Number: 2684701

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01393
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 06
Month: January
Year: 2006

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 5.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable

TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless liquid
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.

Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation

Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 7.5-8.5
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported
Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.

Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit
Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.
Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01398

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 20 NTU
Catalog Number: 2684801

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01398
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 10
Month: October
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable

TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, colorless liquid
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: ammonia formaldehyde nitrogen oxides. carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.

Storage: Keep container tightly closed when not in use. Protect from: heat
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 8.26
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C; 212°F
Melting Point: Not determined
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported

Skin and Eye Irritation Data: None reported
Mutation Data: Hexamethylenetetramine: Cytogenetic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026 std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit
Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

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302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): None

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

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16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

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Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M01360

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: STABLCAL® FORMAZIN STANDARD 100 NTU
Catalog Number: 2684901

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M01360
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: May cause irritation. May cause allergic reaction.
Date of MSDS Preparation:
Day: 10
Month: March
Year: 2005

2. COMPOSITION / INFORMATION ON INGREDIENTS

Hexamethylenetetramine
CAS No.: 100-97-0
TSCA CAS Number: 100-97-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / volume
LD50: Oral mouse LDLo = 512 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation. Flammable solid. May cause allergic reaction.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 90.0 - 100.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: No effects anticipated.

Other components, each
CAS No.: Not applicable

TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Formazin Polymer
CAS No.: Not available
TSCA CAS Number: Various
Percent Range: < 1.0
Percent Range Units: weight / weight
LD50: None reported.
LC50: None reported.
TLV: Not established.
PEL: Not established.
Hazard: Toxic properties unknown.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Turbid, milky suspension
Odor: None
MAY CAUSE EYE AND SKIN IRRITATION
MAY CAUSE ALLERGIC SKIN REACTION

HMIS:
Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 2
Flammability: 0
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation May cause allergic reaction
Skin Absorption: None reported
Target Organs: Not applicable
Ingestion: May cause: gastrointestinal irritation kidney damage
Target Organs: Kidneys
Inhalation: No effects anticipated
Target Organs: Not applicable
Medical Conditions Aggravated: Allergies or sensitivity to hexamethylenetetramine.
Chronic Effects: Chronic overexposure may cause symptoms similar to acute exposure.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: None required.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, this product decomposes to form toxic gases.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Evacuate area and fight fire from a safe distance.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Dike large spills to keep spilled material from entering sewage and drainage systems or bodies of water.
Clean-up Technique: Absorb spilled liquid with non-reactive sorbent material. Sweep up material. Place material in a plastic bag. Mark bag 'Non-hazardous trash', and dispose of as normal refuse. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate as needed to perform spill clean-up. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: Not applicable

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin Do not breathe mist or vapors. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Keep container tightly closed when not in use. Protect from: heat

Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin Do not breathe: mist/vapor Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Turbid, milky suspension
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: 8.14
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C
Melting Point: Not applicable
Specific Gravity (water = 1): 1.01
Evaporation Rate (water = 1): Not determined
Volatile Organic Compounds Content: Not determined
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Miscible
Acid: Miscible
Other: Not determined
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers
Hazardous Decomposition: Heating to decomposition releases: ammonia carbon monoxide formaldehyde nitrogen oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: None reported

Mutation Data: Hexamethylenetetramine: Cytogenic analysis in human Hela cells @ 1 mmol/l; Oncogenic Transformation - hamster kidney - 10 mg/L
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Hexamethylenetetramine: Oral mouse LDLo = 512 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: Hexamethylenetetramine: Water Pollution Factors: BOD_5: 0.015, 0.026, std. dil. sew.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: Not applicable
Special Instructions (Disposal): Dilute material with excess water making a weaker than 5% solution. Open cold water tap completely, slowly pour the material to the drain. Flush system with plenty of water.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: This product may be shipped as part of a chemical kit composed of various compatible dangerous goods for analytical or testing purposes. This kit would have the following classification: Proper Shipping Name: Chemical Kit
Hazard Class: 9 UN Number 3316.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard
Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.

--

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Not applicable

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains no RCRA regulated substances.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: No Prop. 65 listed chemicals are present in this product.

Identification of Prop. 65 Ingredient(s): Not applicable

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Standard solution

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. Lefevre, Marc J. First Aid Manual for Chemical Accidents, 2nd Ed. New York: Van Nostrand Reinhold Company, 1989. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. New York: Van Nostrand Reinhold Co., 1977.

Revision Summary: European MSDS Only Updates in Heading(s) 2,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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SAFETY DATA SHEET

1. Identification

Product identifier **UNLEADED GASOLINE**

Other means of identification

SDS number 002-GHS

Synonyms Regular/Premium/Midgrade - Unleaded Gasoline, RFG - Reformulated Unleaded Gasoline, Conventional Unleaded Gasoline, Oxygenated Unleaded Gasoline, Non-Oxygenated Unleaded Gasoline, CARB (California Air Resource Board) Unleaded Gasoline, RBOB - Reformulated Blendstock for Oxygenate Blending, CBOB - Conventional Blendstock for Oxygenate Blending, Petrol, Motor Fuel.
See section 16 for complete information.

Recommended use Motor Fuel
Motor fuels.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer/Supplier Valero Marketing & Supply Company and Affiliates
One Valero Way
San Antonio, TX 78269-6000

General Assistance 210-345-4593

E-Mail CorpHSE@valero.com

Contact Person Industrial Hygienist

Emergency Telephone 24 Hour Emergency 866-565-5220
1-800-424-9300 (CHEMTREC USA)

2. Hazard(s) identification

Physical hazards	Flammable liquids	Category 1
Health hazards	Skin corrosion/irritation	Category 2
	Germ cell mutagenicity	Category 1B
	Carcinogenicity	Category 1B
	Reproductive toxicity	Category 2
	Specific target organ toxicity, single exposure	Category 3 narcotic effects
	Specific target organ toxicity, repeated exposure	Category 2
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, long-term hazard	Category 2

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement Extremely flammable liquid and vapor. Causes skin irritation. May cause genetic defects. May cause cancer. Suspected of damaging fertility or the unborn child. May cause drowsiness or dizziness. May cause damage to organs (blood, liver, kidney) through prolonged or repeated exposure. May be fatal if swallowed and enters airways. Toxic to aquatic life with long lasting effects.

Precautionary statement

Prevention	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep container tightly closed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting// equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Do not breathe gas/mist/vapors/spray. Wash thoroughly after handling. Wear protective gloves/protective clothing/eye protection/face protection. Use only outdoors or in a well-ventilated area. Avoid release to the environment.
Response	If exposed or concerned: Get medical advice/attention. If inhaled: Remove person to fresh air and keep comfortable for breathing. If swallowed: Immediately call a poison center/doctor. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. In case of fire: Use alcohol-resistant foam, carbon dioxide, dry powder or water fog for extinction. Collect spillage.
Storage	Store locked up. Store in a well-ventilated place. Keep container tightly closed. Keep cool.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Gasoline	86290-81-5	80-100
Toluene	108-88-3	0-30
Hexane (Other Isomers)	96-14-0	5-25
Xylene (o, m, p isomers)	1330-20-7	0-25
Octane (All isomers)	111-65-9	0-18.5
Ethanol	64-17-5	0-10
1,2,4, Trimethylbenzene	95-63-6	0-6
n-Heptane	142-82-5	1-5
Pentane	109-66-0	1-5
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

4. First-aid measures

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
Skin contact	Remove contaminated clothing and shoes. Wash off immediately with soap and plenty of water. Get medical attention if irritation develops or persists. Wash clothing separately before reuse. Destroy or thoroughly clean contaminated shoes. If high pressure injection under the skin occurs, always seek medical attention.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention.
Ingestion	Rinse mouth thoroughly. Do not induce vomiting without advice from poison control center. Do not give mouth-to-mouth resuscitation. If vomiting occurs, keep head low so that stomach content does not get into the lungs. Never give anything by mouth to a victim who is unconscious or is having convulsions. Get medical attention immediately.
Most important symptoms/effects, acute and delayed	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

Indication of immediate medical attention and special treatment needed	In case of shortness of breath, give oxygen. Keep victim warm. Keep victim under observation. Symptoms may be delayed.
General information	If exposed or concerned: get medical attention/advice. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before re-use.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use a solid water stream as it may scatter and spread fire.
Specific hazards arising from the chemical	Vapor may cause flash fire. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.
Special protective equipment and precautions for firefighters	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask.
Fire-fighting equipment/instructions	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask. Withdraw immediately in case of rising sound from venting safety devices or any discoloration of tanks due to fire. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Move containers from fire area if you can do it without risk. In the event of fire, cool tanks with water spray. Cool containers exposed to flames with water until well after the fire is out. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Vapors may form explosive air mixtures even at room temperature. Prevent buildup of vapors or gases to explosive concentrations. Some of these materials, if spilled, may evaporate leaving a flammable residue. Water runoff can cause environmental damage. Use compatible foam to minimize vapor generation as needed.
Specific methods	Use water spray to cool unopened containers.
General fire hazards	Extremely flammable liquid and vapor. Containers may explode when heated.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Local authorities should be advised if significant spills cannot be contained. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. See Section 8 of the SDS for Personal Protective Equipment.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Stop leak if you can do so without risk. This material is a water pollutant and should be prevented from contaminating soil or from entering sewage and drainage systems and bodies of water. Dike the spilled material, where this is possible. Prevent entry into waterways, sewers, basements or confined areas. Use non-sparking tools and explosion-proof equipment. Small Spills: Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. This material and its container must be disposed of as hazardous waste. Large Spills: Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Prevent product from entering drains. Do not allow material to contaminate ground water system. Should not be released into the environment.
Environmental precautions	Gasoline may contain oxygenated blend products (Ethanol, etc.) that are soluble in water and therefore precautions should be taken to protect surface and groundwater sources from contamination. If facility or operation has an "oil or hazardous substance contingency plan", activate its procedures. Stay upwind and away from spill. Wear appropriate protective equipment including respiratory protection as conditions warrant. Do not enter or stay in area unless monitoring indicates that it is safe to do so. Isolate hazard area and restrict entry to emergency crew. Extremely flammable. Review Firefighting Measures, Section 5, before proceeding with clean up. Keep all sources of ignition (flames, smoking, flares, etc.) and hot surfaces away from release. Contain spill in smallest possible area. Recover as much product as possible (e.g. by vacuuming). Stop leak if it can be done without risk. Use water spray to disperse vapors. Use compatible foam to minimize vapor generation as needed. Spilled material may be absorbed by an appropriate absorbent, and then handled in accordance with environmental regulations. Prevent spilled material from entering sewers, storm drains, other unauthorized treatment or drainage systems and natural waterways. Contact fire authorities and appropriate federal, state and local agencies. If spill of any amount is made into or upon navigable waters, the contiguous zone, or adjoining shorelines, contact the National Response Center at 1-800-424-8802.

7. Handling and storage

Precautions for safe handling

Eliminate sources of ignition. Avoid spark promoters. Ground/bond container and equipment. These alone may be insufficient to remove static electricity.
Wear personal protective equipment. Do not breathe dust/fume/gas/mist/vapors/spray. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. Avoid prolonged exposure. Use only with adequate ventilation. Wash thoroughly after handling. The product is extremely flammable, and explosive vapor/air mixtures may be formed even at normal room temperatures. DO NOT handle, store or open near an open flame, sources of heat or sources of ignition. Protect material from direct sunlight. Take precautionary measures against static discharges. All equipment used when handling the product must be grounded. Use non-sparking tools and explosion-proof equipment. When using, do not eat, drink or smoke. Avoid release to the environment.

Conditions for safe storage, including any incompatibilities

Flammable liquid storage. Do not handle or store near an open flame, heat or other sources of ignition. This material can accumulate static charge which may cause spark and become an ignition source. The pressure in sealed containers can increase under the influence of heat. Keep container tightly closed in a cool, well-ventilated place. Keep away from food, drink and animal feedingstuffs. Keep out of the reach of children.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Components	Type	Value
Benzene (CAS 71-43-2)	STEL	5 ppm
	TWA	1 ppm

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value
Cumene (CAS 98-82-8)	PEL	245 mg/m3
		50 ppm
Cyclohexane (CAS 110-82-7)	PEL	1050 mg/m3
		300 ppm
Ethanol (CAS 64-17-5)	PEL	1900 mg/m3
		1000 ppm
Ethylbenzene (CAS 100-41-4)	PEL	435 mg/m3
		100 ppm
n-Heptane (CAS 142-82-5)	PEL	2000 mg/m3
		500 ppm
n-Hexane (CAS 110-54-3)	PEL	1800 mg/m3
		500 ppm
Octane (All isomers) (CAS 111-65-9)	PEL	2350 mg/m3
		500 ppm
Pentane (CAS 109-66-0)	PEL	2950 mg/m3
		1000 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	PEL	435 mg/m3
		100 ppm

US. OSHA Table Z-2 (29 CFR 1910.1000)

Components	Type	Value
Benzene (CAS 71-43-2)	Ceiling	25 ppm
	TWA	10 ppm
Toluene (CAS 108-88-3)	Ceiling	300 ppm
	TWA	200 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	25 ppm
Benzene (CAS 71-43-2)	STEL	2.5 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value
	TWA	0.5 ppm
Cumene (CAS 98-82-8)	TWA	50 ppm
Cyclohexane (CAS 110-82-7)	TWA	100 ppm
Ethanol (CAS 64-17-5)	STEL	1000 ppm
Ethylbenzene (CAS 100-41-4)	TWA	20 ppm
Gasoline (CAS 86290-81-5)	STEL	500 ppm
	TWA	300 ppm
Hexane (Other Isomers) (CAS 96-14-0)	STEL	1000 ppm
	TWA	500 ppm
n-Heptane (CAS 142-82-5)	STEL	500 ppm
	TWA	400 ppm
n-Hexane (CAS 110-54-3)	TWA	50 ppm
Octane (All isomers) (CAS 111-65-9)	TWA	300 ppm
Pentane (CAS 109-66-0)	TWA	600 ppm
Toluene (CAS 108-88-3)	TWA	20 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	STEL	150 ppm
	TWA	100 ppm

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
1,2,4, Trimethylbenzene (CAS 95-63-6)	TWA	125 mg/m3
		25 ppm
Benzene (CAS 71-43-2)	STEL	1 ppm
	TWA	0.1 ppm
Cumene (CAS 98-82-8)	TWA	245 mg/m3
		50 ppm
Cyclohexane (CAS 110-82-7)	TWA	1050 mg/m3
		300 ppm
Ethanol (CAS 64-17-5)	TWA	1900 mg/m3
		1000 ppm
Ethylbenzene (CAS 100-41-4)	STEL	545 mg/m3
		125 ppm
	TWA	435 mg/m3
		100 ppm
Hexane (Other Isomers) (CAS 96-14-0)	Ceiling	1800 mg/m3
		510 ppm
	TWA	350 mg/m3
		100 ppm
n-Heptane (CAS 142-82-5)	Ceiling	1800 mg/m3
		440 ppm
	TWA	350 mg/m3
		85 ppm
n-Hexane (CAS 110-54-3)	TWA	180 mg/m3
		50 ppm
Octane (All isomers) (CAS 111-65-9)	Ceiling	1800 mg/m3
		385 ppm
	TWA	350 mg/m3
		75 ppm
Pentane (CAS 109-66-0)	Ceiling	1800 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
		610 ppm
	TWA	350 mg/m3
		120 ppm
Toluene (CAS 108-88-3)	STEL	560 mg/m3
		150 ppm
	TWA	375 mg/m3
		100 ppm
Xylene (o, m, p isomers) (CAS 1330-20-7)	STEL	655 mg/m3
		150 ppm
	TWA	435 mg/m3
		100 ppm

Biological limit values

ACGIH Biological Exposure Indices

Components	Value	Determinant	Specimen	Sampling Time
Benzene (CAS 71-43-2)	25 µg/g	S-Phenylmercapturic acid	Creatinine in urine	*
Ethylbenzene (CAS 100-41-4)	0.7 g/g	Sum of mandelic acid and phenylglyoxylic acid	Creatinine in urine	*
n-Hexane (CAS 110-54-3)	0.4 mg/l	2,5-Hexanedi - on, without hydrolysis		*
	0.4 mg/l	2,5-Hexanedion, without hydrolysis	Urine	*
Toluene (CAS 108-88-3)	0.3 mg/g	o-Cresol, with hydrolysis	Creatinine in urine	*
	0.03 mg/l	Toluene	Urine	*
	0.02 mg/l	Toluene	Blood	*
Xylene (o, m, p isomers) (CAS 1330-20-7)	1.5 g/g	Methylhippuric acids	Creatinine in urine	*

* - For sampling details, please see the source document.

Exposure guidelines

US - California OELs: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
Cumene (CAS 98-82-8)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.
Toluene (CAS 108-88-3)	Can be absorbed through the skin.

US - Minnesota Haz Subs: Skin designation applies

Cumene (CAS 98-82-8)	Skin designation applies.
Toluene (CAS 108-88-3)	Skin designation applies.

US - Tennesse OELs: Skin designation

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Benzene (CAS 71-43-2)	Can be absorbed through the skin.
n-Hexane (CAS 110-54-3)	Can be absorbed through the skin.

US. NIOSH: Pocket Guide to Chemical Hazards

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Cumene (CAS 98-82-8)	Can be absorbed through the skin.

Appropriate engineering controls Provide adequate general and local exhaust ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof equipment.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses. If splash potential exists, wear full face shield or chemical goggles.
Skin protection	
Hand protection	Avoid exposure - obtain special instructions before use. Wear protective gloves. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier.
Other	Wear chemical-resistant, impervious gloves. Full body suit and boots are recommended when handling large volumes or in emergency situations. Flame retardant protective clothing is recommended.
Respiratory protection	Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator. If workplace exposure limits for product or components are exceeded, NIOSH approved equipment should be worn. Proper respirator selection should be determined by adequately trained personnel, based on the contaminants, the degree of potential exposure and published respiratory protection factors. This equipment should be available for nonroutine and emergency use.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Consult supervisor for special handling instructions. Avoid contact with eyes. Avoid contact with skin. Keep away from food and drink. Wash hands before breaks and immediately after handling the product. Provide eyewash station and safety shower. Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Appearance	Light straw to red clear liquid with characteristic strong odor of gasoline.
Physical state	Liquid.
Form	Liquid.
Color	Light straw to red clear.
Odor	Characteristic Gasoline Odor (Strong).
Odor threshold	Not available.
pH	Not available.
Melting point/freezing point	44.01 °F (6.67 °C) May start to solidify at this temperature. This is based on data for the following ingredient: Cyclohexane. Weighted average: -91.9 deg C (-133.4 deg F)
Initial boiling point and boiling range	80.06 - 440.06 °F (26.7 - 226.7 °C)
Flash point	-40.0 °F (-40.0 °C) (closed cup)
Evaporation rate	10 - 11 BuAc
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	1.3 %
Flammability limit - upper (%)	7.1 %
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	60.8 - 101.3 kPa (20°C)
Vapor density	3 - 4 (Air=1)
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Very slightly soluble.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	> 500 °F (> 260 °C)
Decomposition temperature	Not available.
Viscosity	Not available.

Other information

Flash point class	Flammable IA
VOC (Weight %)	100 %

10. Stability and reactivity

Reactivity	None known.
Chemical stability	Stable under normal temperature conditions and recommended use.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Heat, flames and sparks. Ignition sources. Contact with incompatible materials. Do not pressurize, cut, weld, braze, solder, drill, grind or expose empty containers to heat, flame, sparks, static electricity, or other sources of ignition; they may explode and cause injury or death.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Ingestion	Swallowing or vomiting of the liquid may result in aspiration into the lungs.
Inhalation	In high concentrations, mists/vapors may irritate throat and respiratory system and cause coughing. May cause drowsiness or dizziness.
Skin contact	Causes skin irritation. Prolonged contact may cause dryness of the skin.
Eye contact	May cause eye irritation.
Symptoms related to the physical, chemical and toxicological characteristics	Irritation of nose and throat. Irritation of eyes and mucous membranes. Skin irritation. Unconsciousness. Corneal damage. Narcosis. Cyanosis (blue tissue condition, nails, lips, and/or skin). Decrease in motor functions. Behavioral changes. Edema. Liver enlargement. Jaundice. Conjunctivitis. Proteinuria. Defatting of the skin. Rash.

Information on toxicological effects

Acute toxicity Based on available data, the classification criteria are not met.

Components	Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)		
Acute		
Dermal		
LD50	Rabbit	> 3160 mg/kg
Inhalation		
LC50	Rat	> 2000 mg/l, 48 Hours
Oral		
LD50	Rat	6 g/kg
Benzene (CAS 71-43-2)		
Acute		
Oral		
LD50	Rat	3306 mg/kg
Cumene (CAS 98-82-8)		
Acute		
Inhalation		
LC50	Mouse	2000 mg/l, 7 Hours
	Rat	8000 mg/l, 4 Hours
Oral		
LD50	Rat	1400 mg/kg
Cyclohexane (CAS 110-82-7)		
Acute		
Oral		
LD50	Rat	12705 mg/kg

Components	Species	Test Results
Ethanol (CAS 64-17-5)		
Acute		
Inhalation		
LC50	Rat	30000 mg/m3
Ethylbenzene (CAS 100-41-4)		
Acute		
Dermal		
LD50	Rabbit	> 5000 mg/kg
Oral		
LD50	Rat	5.46 g/kg
n-Heptane (CAS 142-82-5)		
Acute		
Inhalation		
LC50	Rat	103 mg/l, 4 Hours
n-Hexane (CAS 110-54-3)		
Acute		
Oral		
LD50	Rat	28710 mg/kg
Octane (All isomers) (CAS 111-65-9)		
Acute		
Inhalation		
LC50	Rat	118 mg/l, 4 Hours
Pentane (CAS 109-66-0)		
Acute		
Inhalation		
LC50	Rat	364 mg/l, 4 Hours
Toluene (CAS 108-88-3)		
Acute		
Dermal		
LD50	Rabbit	14.1 ml/kg
Inhalation		
LC50	Rat	8000 mg/l, 4 Hours
Oral		
LD50	Rat	2.6 g/kg
Xylene (o, m, p isomers) (CAS 1330-20-7)		
Acute		
Oral		
LD50	Rat	4300 mg/kg

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Based on available data, the classification criteria are not met.

Respiratory or skin sensitization

Respiratory sensitization Based on available data, the classification criteria are not met.

Skin sensitization Based on available data, the classification criteria are not met.
This substance may have a potential for sensitization which may provoke an allergic reaction among sensitive individuals.

Germ cell mutagenicity May cause genetic defects.
In in-vitro experiments, neither benzene, toluene nor xylene changed the number of sister-chromatid exchanges (SCEs) or the number of chromosomal aberrations in human lymphocytes. However, toluene and xylene caused a significant cell growth inhibition which was not observed with benzene in the same concentrations. In in-vivo experiments, toluene changed the number of sister-chromatid exchanges (SCEs) in human lymphocytes. Toluene may cause heritable genetic damage.

Carcinogenicity May cause cancer.

IARC Monographs. Overall Evaluation of Carcinogenicity

Benzene (CAS 71-43-2)	1 Carcinogenic to humans.
Cumene (CAS 98-82-8)	2B Possibly carcinogenic to humans.
Ethylbenzene (CAS 100-41-4)	2B Possibly carcinogenic to humans.
Gasoline (CAS 86290-81-5)	2B Possibly carcinogenic to humans.
Toluene (CAS 108-88-3)	3 Not classifiable as to carcinogenicity to humans.
Xylene (o, m, p isomers) (CAS 1330-20-7)	3 Not classifiable as to carcinogenicity to humans.

NTP Report on Carcinogens

Benzene (CAS 71-43-2)	Known To Be Human Carcinogen.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Reproductive toxicity Suspected of damaging fertility or the unborn child.
Benzene, xylene and toluene have demonstrated animal effects of reproductive toxicity. Animal studies of benzene have shown testicular effects, alterations in reproductive cycles, chromosomal aberrations and embryo/fetotoxicity. Ethanol has demonstrated human effects of reproductive toxicity. Can cause adverse reproductive effects - such as birth defects, miscarriages, or infertility. Avoid exposure to women during early pregnancy. Avoid contact during pregnancy/while nursing.

Specific target organ toxicity - single exposure May cause drowsiness or dizziness.

Specific target organ toxicity - repeated exposure May cause damage to the following organs through prolonged or repeated exposure: Blood. Kidneys. Liver.

Aspiration hazard May be fatal if swallowed and enters airways.

Chronic effects Repeated exposure of laboratory animals to high concentrations of gasoline vapors has caused kidney damage and cancer in rats and cancer in mice. Gasoline was evaluated for genetic activity in assays using microbial cells, cultured mammalian cells and rat bone marrow cells. The results were all negative so gasoline was considered nonmutagenic under these conditions. Overexposure to this product or its components has been suggested as a cause of liver abnormalities in laboratory animals and humans. Lifetime studies by the American Petroleum Institute have shown that kidney damage and kidney cancer can occur in male rats after prolonged inhalation exposures at elevated concentrations of total gasoline. Kidneys of mice and female rats were unaffected. The U.S. EPA Risk Assessment Forum has concluded that the male rat kidney tumor results are not relevant for humans. Total gasoline exposure also produced liver tumors in female mice only. The implication of these data for humans has not been determined.

Further information Symptoms may be delayed.

12. Ecological information

Ecotoxicity Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Components		Species	Test Results
1,2,4, Trimethylbenzene (CAS 95-63-6)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	7.19 - 8.28 mg/l, 96 hours
Benzene (CAS 71-43-2)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	8.76 - 15.6 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	7.2 - 11.7 mg/l, 96 hours
Cumene (CAS 98-82-8)			
Aquatic			
Crustacea	EC50	Brine shrimp (Artemia sp.)	3.55 - 11.29 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	2.7 mg/l, 96 hours
Cyclohexane (CAS 110-82-7)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	3.961 - 5.181 mg/l, 96 hours
		Striped bass (Morone saxatilis)	8.3 mg/l, 96 hours

Components		Species	Test Results
Ethanol (CAS 64-17-5)			
Aquatic			
Algae	EC50	Freshwater algae	275 mg/l, 72 Hours
		Marine water algae	1970 mg/l
Fish	LC50	Fathead minnow (Pimephales promelas)	> 100 mg/l, 96 hours
		Freshwater fish	11200 mg/l, 96 Hours
Invertebrate	EC50	Freshwater invertebrate	5012 mg/l, 48 Hours
		Marine water invertebrate	857 mg/l, 48 Hours
Ethylbenzene (CAS 100-41-4)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	1 - 4 mg/l, 48 hours
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	4 mg/l, 96 hours
n-Heptane (CAS 142-82-5)			
Aquatic			
Fish	LC50	Western mosquitofish (Gambusia affinis)	4924 mg/l, 96 hours
n-Hexane (CAS 110-54-3)			
Aquatic			
Fish	LC50	Fathead minnow (Pimephales promelas)	2.101 - 2.981 mg/l, 96 hours
Toluene (CAS 108-88-3)			
Aquatic			
Crustacea	EC50	Water flea (Daphnia magna)	5.46 - 9.83 mg/l, 48 hours
Fish	LC50	Pink salmon (Oncorhynchus gorbuscha)	6.86 - 8.48 mg/l, 96 hours
Xylene (o, m, p isomers) (CAS 1330-20-7)			
Aquatic			
Fish	LC50	Rainbow trout,donaldson trout (Oncorhynchus mykiss)	8 mg/l, 96 Hours

Persistence and degradability Not available.

Bioaccumulative potential Not available.

Partition coefficient n-octanol / water (log Kow)

Benzene (CAS 71-43-2)	2.13
Cumene (CAS 98-82-8)	3.66
Cyclohexane (CAS 110-82-7)	3.44
Ethanol (CAS 64-17-5)	-0.31
Ethylbenzene (CAS 100-41-4)	3.15
Hexane (Other Isomers) (CAS 96-14-0)	3.6
Octane (All isomers) (CAS 111-65-9)	5.18
Pentane (CAS 109-66-0)	3.39
Toluene (CAS 108-88-3)	2.73
Xylene (o, m, p isomers) (CAS 1330-20-7)	3.2
n-Heptane (CAS 142-82-5)	4.66
n-Hexane (CAS 110-54-3)	3.9

Mobility in soil Not available.

Other adverse effects Not available.

13. Disposal considerations

Disposal instructions Dispose in accordance with all applicable regulations. This material and its container must be disposed of as hazardous waste. Dispose of this material and its container to hazardous or special waste collection point. Incinerate the material under controlled conditions in an approved incinerator. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container.

Hazardous waste code D001: Waste Flammable material with a flash point <140 °F
D018: Waste Benzene

US RCRA Hazardous Waste U List: Reference

Benzene (CAS 71-43-2)	U019
Cumene (CAS 98-82-8)	U055
Cyclohexane (CAS 110-82-7)	U056
Toluene (CAS 108-88-3)	U220
Xylene (o, m, p isomers) (CAS 1330-20-7)	U239

Waste from residues / unused products Dispose of in accordance with local regulations.

Contaminated packaging Offer rinsed packaging material to local recycling facilities.

14. Transport information

DOT

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	139, B33, B101, T8
Packaging exceptions	150
Packaging non bulk	202
Packaging bulk	242

IATA

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	Yes
ERG Code	3H
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1203
UN proper shipping name	Gasoline
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	
Marine pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Benzene (CAS 71-43-2)	Cancer

Central nervous system
Blood
Aspiration
Skin
Eye
Respiratory tract irritation
Flammability

CERCLA Hazardous Substance List (40 CFR 302.4)

Benzene (CAS 71-43-2)	LISTED
Cumene (CAS 98-82-8)	LISTED
Cyclohexane (CAS 110-82-7)	LISTED
Ethanol (CAS 64-17-5)	LISTED
Ethylbenzene (CAS 100-41-4)	LISTED
Gasoline (CAS 86290-81-5)	LISTED
Hexane (Other Isomers) (CAS 96-14-0)	LISTED
n-Heptane (CAS 142-82-5)	LISTED
n-Hexane (CAS 110-54-3)	LISTED
Octane (All isomers) (CAS 111-65-9)	LISTED
Pentane (CAS 109-66-0)	LISTED
Toluene (CAS 108-88-3)	LISTED
Xylene (o, m, p isomers) (CAS 1330-20-7)	LISTED

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories
Immediate Hazard - No
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Chemical name	CAS number	% by wt.
Toluene	108-88-3	0-30
Xylene (o, m, p isomers)	1330-20-7	0-25
1,2,4, Trimethylbenzene	95-63-6	0-6
Cumene	98-82-8	0-5
Ethylbenzene	100-41-4	0-5
Benzene	71-43-2	0-4.9
n-Hexane	110-54-3	0-3
Cyclohexane	110-82-7	0-3

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Pentane (CAS 109-66-0)

Safe Drinking Water Act (SDWA) Not regulated.

Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number

Toluene (CAS 108-88-3) 6594

Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))

Toluene (CAS 108-88-3) 35 % weight/volumn

DEA Exempt Chemical Mixtures Code Number

Toluene (CAS 108-88-3) 594

US state regulations

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

US. Massachusetts RTK - Substance List

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. New Jersey Worker and Community Right-to-Know Act

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Pennsylvania Worker and Community Right-to-Know Law

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethanol (CAS 64-17-5)
Ethylbenzene (CAS 100-41-4)
Gasoline (CAS 86290-81-5)
Hexane (Other Isomers) (CAS 96-14-0)
n-Heptane (CAS 142-82-5)
n-Hexane (CAS 110-54-3)
Octane (All isomers) (CAS 111-65-9)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. Rhode Island RTK

1,2,4, Trimethylbenzene (CAS 95-63-6)
Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Cyclohexane (CAS 110-82-7)
Ethylbenzene (CAS 100-41-4)
n-Hexane (CAS 110-54-3)
Pentane (CAS 109-66-0)
Toluene (CAS 108-88-3)
Xylene (o, m, p isomers) (CAS 1330-20-7)

US. California Proposition 65

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

Benzene (CAS 71-43-2)
Cumene (CAS 98-82-8)
Ethylbenzene (CAS 100-41-4)
Toluene (CAS 108-88-3)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

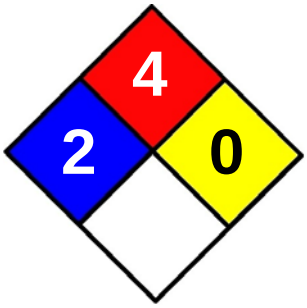
Issue date 13-May-2013

Revision date 23-May-2014

Version # 03

Further information HMIS® is a registered trade and service mark of the NPCA.

NFPA Ratings



References

ACGIH
EPA: AQUIRE database
NLM: Hazardous Substances Data Base
US. IARC Monographs on Occupational Exposures to Chemical Agents
HSDB® - Hazardous Substances Data Bank
IARC Monographs. Overall Evaluation of Carcinogenicity
National Toxicology Program (NTP) Report on Carcinogens
ACGIH Documentation of the Threshold Limit Values and Biological Exposure Indices

Disclaimer

This material Safety Data Sheet (SDS) was prepared in accordance with 29 CFR 1910.1200 by Valero Marketing & Supply Co., ("VALERO"). VALERO does not assume any liability arising out of product use by others. The information, recommendations, and suggestions presented in this SDS are based upon test results and data believed to be reliable. The end user of the product has the responsibility for evaluating the adequacy of the data under the conditions of use, determining the safety, toxicity and suitability of the product under these conditions, and obtaining additional or clarifying information where uncertainty exists. No guarantee expressed or implied is made as to the effects of such use , the results to be obtained, or the safety and toxicity of the product in any specific application. Furthermore, the information herein is not represented as absolutely complete, since it is not practicable to provide all the scientific and study information in the format of this document, plus additional information may be necessary under exceptional conditions of use, or because of applicable laws or government regulations.

APPENDIX C

Heat Illness Prevention Program

HEAT ILLNESS
PREVENTION PROGRAM

CORPORATE HEALTH AND SAFETY DIRECTOR	:	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	:	**10/2019**
REVISION DATE	:	**03/2023**
REVISION NUMBER	:	**2**

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1. PURPOSE

Roux Associates, Inc. and its affiliated **companies**, Roux Environmental Engineering and Geology, D.P.C, and Remedial Engineering (collectively, "Roux") has established this heat illness prevention program to assist in preventing workplace accidents, injuries, and illnesses associated with temperature extremes. Roux is committed to taking every precaution to protect employees who might be exposed to heat stress, including establishing safe work practices, heat illness prevention controls, and emergency preparedness, which will be detailed in this plan.

2. SCOPE AND APPLICABILITY

Roux's Heat Illness Prevention Program applies to all employees who may be exposed to heat stress in the field.

3. ROLES AND RESPONSIBILITIES

The Heat Illness Prevention Program Administrator for Roux is the Corporate Health and Safety Director (CHSD), Brian Hobbs, CIH, CSP. The daily administration of the program is delegated to the Operations Manager (OM) and Office Health and Safety Manager (OHSM). The CHSD has the authority, responsibility, and overall accountability for the comprehensive implementation of this program.

All managers and supervisors shall implement and maintain the heat illness prevention program in work areas where there is a potential for heat stress.

Management Responsibilities

Management (i.e., Project Managers, Project Principals, OM) must provide the following to promote compliance and foster a good safety culture:

- Comply with applicable standards.
- Inform employees of the provisions of the heat illness prevention program and ensure understanding.
- Provide sufficient water, shade, rest areas, and other heat illness controls for employees.
- Assist with establishing work practices to minimize heat stress risks, such as acclimatization, required rest periods, employee monitoring, and strategic scheduling.
- Encourage employees to report hazardous conditions or heat illness symptoms.
- Provide training to any employee who could possibly be exposed to the risk of heat illness.

Employee Responsibilities

Employees are expected to actively participate in the organization's heat illness prevention program, which includes the following responsibilities:

- Receive appropriate training with regards to heat stress.
- Understand core concepts of heat illness prevention and follow guidelines to mitigate risks.
- Recognize the signs and symptoms of heat illness and immediately report them.
- Cooperate with workplace inspections and incident investigations.

Effective Communication

All Roux employees shall be accountable for ensuring there is effective communication with both the field team and their subcontractors. Communication between Roux employees project leads (e.g., Project Principal, Project Managers) and subcontractors (if applicable) will be established and maintained, so that employees can quickly contact should there be a change in condition or someone at the Site exhibits signs/symptoms of heat stress. These

types of incidents would follow Roux's Incident Investigation and Reporting Management Program 2.12 and Roux's Injury Illness Prevention Program 2.22.

4. HAZARD IDENTIFICATION AND ASSESSMENT

Prior to scheduled field work, the project team shall ensure a hazard assessment is conducted as it relates to heat stress. This will include a determination of how much heat and exertion employees are likely to be exposed to based on the work activity.

Factors that can increase heat stress can include the following:

- Temperatures at the work site;
- Humidity;
- A lack of air movement or exchange;
- The amount of time employees spend working in the heat;
- The time of day work takes place;
- Sources of radiant heat (e.g., sunlight, fire, or hot furnace);
- Work activities that produce heat (e.g., welding);
- Physical contact with warm or hot objects or liquids;
- The clothing and PPE employees are required to wear; and/or
- Physically strenuous work.

Results of the hazard analysis should be used to determine appropriate controls for mitigating heat stress, whenever possible, for planning acclimatization and for developing work schedules that rotate workers to limit employee exposure. Typically, the Site Supervisor (SS) or Site Health and Safety Officer (SHSO) shall conduct worksite observations to assure all employees follow heat illness prevention procedures and that hazards are sufficiently controlled. However, all employees should be continuously evaluating work site conditions and be able to recognize heat stressors in order to prevent heat illnesses.

5. TRAINING

All Roux employees shall be trained on the topics listed below prior to beginning work, which may potentially expose workers to heat stress.

Training Topics

- The environmental, behavioral, and personal risk factors for heat illness, such as radiant heat sources, exertion, clothing and PPE, and use of alcohol or drugs.
- Types of heat illnesses, common symptoms, and appropriate emergency response for each.
- The knowledge that mild symptoms may quickly become more severe or life-threatening.
- The importance of immediately reporting any signs or symptoms of heat illness to the supervisor.
- The employer's responsibility to provide shade, water, access to first aid, and cool-down rests during work and the employee's freedom to exercise their rights under this standard without fear of retaliation.
- The employer's heat stress plan and its procedures:
  - Procedures for employees who are newly assigned to work in high heat areas.

  - The organization's acclimatization methods, as applicable.
  - Heat wave procedures.
  - Heat illness and emergency response, including contact information.
- The importance of frequent consumption of water and the taking of rest breaks.
- How heat illness prevention applies to employees' specific tasks.

Increasing Training Effectiveness:

- The SS/SHSO will hold daily tailgates with the field team to go over daily work tasks and basic safety information including Job Safety Analysis (JSA) review as well as incorporate elements such as current weather and effects on the work activities for the day.
- If a heat wave or high heat is anticipated, OHSMs and/or OMs will provide communications to Roux employees prior to their shifts and remind them of any special high heat procedures.

6. DRINKING WATER

Employees shall be given access to potable drinking water. Access to water will be provided as near as possible to where employees are working, and there shall be enough locations so employees will have sufficient water. Water should be fresh and pure, free of taste or smell that would discourage employees from drinking, comfortably cool, and obtained from an approved source.

The recommendation is that during warm or hot weather, employees drink four 8-ounce glasses of water, or a total of one quart per hour, throughout the entire work shift. Easy access to sufficient potable drinking water throughout the work shift encourages employees to drink.

During a heat wave, water shall be replenished more often to keep available and cool. Water containers (and all spouts and levers) must be kept clean. If able, provide single use drinking cups with appropriate waste receptacle. Accessible sanitation facilities shall also be maintained at work Sites as appropriate.

SS/SHSO are responsible for the following:

- Drink sufficient water before, during, and after work shifts to maintain hydration.
- Encourage frequent drinking of small amounts of water throughout the shift. In high heat environments, remind field staff and subcontractors that drinking extra water may be necessary.
- Discourage the choosing of drinks with caffeine or sugar that may possibly dehydrate employees instead of water. Also, discourage the drinking of alcohol.
- Monitor the water supply.
- If employees become dehydrated and are unable to alleviate symptoms with the steps below, get them immediate medical attention.

Field Staff/Subcontractors are responsible for the following:

- Drink sufficient water before, during, and after work shifts to maintain hydration. Drink up to 4 cups of water per hour, especially during hot weather.
- Be aware that in high heat situations, you may need to drink more water.
- Monitor yourself and others for signs of dehydration. If you feel dehydrated:
  - Follow Roux's Incident Notification Flowchart;

- Rest in the shaded resting area; and
- Drink water in small amounts, but frequently.

7. ACCESS TO SHADE

Access to shaded areas will be provided to Roux staff, as needed. Employees are encouraged to use these areas when they feel overheated. Roux's SS/SHSO shall oversee the proper implementation of shaded areas and will communicate these locations on a daily basis with the Field Team.

Depending on the Site, shaded areas can include the following:

- Pop-up Tents
- Canopies
- Umbrellas
- Structures mechanically ventilated or open to air movement
  - Garage
- Conex mounted RV canopies
- Full and thick tree canopies that block direct sunlight
- Buildings
- Enclosed areas only if they provide cooling comparable to shade in open air
  - Vehicles with air conditioning

Shaded Area Requirements

Shade shall be strong enough to cool employees down and other shadows should not be visible in the shade. Shade will be provided by Roux when the air temperature exceeds 80°F. If the temperature is less than 80°F, shade will be available and provided upon request. The SS/SHSO will monitor conditions to determine when the air will exceed (and is exceeding) 80°F. For most Sites, air will be monitored hourly and shade will be setup immediately if 80°F is exceeded.

Shade shall be located as close as practical to areas where employees are working and is easily accessible. These areas will be considered safe and free from other hazards. Shaded areas should be large enough to accommodate all employees who are on a break, resting, or recovering without crowding. Should natural vegetation be used for shade, the SS/SHSO will evaluate shade for effectiveness.

Field Staff Responsibilities

Field Staff should take ordinary rest breaks in the shaded areas and monitor themselves for signs of heat stress, and go to the shaded area when they need to cool down. Any issues or problems with shaded areas should be reported to the SS/SHSO for the Site.

If shaded areas are used for a preventative cool-down, the SS/SHSO will ensure the affected employees will remain in the shade until they begin to feel better. The SS/SHSO will continue to monitor the employees and ask them if they are experiencing symptoms of a heat illness. Employees shall not be sent back to work before symptoms have ended and at a minimum at least 10 minutes of rest.

8. MONITORING AND SCHEDULING

Monitoring

The SS/SHSO and Field Team will continue to monitor themselves and others for signs of heat illness. The SS/SHSO will monitor when the air temperature exceeds 80°F. Throughout the summer, weather and temperature will be monitored at least two weeks ahead, and the work schedule will be planned to accommodate the expected weather.

Scheduling

Scheduling accommodations may include:

- Working during cooler hours of the day
- Working at night
- Stopping work early
- Rescheduling work activities
- Increasing frequency of breaks

In general, strenuous work activities shall be rescheduled to the coolest parts of the day.

Special precautions are required for temperatures above 80°F, 95°F, and heat waves. These precautions are provided in sections below.

9. ACCLIMATIZATION AND NEW EMPLOYEE PROCEDURES

Roux requires employees to be acclimatized in order for them to better tolerate heat in the workplace. Acclimatization is the physical process of adapting to a different thermal environment, allowing a better toleration of heat. Acclimatization procedures require gradual exposure that gives the employee time to adjust to each level of exposure. Acclimatization is essential for new employees, but is necessary for all employees when the temperature significantly changes. Heat stress is much more likely if these procedures are not followed.

The SS/SHSO is responsible for observing new employees during their first 14 days of employment in high heat areas.

Re-acclimatization is necessary if employees are absent from high heat environments for a week or more or the temperature increases significantly.

10. HEAT WAVE AND EXTREME HEAT PROCEDURES

Heat Wave Procedures

A heat wave is defined as consistent temperatures over 80°F or if the temperature is 10° higher than the average daily temperatures in the preceding 5 days.

SS/SHSO and Project Management (e.g., PP, PM) shall closely observe and monitor employees during a heat wave. The Field Teams should institute a ratio of one SS to 20 or fewer employees, a mandatory buddy system, or a consistent practice for supervisors to check on employees. Pre-shift meetings to review high heat procedures with employees will be carried out to emphasize work rest schedules, drinking water, shade, etc.

Extreme Heat Procedures

When work site temperatures equal or exceed 95°F, the employer will enact extreme heat procedures:

- Employees will be closely observed by the SS/SHSO for signs of heat illness. New employees will be supervised for acclimatization.
- Effective communication and monitoring will be assured through the use of periodic check ins with the SS/SHSO via phone. Communications between employees and Project Management (e.g., PP/PM) will be established and maintained. Mandatory 10-minute break periods are required for every two hours worked. SS/SHSO must enforce this rule.
- Pre-shift safety tailgate meetings will occur to review procedures and to remind employees to drink water and take cool-down rests if needed. SS/SHSO shall remind employees to rest and drink water. Employees should drink more water than usual.

11. EMERGENCY RESPONSE PROCEDURES

Roux is dedicated to providing prompt appropriate care for all employees who report or show symptoms of heat illness. If an employee shows signs of heat illness, they will be monitored and shall not be left alone or sent home without being offered first aid or emergency medical services. If on-Site personnel require any medical treatment, the following steps will be taken:

1. Notify Roux's Project and Corporate Management Team for any work-related injury and/or illness occurrence, and communicate with the contracted Occupational Health Care Management Provider, AllOne Health (AOH), immediately following the notifications provided above.
2. Based on discussions with the Project Team, Corporate Management, and the AOH evaluation, if medical attention beyond onsite First Aid is warranted, transport the injured / ill person (IP) to the Urgent Care Center, or notify the Fire Department or Ambulance Emergency service and request an ambulance or transport the victim to the hospital, and continue communications with Corporate Management Team. An Urgent Care/Hospital Route map with locations and directions are provided within Site Specific Health and Safety Plans.
3. First aid medical support will be provided by onsite personnel trained and certified in First Aid, Cardio Pulmonary Resuscitation (CPR), Automatic External Defibrillation (AED), and Blood-Borne Pathogens (BBP) Awareness, until relieved by emergency medical services (EMS).
4. The SHSO and Project Manager will perform a Loss Investigation (LI) and the Project Team will complete the final Loss Report.

12. HEAT-RELATED ILLNESSES

Heat Stress

Heat stress is a significant potential hazard and can be associated with heavy physical activity and/or the use of personal protective equipment (PPE) in hot weather environments. For these reasons, the company will provide potable drinking water and access to shade or other areas of relief (i.e., air-conditioned vehicles, work trailers). Supervisors, prior to supervising personnel in the field as well as all personnel involved with the field work of a project, are trained in this HASP that includes preventing heat-related illnesses and the below procedures in response to heat-related symptoms and illness. Since much of our work is dependent upon environmental factors beyond our control, we must closely monitor air temperature and humidity and be aware of avoiding radiant heat sources and providing as much air circulation as possible wherever we work. Physical factors that need to be evaluated as part of our Job Safety Analysis (JSA) reviews include the level of physical activity and duration of work and the type (i.e., color, weight breathability) of the clothing we select. In addition, personal factors such as age, weight, fitness, drug/alcohol use, and prior history of heat-related illness need to be considered.

Heat cramps are brought on by prolonged exposure to heat. As an individual sweats, water and salts are lost by the body, resulting in painful muscle cramps. The signs and symptoms of heat stress are as follows:

- Severe muscle cramps, usually in the legs and abdomen;
- Exhaustion, often to the point of collapse; and
- Dizziness or periods of faintness.

First aid treatment includes, but is not limited to, shade, rest, and fluid replacement. Typically, the individual should recover within one-half hour while being monitored constantly. If the individual has not improved substantially within 30 minutes and the body temperature has not decreased, the individual should be transported to a hospital for medical attention.

Heat Exhaustion

Heat exhaustion may occur in a healthy individual who has been exposed to excessive heat while working or exercising. The circulatory system of the individual fails as blood collects near the skin to rid the body of excess heat through transference. The signs and symptoms of heat exhaustion are as follows:

- Rapid and shallow breathing;
- Weak pulse;
- Cold and clammy skin with heavy perspiration;
- Skin appears pale;
- Fatigue and weakness;
- Dizziness; and
- Elevated body temperature.

First aid treatment include, but is not limited to, cooling the victim, elevating the feet, and replacing fluids. If the individual is not substantially improved within 30 minutes and the body temperature has not decreased, the individual should be transported to the hospital for medical attention.

Heat Stroke

Heat stroke occurs when an individual is exposed to excessive heat and stops sweating. This condition is classified as a MEDICAL EMERGENCY requiring immediate cooling of the victim and transport to a medical facility. The signs and symptoms of heat stroke are as follows:

- Dry, hot red skin;
- Body temperature approaching or above 105 degrees F;
- Confusion, altered mental state, slurred speech;
- Seizures;
- Large (dilated) pupils; and
- Loss of consciousness – the individual may go into a coma.

First aid treatment requires immediate cooling and transportation to a medical facility. Heat stress is a significant hazard if any type of protective equipment (semi-permeable or impermeable) that prevents evaporative cooling is worn in hot weather environments.

13. OTHER HEAT CONTROLS

Clothing and PPE

Employees should choose clothing that is reflective, light-colored, lightweight, loose-fitting and breathable. Clothing should cover the exposed parts of the body. In direct sun, hard hats with a brim or bill may be helpful. Should specialized cooling garments be applicable, please consult with your OM/OHSM/CHSD.

Managing Employee Risk Factors

It is recommended that employees are aware of how their health can affect their risk of heat stress. The following increases ones risk for a heat related illness:

- A poor level of physical fitness
- Obesity
- Chronic or acute illnesses
- Conditions such as diabetes, heart disease, or high blood pressure
- Certain medications, such as diuretics
- Age (60+)

Employees should:

- Maintain their health outside of work
- Be aware of the effects of medications
- Drink adequate amounts of water
- Eat light, cool meals during work shifts and save heavy meals until after the shift is over
- Do not skip meals: food helps replace electrolytes when sweating
- Take breaks as needed
- Do not consume alcohol prior to working in a hot environment

APPENDIX D

Personal Protective Equipment (PPE) Management Program

PERSONAL PROTECTIVE EQUIPMENT
MANAGEMENT PROGRAM

CORPORATE HEALTH AND SAFETY DIRECTOR	:	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	:	**01/2019**
REVIEW DATE	:	**03/2023**
REVISION NUMBER	:	**4**

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1. PURPOSE

Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C., and Remedial Engineering (collectively, "Roux") has instituted the following program to establish guidelines for the selection of personal protective equipment (PPE) for use by Roux personnel performing field activities in hazardous environments. PPE is not meant to be a substitute for engineering, work practice, and/or administrative controls, but PPE should be used in conjunction with these controls to protect employees in the workplace. Clothing, body coverings, and other accessories designed to prevent worker exposure to workplace hazards are all types of PPE. To ensure adequate PPE employee-owned PPE is evaluated on a case-by-case basis to insure its adequacy, maintenance and sanitation.

2. SCOPE AND APPLICABILITY

These guidelines apply to all PPE selection decisions to be made in implementing the Roux program. The foundations for this program are the numerous Occupational Health and Safety Administration (OSHA) standards related to PPE cited in 29 CFR 1910 Subpart I, 29 CFR 1926 Subpart E, and the hazardous environment work employee protection requirements under the OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) standard at 29 CFR 1910.120 and 1926.65. To ensure hazard assessments are documented, the levels of protection, types of protection, and tasks requiring protection are covered in site-specific Health and Safety Plans (HASPs) and Job Safety Analyses (JSAs).

3. PROCEDURES

Due to the varied nature of site activities and the different potential hazards associated with different sites, several aspects must be considered when selecting PPE. The following text describes PPE selection logic and provides guidelines and requirements for the appropriate selection and use of PPE.

3.1 Introduction

To harm the body, chemicals must first gain entrance. The intact skin and respiratory tract are usually the first body tissues that are exposed to chemical contaminants. These tissues provide barriers to some chemicals but in many cases, are damaged themselves or are highly permeable by certain chemical compounds. PPE therefore is used to minimize or eliminate chemical compounds from coming into contact with these first barrier tissues.

The proper selection of equipment is important in preventing exposures. The Project Manager (PM) or health and safety personnel making the selection will have to take several factors into consideration. The level of protection, type, and kind of equipment selected depends on the hazardous conditions. In some cases, additional selection factors include cost, availability, compatibility with other equipment, and performance. An accurate assessment of all these factors must be made before work can be safely carried out.

3.1.1 Training

Training shall be provided to all field-based employees in the proper use and care of PPE. Training shall include, but is not limited to, the initial 40-hour HAZWOPER training, annual 8-hour HAZWOPER refresher training, and site-specific PPE training. The training program includes when PPE is necessary; what types of PPE are necessary; how to don, doff, adjust and wear PPE; the limitations of PPE; the proper care, maintenance, useful life and disposal of PPE. In addition, retraining shall be conducted when workplace changes require a change in PPE when an employee demonstrates a lack of knowledge or improper use of PPE is identified. Training certifications are provided to employees that include the date of training and certification subject.

3.2 Types of PPE

The type and selection of PPE must meet certain general criteria and requirements as required under OSHA 29 CFR 1910.132 (General Industry) and 1926.95 (Construction). In addition to these general requirements, specific requirements and specifications exist for some types of PPE that form the basis of the protective clothing scheme. All manufacturer's recommendations for PPE care and use shall be followed. All PPE shall be maintained in a sanitary and reliable condition. Additionally, proper fit and/or size shall be evaluated to ensure adequate protection for all employees. Should PPE become defective, it shall be immediately removed from service and discarded.

The following is a list of the common types of specific PPE and the specific requirements for the PPE type, where applicable:

1. Hard Hats - Regulated by 29 CFR 1910.135 and 1926.100; and, specified in ANSI Z89.1.
2. Face Shields and Safety Glasses - Regulated by 29 CFR 1910.133 and 1926.102; and, specified in ANSI Z87.1.
3. Respiratory Protection - Regulated by 29 CFR 1910.134 and 1926.103.
4. Hand Protection - Not specifically regulated.
5. Foot Protection - Regulated by 29 CFR 1910.136 and 1926.96; and, specified in ANSI Z41.1.
6. Protective Clothing (e.g., fully encapsulated suits, aprons) - Not specifically regulated.

3.3 Protective Clothing Selection Criteria

3.3.1 Chemicals Present

The most important factor in selecting PPE is the determination of what chemicals the employee may be exposed to. On field investigations, the number of chemicals may range from a few to several hundred. The exact chemicals or group of chemicals present at the site (certain groups tend to require similar protection) can be determined by collecting and analyzing samples of the air, soil, water, or other site media. When data are lacking, research into the hazardous materials used or stored at the site can be used to infer potential chemical exposures on the site.

The most appropriate clothing shall be selected once the known, or suspected chemicals have been identified and taken into consideration based on the type of work to be performed.

Protective garments are made of several different substances for protection against specific chemicals. There is no universal protective material. All will decompose, be permeated by, or otherwise fail to protect under given circumstances. Fortunately, most manufacturers make guides to the use of their products (i.e., Dupont's Tyvek™ Permeation Guide). These guides are usually for gloves and coveralls and typically provide information regarding chemical degradation rates (failure of the material to maintain structural integrity when in contact with the chemical), and may provide information on the permeation rate (whether or not the material allows the chemical to pass through). When permeation tables are available, they shall be used in conjunction with degradation tables to determine the most appropriate protective material for the specific chemical hazard(s).

During most site work, chemicals are usually in mixed combinations, and the protective materials are not in continuous contact with pure chemicals for long periods of time; therefore, the selected material may be adequate for the particular chemical of most concern and type of work being performed, yet not the "best" protecting material for all site chemicals and activities. Selection shall depend upon the most hazardous

chemicals based on their hazards and concentrations. Sometimes layering (i.e., using several different layers of protective materials) affords the best protection.

3.3.2 Concentration of the Chemical(s)

One of the major criteria for selecting protective material is the concentration of the chemical(s) in air, liquid, and/or solid state. Airborne and liquid chemical concentrations should be compared to the OSHA standards and/or American Conference of Governmental Industrial Hygienists (ACGIH) and National Institute for Occupational Safety and Health (NIOSH) guidelines to determine the level of skin or other absorptive surface (e.g., eyes) protection needed. While these standards are not designed specifically for skin exposed directly to the liquid, they may provide skin designations indicative of chemicals known to have significant skin or dermal absorption effects. For example, airborne levels of PCBs on-site may be low because it is not very volatile, so the inhalation hazard may be minimal; however, PCB-containing liquid coming in direct contact with the skin may cause overexposure. Thus, PCBs have been assigned a skin designation in both the OSHA and ACGIH exposure limit tables.

3.3.3 Physical State

The characteristics of a chemical may range from nontoxic to extremely toxic, depending on its physical state. Inorganic lead in soil would not be considered toxic to site personnel, unless it became airborne, since it is generally not absorbed through the intact skin. However, organic lead in a liquid could be readily absorbed through the skin. Soil is frequently contaminated with hazardous materials. Concentrations will vary from a few parts per million to nearly one hundred percent by volume. The degree of hazard is dependent on the type of soil and concentration of the chemical. Generally speaking, "dry" soils that have not become airborne do not pose a hazard to site personnel if they take minimal precautions, such as wearing some type of lightweight gloves.

3.3.4 Length of Exposure

The length of time a material is exposed to a chemical increases the probability of a breakthrough. Determinations of actual breakthrough times for short-term exposures indicate that several different materials can be used that would be considered inadequate under long-term exposures. It should be kept in mind that during manufacturer’s permeation testing, a pure (100% composition) liquid is usually placed in direct contact with the material producing a worst-case situation.

3.3.5 Abrasion

When selecting protective clothing, the job the employee is engaged in must be taken into consideration. Persons moving drums or performing other manual tasks may require added protection for their hands, lower chest and thighs. The use of leather gloves and a heavy apron over other normal protective clothing will help prevent damage to the normal PPE, and thus reduce worker exposures.

3.3.6 Dexterity

Although protection from skin and inhalation hazards is the primary concern when selecting PPE, the ability to perform the assigned task must be maintained. For example, personnel cannot be expected to perform work that requires fine dexterity if they must wear a thick glove. Therefore, the PPE selection process must consider the task being performed and provide PPE alternatives or techniques that allow dexterity to be maintained while still protecting the worker (e.g., wearing tight latex gloves over more bulky hand protection to increase dexterity).

3.3.7 Ability to Decontaminate

If disposable clothing cannot be used, the ability to decontaminate the materials selected must be taken into consideration. Once a chemical makes contact with the material, the PPE must be cleaned before it can be reused. If the chemical has completely permeated the material, the clothing cannot be adequately decontaminated, and the material should be discarded.

3.3.8 Climactic Conditions

The human body works best with few restraints from clothing. Protective clothing adds a body burden by increasing weight, restricting movement, and preventing the body's natural cooling process. In severe situations, a modified work program must be used.

Some materials act differently when they are very hot and very cold. For example, PVC becomes almost brittle in very cold temperatures. If there are any questions about the stability of the protective materials under different conditions, the manufacturer should be contacted prior to using PPE in the field.

3.3.9 Work Load

Like climactic conditions, the type of work activity may affect work duration and the ability of personnel to perform certain tasks. Similarly, the amount of protective materials a person wears will affect their ability to perform certain tasks. For example, a person in a total encapsulating suit, even at 72°F, cannot work for more than a short period of time without requiring a break.

The work schedule should be adjusted to maintain the health of the employees. Modified work practices may include allowing more time for individual job tasks and implementing work/rest cycles per NIOSH and ACGIH thermal stress recommendations. Special consideration should be given to the selection of clothing that both protects the worker and adds the least burden when personnel are required to perform strenuous tasks. Excessive bodily stress frequently represents the most significant hazard encountered during field work.

3.4 Types of Protective Materials

1. Cellulose or Paper: suitable for nuisance dusts and coarse fibers.
2. Natural and Synthetic Fibers
    a. Tyvek™: suitable small sized hazardous particles, including lead, asbestos, and mold.
    b. Tychem™: suitable for a variety of hazards from light liquid splashes to heavy exposures of industrial chemicals and agents.
    c. Nomex™: suitable for flame-resistance, radiation resistance, acids, alkalis, fluorocarbon refrigerants (CFCs), and non-polar solvents.
3. Elastomers
    a. Polyethylene: suitable for polar substances and solvents.
    b. Saran™ : suitable for flame-resistance, acids, alkalis, oils, and organic solvents.
    c. Polyvinyl Chloride (PVC): suitable for alcohols, oils, inorganic acids, alkalis, and salts.
    d. Neoprene: suitable for polar/non-polar substances, petroleum mixtures, and ≤ 200 F heat resistance.
    e. Butyl Rubber: suitable for polar substances and solvents.
    f. Viton: suitable for non-polar substances, petroleum mixtures, and ≤ 200 F heat resistance.

g. Nitrile: suitable for polar/non-polar substances and petroleum mixtures.

3.5 Protection Levels

3.5.1 Level A Protection

Level A protection (a fully encapsulated suit) is used when skin hazards exist or when there is no known data that positively rule out skin and other absorption hazards. Per the Roux Respiratory Protection Management Program, Roux employees are not authorized to enter an IDLH atmosphere; therefore, the program does not allow the use of supplied-air respirators (SARs) or self-contained breathing apparatus (SCBA). At no time will Level A work be performed without the consent of the CHSD and OM.

The following conditions suggest a need for Level A protection:

- Confined facilities where probability of skin contact is high;
- Sites containing known skin hazards;
- Sites with no established history to rule out skin and other absorption hazards;
- Atmosphere immediately dangerous to life and health (IDLH) through the skin absorption route;
- Site exhibiting signs of acute mammalian toxicity (e.g., dead animals, illnesses associated with past entry into site by humans);
- Sites at which sealed drums of unknown materials must be opened;
- Total atmospheric readings on the Photoionization Detector (PID), Flame Ionization Detector (FID), and similar instruments indicate 500 to 1,000 ppm of unidentified substances; and
- Extremely hazardous substances (e.g., cyanide compounds, concentrated pesticides, Department of Transportation Poison "A" materials, suspected carcinogens and infectious substances) are known or suspected to be present and skin contact is possible.

The following items constitute Level A protection:

- Open circuit, pressure-demand self-contained breathing apparatus (SCBA);
- Totally encapsulated suit;
- Gloves, inner (surgical type);
- Gloves, outer;
- Chemical protective;
- Boots, chemical protective, steel toe and shank;
- Radiation detector (if applicable); and
- Communications.

3.5.2 Level B Protection

Level B protection is utilized when the highest level of respiratory protection is needed but hazardous material exposure to the few unprotected areas of the body is unlikely.

The following conditions suggest a need for Level B protection:

- The type and atmospheric concentration of toxic substances have been identified and they require the highest level of respiratory protection;

- IDLH atmospheres where the substance or concentration in the air does not present a severe skin hazard;
- The type and concentrations of toxic substances do not meet the selection criteria permitting the use of air-purifying respirators; and
- It is highly unlikely that the work being done will generate high concentrations of vapors, gases or particulates, or splashes of materials that will affect the skin of personnel.

Personal protective equipment for Level B includes:

- Open circuit, pressure-demand SCBA;
- Chemical protective clothing:
- Overalls and long-sleeve jacket; or
- Coveralls;
- Gloves, inner (surgical type); gloves, outer, chemical protective;
- Boots, chemical protective, steel toe, and shank; and
- Communications optional.

3.5.3 Level C Protection

Level C protection is utilized when both skin and respiratory hazards are well defined, and the criteria for using negative pressure respirators have been fulfilled (i.e., known contaminants and contaminant concentrations, acceptable oxygen levels, approved filter/cartridge available, known cartridge service life, etc.). Level C protection may require an emergency escape respirator during specific initial entry and site reconnaissance situations or when applicable after that.

Personal protective equipment for Level C typically includes:

- full facepiece air-purifying respirator;
- emergency escape respirator (optional);
- chemical protective clothing:
  - overalls and long-sleeved jacket; or
  - coveralls;
- gloves, inner (surgical type);
- gloves, outer, chemical protective; and
- boots, chemical protective, steel toe, and shank.

3.5.4 Level D Protection

Level D is the basic work uniform. Personal protective equipment for Level D includes:

- Coveralls;
- Safety boots/shoes;
- Eye protection;
- Hand protection;

- Reflective traffic safety vest (mandatory for traffic areas or railyards);
- Hard hat (with face shield is optional); and
- Emergency escape respirator is optional.

3.5.5 Level E Protection

Level E protection is used when radioactivity above 10 millirems per hour (mrems/hr) is detected at the site. Personal protective equipment for Level E includes:

- Coveralls;
- Air purifying respirator (i.e., P100 or equivalent);
- Time limits on exposure;
- Appropriate dermal protection for the type of radiation present, and
- Radiation dosimetry and ambient monitoring.

3.5.6 Additional Considerations

Fieldwork will contain a variety of situations due to chemicals in various concentrations and combinations. These situations may be partially ameliorated by following the work practices listed below:

1. Foot protection is needed on every site. If the ground to be worked on is contaminated with liquid, and it is necessary to walk in the chemicals, some sort of protective shoe coverings or "booties" can be worn over the boots. Shoe coverings should be designed with soles to help prevent slips. Using disposable shoe coverings when contacting liquid contamination can cut down on overall decontamination requirements. If non-liquids are to be encountered, a Tyvek™ bootie could be used. The advantage of booties is questionable if the ground contains any sharp objects. Boots should be worn with either cotton or wool socks to help absorb perspiration.
2. If the site situation requires the use of hard hats, chin straps should be used if a person will be stooping over where his/her hat may fall off. Respirator straps should not be placed over the hard hats, as this will affect the fit of the respirator.

   Some types of protective materials conduct heat and cold readily. In cold conditions, natural material clothing should be worn under protective clothing. Protective clothing should be removed prior to allowing a person "to get warm." Applying heat, such as with a space heater, to the outside of the protective clothing may drive contaminant permeation. In hot weather, under clothing will absorb sweat. It is recommended that workers use all cotton undergarments.
3. Body protection should be worn and taped to prevent anything from running into the top of the boot. Gloves should be worn and taped to prevent substances from entering the top of the glove. Duct tape is preferred, but masking tape can be used. When aprons are used, they should be taped across the back for added protection. However, this should be done in such a way that the person has mobility.
4. Atmospheric conditions such as precipitation, temperature, wind direction, humidity, wind velocity, and pressure determine the behavior of contaminants in air or the potential for volatile materials to become airborne. These parameters should be considered in determining the need for and the level of protection.
5. A program must be established for periodic air monitoring during site operations. Without an air monitoring program, any changes to air quality would go undetected and might jeopardize on-site personnel. Monitoring can be done with various types of air pumps and filtering devices followed by laboratory analysis of the filtration media, personnel dosimeters, and periodic walk-throughs by personnel carrying real-time direct-reading survey instruments.

6. For operations in the exclusion zone, different levels of protection may be selected, and various types of chemical-resistant clothing may be worn. This selection should be based on the job function, reason for being in the area, and the potential for skin contact with, or inhalation of, the chemicals present.
7. Escape masks must be readily available when levels of respiratory protection do not include a SCBA and the possibility of an IDLH atmosphere exists. The use and placement of escape masks should be made on a case-by-case basis. Escape masks should be strategically located at the site in areas that have higher possibilities of vapors, gases or particulates.

APPENDIX E

Generic Community Air Monitoring Plan

Appendix 1A
New York State Department of Health
Generic Community Air Monitoring Plan

Overview

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate DEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or

overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

1. If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

2. If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

3. If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

4. All 15-minute readings must be recorded and be available for State (DEC and NYSDOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

1. If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

2. If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

3. All readings must be recorded and be available for State (DEC and NYSDOH) and County Health personnel to review.

December 2009

Appendix 1B
Fugitive Dust and Particulate Monitoring

A program for suppressing fugitive dust and particulate matter monitoring at hazardous waste sites is a responsibility on the remedial party performing the work. These procedures must be incorporated into appropriate intrusive work plans. The following fugitive dust suppression and particulate monitoring program should be employed at sites during construction and other intrusive activities which warrant its use:

1. Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate fugitive dust.

2. Particulate monitoring must be employed during the handling of waste or contaminated soil or when activities on site may generate fugitive dust from exposed waste or contaminated soil. Remedial activities may also include the excavation, grading, or placement of clean fill. These control measures should not be considered necessary for these activities.

3. Particulate monitoring must be performed using real-time particulate monitors and shall monitor particulate matter less than ten microns (PM10) with the following minimum performance standards:

(a) Objects to be measured: Dust, mists or aerosols;
(b) Measurement Ranges: 0.001 to 400 mg/m3 (1 to 400,000 :ug/m3);
(c) Precision (2-sigma) at constant temperature: +/- 10 :g/m3 for one second averaging; and +/- 1.5 g/m3 for sixty second averaging;
(d) Accuracy: +/- 5% of reading +/- precision (Referred to gravimetric calibration with SAE fine test dust (mmd= 2 to 3 :m, g= 2.5, as aerosolized);
(e) Resolution: 0.1% of reading or 1g/m3, whichever is larger;
(f) Particle Size Range of Maximum Response: 0.1-10;
(g) Total Number of Data Points in Memory: 10,000;
(h) Logged Data: Each data point with average concentration, time/date and data point number
(i) Run Summary: overall average, maximum concentrations, time/date of maximum, total number of logged points, start time/date, total elapsed time (run duration), STEL concentration and time/date occurrence, averaging (logging) period, calibration factor, and tag number;
(j) Alarm Averaging Time (user selectable): real-time (1-60 seconds) or STEL (15 minutes), alarms required;
(k) Operating Time: 48 hours (fully charged NiCd battery); continuously with charger;
(l) Operating Temperature: -10 to 50^{o} C (14 to 122^{o} F);
(m) Particulate levels will be monitored upwind and immediately downwind at the working site and integrated over a period not to exceed 15 minutes.

4. In order to ensure the validity of the fugitive dust measurements performed, there must be appropriate Quality Assurance/Quality Control (QA/QC). It is the responsibility of the remedial party to adequately supplement QA/QC Plans to include the following critical features: periodic instrument calibration, operator training, daily instrument performance (span) checks, and a record keeping plan.

5. The action level will be established at 150 ug/m3 (15 minutes average). While conservative,

this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m3, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. Corrective measures may include increasing the level of personal protection for on-site personnel and implementing additional dust suppression techniques (see paragraph 7). Should the action level of 150 ug/m3 continue to be exceeded work must stop and DER must be notified as provided in the site design or remedial work plan. The notification shall include a description of the control measures implemented to prevent further exceedances.

6. It must be recognized that the generation of dust from waste or contaminated soil that migrates off-site, has the potential for transporting contaminants off-site. There may be situations when dust is being generated and leaving the site and the monitoring equipment does not measure PM10 at or above the action level. Since this situation has the potential to allow for the migration of contaminants off-site, it is unacceptable. While it is not practical to quantify total suspended particulates on a real-time basis, it is appropriate to rely on visual observation. If dust is observed leaving the working site, additional dust suppression techniques must be employed. Activities that have a high dusting potential--such as solidification and treatment involving materials like kiln dust and lime--will require the need for special measures to be considered.

7. The following techniques have been shown to be effective for the controlling of the generation and migration of dust during construction activities:

(a) Applying water on haul roads;
(b) Wetting equipment and excavation faces;
(c) Spraying water on buckets during excavation and dumping;
(d) Hauling materials in properly tarped or watertight containers;
(e) Restricting vehicle speeds to 10 mph;
(f) Covering excavated areas and material after excavation activity ceases; and
(g) Reducing the excavation size and/or number of excavations.

Experience has shown that the chance of exceeding the 150ug/m3 action level is remote when the above-mentioned techniques are used. When techniques involving water application are used, care must be taken not to use excess water, which can result in unacceptably wet conditions. Using atomizing sprays will prevent overly wet conditions, conserve water, and provide an effective means of suppressing the fugitive dust.

8. The evaluation of weather conditions is necessary for proper fugitive dust control. When extreme wind conditions make dust control ineffective, as a last resort remedial actions may need to be suspended. There may be situations that require fugitive dust suppression and particulate monitoring requirements with action levels more stringent than those provided above. Under some circumstances, the contaminant concentration and/or toxicity may require additional monitoring to protect site personnel and the public. Additional integrated sampling and chemical analysis of the dust may also be in order. This must be evaluated when a health and safety plan is developed and when appropriate suppression and monitoring requirements are established for protection of health and the environment.

APPENDIX F

Cleveland Cliffs Health and Safety Program

CLEVELAND-CLIFFS STEEL

Safety Handbook

Effective Date:	11-14-2022	Supersedes:	All Previous Versions
		Standard No.:	CCS_HSS_MAN_001.1
		Follow-Up Review Date:	11-14-2023

APPROVED

K. Dirk Berard
Senior Director Health Safety Security — 11/14/2022

APPROVER — DATE

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1 Purpose/Scope

1.1 This Handbook establishes minimum standards for Personal protective equipment, Ariel lifts and Scissor lifts, Entering Buildings / Departments, Excavations, Floors and Pit Openings Fire Prevention and Firefighting, General Requirements, Housekeeping, Incident Investigation Industrial Vehicles: Operation and Care, Ladders, Scaffolding and Staging, Personal Protective Equipment, Personal Vehicles, Powered Hand Tools and Fixed Equipment, Safe Storing, Loading and Manual Handing of Material, Three-Part Communication, Use and Care of Hand Tools, Use of Tape for Hazard Demarcation, Walkways, Work Areas, Roadways, Stairs and Doors Welding Burning and Cutting, Working at Overhead Locations.

1.2 This policy applies to employees of Cleveland-Cliffs Steel business units, contractors, subcontractors and hired labor employees performing work for or on behalf of Cleveland-Cliffs Steel on premises owned, rented or otherwise occupied by Cleveland-Cliffs Steel.

2 Responsibilities and Authorities

2.1 This standard was jointly developed with participation from the represented workforce and management.

2.2 Each facilities management is responsible for the implementation of this standard.

2.3 The Senior Director of Health, Safety and Security is responsible for authorizing this standard.

3 References

3.1 References

- CCS_HSS_STD_001.1 Energy Isolation Safety Standard
- CCS_HSS_STD_002.1 Overhead Crane Safety Standard
- CCS_HSS_STD_003.1 Rail Safety Standard
- CCS_HSS_STD_004.1 Confined Space Safety Standard
- CCS_HSS_STD_005.1 Fall Protection Safety Standard
- CCS_HSS_STD_006.1 Aerial Lifts Safety Standard
- CCS_HSS_STD_007.1 Mobile Equipment Safety Standard
- CCS_HSS_STD_008.1 Tool Safety Standard
- CCS_HSS_STD_009.1 Cutting, Burning, and Welding Safety Standard
- 1910.67 Aerial Lifts and Mobile Work Platforms
- 1910.252 Welding Burning and Brazing
- 1910.176 Material Handling

- 1910.141 General Environmental Controls
- 1910.132 Personal Protective Equipment
- ANSI Z-89.1
- ASTM-F2413
- ANSI Z.87
- ANSI 105
- NIOSH 42 CFR 84

4 Resources

4.1 None

5 Requirements

5.1 General Requirements

5.1.1 Employees must report to work “Fit for Duty”

- A state which enables the employee to perform assigned tasks competently and in a manner which does not compromise or threatens the safety of health of yourselves or others.

5.1.2 Keep yourself or others outside the “Line of Fire”

- Pinch points, release of hazardous energy, beneath the path of dropped objects, path of mobile equipment etc.

5.1.3 Horseplay, startling, teasing, throwing of objects, scuffling or distracting another employee is strictly prohibited.

5.1.4 Never lean against, sit, or stand, on temporary hand railings or guard railings of any kind.

5.1.5 Before sitting in a chair assure that it is in good repair (including all of the legs) and that is placed on a flat level surface, with all of the legs making contact with the floor surface.

- While sitting in a chair, never tip the chair to cause one or more of the chair legs to lose contact with the floor surface.
- While sitting in a chair, never prop your feet on a surface above the level of the seat or in any other way that will cause the chair to become unstable.
- Chairs with a single post and a base shall have a minimum of 5 legs, with or without casters, originating from the center post

5.1.6 Never dispose of empty aerosol cans or gas cylinders in dumpsters or containers in which they could end up in molten metal, scrap, or be exposed to heat.

5.1.7 Intercoms, PA Systems and Two-way radios are to be used for business purposes only. Non-essential communication and inappropriate language are prohibited.

5.1.8 Cell phones and laptop computers provided by the company and used to conduct business may be carried on the plant property and into operating areas.

- Cell phones with photographic or video capabilities shall not be used for taking photographs or videos on company property unless authorized by Cleveland-Cliffs Steel management.
- Cell phones or electronic devices shall not be used in operating areas. Employees must move to a safe location before using these devices.

5.1.9 When operating a company-owned vehicle, rental vehicle, leased vehicle or personal vehicle, while performing company business, drivers shall not operate a cell phone, electronic communication device or any other electronic equipment, that is NOT "Hands-Free" equipped.

- The term “Hands-free" equipped is defined as an attachment, add-on, built-in feature or addition to a mobile cellular telephone that, when used, allows the driver to maintain both hands on the steering wheel when receiving, talking and terminating a cellular call. The hands-free accessory can be either permanently installed in the vehicle or may be portable.
- This rule shall apply to company-owned/issued devices or ones owned by the employee.
- If an employee must utilize a cell phone or tablet that are not “Hands-free” they shall drive to a safe location and stop the vehicle prior to activating the device, remaining there until the communication is completed.

5.2 Personal Vehicles

5.2.1 Anyone on a motorcycle shall be wearing an approved motorcycle helmet according to local and state laws and/or plant specific policy.

- Motorcycles are only permitted to be ridden and parked in Cleveland-Cliffs Steel approved locations.

5.2.2 Obey posted signs (speed limit, parking areas, directional signs, etc.)

5.2.3 No personal trailers, boats, campers, etc. allowed on property without written approval by plant general manager or designee.

5.2.4 If a personal vehicle becomes disabled on Cleveland-Cliffs Steel property, employees are not permitted to work on the vehicle, but must call an (outside) Road Service to respond.

- Note: This restriction does not apply to simple repairs, such as changing a flat tire, jump starting a dead battery, and third-party windshield repair.

5.3 Entering Buildings / Departments

5.3.1 Do not go into any department, other than your own, unless your work requires you to do so.

5.3.2 Sign in and out as required by the department prior to entering and after exiting the operations area.

5.3.3 When going into other departments contact the appropriate department person at the sign in location and comply with that department's safety rules, including the wearing of all appropriate personal protective equipment.

5.3.4 Always enter through designated man doors.

- It is only permitted to enter through a roll-up door, if a man door is not present and the door has been pinned, posted and operational control is locked out.

5.3.5 When entering a building, stop and assess operational conditions and possible movement of overhead cranes or other mobile equipment before proceeding. Do not assume that crane or mobile equipment operators can see you.

5.3.6 Warning signs and warning signal systems have been established in each department. Know and obey the signs and signals of the department where you work and those of any department that your work requires you to enter.

5.3.7 Signals - Make sure you know the Emergency Signals and Evacuation Plans in each department where you work.

5.4 Incident Investigation

5.4.1 Report all work-related injuries, occupational illnesses, near misses and equipment, product and property damage incidents to Cleveland-Cliffs Steel Management immediately.

- If a work-related injury or illness is not immediately apparent, it shall be reported as soon as the injury or illness is discovered.

5.4.2 Employees have the right to report work-related injuries and illnesses; and employers are prohibited from discharging or in any manner discriminating against employees for reporting work-related injuries or illnesses.

5.4.3 All involved employees are required to cooperate with management, union safety advocates /coordinators, and other people investigating any incidents or exposures. When asked about an incident with injury/incident/exposure, provide detailed factual information of what was witnessed. This will include:

- All perishable evidence must be preserved
- Interviews
- Statements
- Photos/videos

5.4.4 Emergency Reporting Procedures and Emergency Action Plan must be followed.

5.5 Three-Part Communication

5.5.1 Three-part communication shall be included in all applicable Job Safety Procedures and when the actions of another person is affected. Applicable Job Safety Procedures shall include, LOTOs, temporary work instruction, crane boarding/ de-boarding requirements etc. or where more than one person or crew is working together on a task.

5.5.2 Anytime more than one person or crew is involved in a task that requires understanding and coordination between the two, clear and concise "Initiate-Acknowledge-Confirm (IAC)" communication shall be utilized in the following manner:

- Employee 1 – Initiates communication.
- Employee 2 – Acknowledges by repeating the message.
- Employee 1 – Confirms that Employee 2 received the correct message.

5.5.3 All work shall PAUSE if any of the three parts of IAC are not clearly understood (i.e., employee 1 does not initiate the communication, employee 2 does not acknowledge the initial communication, or employee 1 does not confirm correct understanding from employee 2).

5.5.4 Avoid using single word responses that could be easily confused such as "Go" and "No" or using phrases that end in an action that rely a single word such as "Clear" or "Not clear". Use words like negative, positive, or phrases that repeat the emphasis sentence such as "We are not, I repeat, not clear."

5.5.5 Any confusion in communications should result in a pause of work to clarify what is being said and what actions need to occur.

5.6 Housekeeping

5.6.1 Keep your work area clean and clear. Pick up and dispose of debris as it accumulates. Return hand tools and equipment to their proper storage places when finished with them.

- Keep all walkways, aisles, stairs, and platforms clear of obstructions. Do not pile materials in any area where people must walk. Be sure that materials which are stacked or piled near walkways do not project into aisles, stairs or platforms and that they are properly stacked so they will not topple or fall.
- Do not obstruct access to emergency exits, fixed ladders, stairways, electrical switches, shutoff valves, firefighting or rescue equipment and safety eyewash fountains or safety showers. Do not store any material in, on, or in front of switch boxes or other electrical equipment.

5.6.2 When you have completed repair, construction, or maintenance work of any kind, take time to clean the area. Pick up and remove all waste and salvaged materials. Return all hand tools and equipment to proper storage. Remove all loose objects after completing overhead work. Replace all covers, guards and/or access panels.

5.6.3 Containers shall be provided for the collection and separation of waste, trash, and other refuse. Containers used for oily, flammable, or hazardous wastes (such as caustics, acids, harmful dust, etc.) shall be equipped with covers and labeled. Garbage and other waste shall be disposed of at frequent and regular intervals. Never dispose of trash or non-metallic waste in scrap metal containers.

- When working with, moving or cleaning materials such as metal, wood, glass, etc., do not use your hands, forearms, or other parts of your body to remove slag, slivers, chips, dust, etc. from materials or surrounding areas.

5.6.4 Each plant shall develop a housekeeping program, which at a minimum must include a monthly area housekeeping inspection.

5.7 Personal Clothing / Jewelry

5.7.1 Employee's bodies shall be covered during work hours to comply with department and plant regulations. Only approved apparel, worn in the proper manner shall be permitted in the plant.

5.7.2 Pants must extend at least to the ankles.

5.7.3 Long sleeved shirts are required in all operating areas with the sleeves down and buttoned at the wrist. The shirt shall be tucked into the trousers and fully buttoned up the front to the first button below the collar button. The collar button shall be buttoned when directed by specific Department Procedures. Exceptions to this rule:

- This rule does not apply to non-operating areas such as office areas, break rooms, general office buildings, etc.
- Permitting rolled up long sleeves in operating areas (Machine Shops. Etc.), shall be documented in writing and approved by the Plant Manager and Safety Department.

5.7.4 Work clothes shall not be cleaned in flammable liquids, such as gasoline, kerosene, or similar fluids.

5.7.5 Synthetic clothing including under clothing, that is not made of approved fire retardant or fire-resistant materials, shall not be worn in hot metal areas or when exposed to burning, welding, flame, high radiant heat areas or potential arc flash.

5.7.6 Do not wear clothing that is loose fitting, torn, or ragged, too long (pant legs/shirt sleeves) or with attached hoods (i.e., hooded sweatshirts) to avoid being caught on projections or in moving machinery.

5.7.7 Permanently affixed hooded garments are not permitted unless a documented hazard assessment has been conducted and requirement is specified in a Job Safety Procedure. (I.e., hooded tap coats, disposable coveralls, etc.)

5.7.8 Wearing of finger rings (including silicone or rubber rings), loose-fitting wrist bracelets, exposed dangling necklaces, and dangling earrings or nose rings, other than stud type earrings, or having gauged ear lobes that are open, are prohibited in all operating areas.

- Stud type earrings are permitted in the operating areas as long as they are single studs and fit directly over the opening in the ear lobe and do not project up or down in any manner.
- Gauged ear lobes that have the hole plugged with a solid blank or covered with tape or a Band-Aid are permitted.
- All earrings and gauged lobes must be covered with tape or a Band-Aid while performing any type of electrical work.

5.7.9 Employees with shoulder length or longer hair, or long facial hair (beards) shall be maintained / secured so that it does not create a hazard.

5.8 Personal Protective Equipment

5.8.1 Cleveland-Cliffs Steel employees shall be trained on the proper inspection and use of all Personal Protective Equipment (PPE) issued to them.

- Unauthorized alterations of personal protective equipment in any way are strictly prohibited.

5.8.2 All Personal Protective Equipment (PPE) must follow manufacturer's recommendations and requirements.

5.8.3 Always inspect the PPE before use and replace if needed. Report defects to Cleveland-Cliffs Steel Management immediately.

5.8.4 Cleveland-Cliffs Steel employees are not permitted to use PPE on Cleveland-Cliffs Steel property that were not approved and provided by Cleveland-Cliffs.

5.8.5 Job Safety Procedures or Department Rules shall specify the PPE required for each job. If the PPE is not identified, contact Cleveland-Cliffs Steel Management to confirm PPE requirements before starting the task or if the task's conditions have changed and may require additional PPE.

5.8.6 Persons working within 10 feet of a body of water, 4 feet or greater in depth, shall wear an approved PFD (personal floatation device), if not protected by handrail or other fall protection.

5.8.7 Protective Helmets

5.8.8 Only Cleveland-Cliffs Steel approved Protective helmets conforming to ANSI Z-89.1 Industrial Standard shall be worn. Your protective helmet shall:

- Be worn with bill to the front.

  Unless an approved exception is documented in a hazard assessment and Job Safety Procedure.

- Without altering or wearing anything that would affect the suspension system.
- Hats (baseball type hats, tassel caps, toboggans, etc.) that may affect the fit of the helmet shall not be worn under the protective helmet. Welders' caps, liners or other tight fitting garment that do not affect the hat hard suspension are permitted to be worn under the helmets.
- Without painting, drilling, or otherwise altering the helmet shell.
- With your first and last name printed or labeled onto the front of the helmet.
- With reflective safety tape as follows: · At least a three (3) inch long strip on each side and back of the helmet placed approximately one (1) inch up from the brim of the hat.
- Hardhat or suspension cracked, chipped, burnt, or otherwise suspected to be damaged shall be taken out of service immediately.
- Employees operating or riding in enclosed crane cabs or mobile equipment are not required to wear hard hats unless directed to do so by a specific Job Safety Procedure.
- A red flashing light placed where visible is required to enter designated coil fields, low visibility situations and/or as specified in a Job Safety Procedure. (I.e. roll storage racks, slab yards, batch annealing operations, etc.)

5.8.9 Metatarsal Boots

- Only Cleveland-Cliffs Steel approved six inch or higher, safety toe, safety boots with permanently attached or internal metatarsal guards conforming to ANSI Z-41 Industrial Standard in good repair, properly laced and tied shall be worn by Cleveland-Cliffs Steel employees.
- Cleveland-Cliffs Steel employees are only permitted to obtain metatarsal boots through Cleveland-Cliffs Steel approved metatarsal boot vendors.
- Rubber type metatarsal boots are not permitted unless required by the Job Safety Procedure.
- Temporary metatarsal guards are not permitted.

5.8.10 Safety Glasses

5.8.11 Only Cleveland-Cliffs Steel approved safety plastic framed glasses with permanently attached side shields or wrap around design which meet the ANSI Z.87 Industrial Standard shall be worn by Cleveland-Cliffs Steel employees.

- Employees are only permitted to obtain prescription safety glasses through Cleveland-Cliffs Steel approved eye glass vendors.
- Additional eye protection, such as face shields, welding helmets, goggles, etc., may be required for specific jobs. Always wear the type of eye protection prescribed for the job as specified by the Job Safety Procedure.
- Employees operating or riding in fully enclosed crane cabs or mobile equipment with all windows closed are not required to wear approved safety glasses unless directed to do so by a specific Job Safety Procedure.
- Sunglasses, mirrored sunglasses, transition glasses, etc. are not permitted to be worn inside the plant.

  Prescription exemptions and or medical conditions must be documented in writing and be approved by the employee's doctor / plant medical and the Safety Department

  Employees performing tasks identified in the Job Safety Procedure requiring dark lenses shall be provided the appropriate glasses, clip-ons, flip downs, goggles, face shields, or hoods.

5.8.12 Face Protection

5.8.13 Only Cleveland-Cliffs Steel approved face shields which meet the ANSI Z.87 Industrial Standard shall be worn.

5.8.14 The material constructing the face shield shall be selected based on the potential hazard. Solid material (polycarbonate, acetate, etc.) face shields shall be worn when the hazards is either liquid, molten, arc flash, impact or steam.

5.8.15 Face shields shall be worn in addition to approved safety glasses or goggles.

5.8.16 A face shield shall be worn in the down position if the work activity includes one or more of the following hazards:

- Handling metal or plastic banding while banding coils or other materials, picking up and carrying loose bands or when cutting bands from coils, bundles, pallets, etc. (> 6 inches in length).
- Employees within an arms' length of metal ends, samples, scrap or other materials that can whip or spring, striking the face (I.e. edge trim, weld scarf, scrap bales, flashing).
- Handling full width samples or scrap.

- Exposure to flame, sparks, ultraviolet radiation (welding) arc flash or radiant heat as defined in a hazard assessment.
- Exposure to molten metal (zinc, aluminum, steel, iron, etc.).
- Exposure to acidic, caustic, hot and/or cryogenic fluids
- Spraying with pressurized (>25 psi) liquids, air and mixtures. (I.e. refractory gunning, pressure washing, cleaning via water hose, abrasive blasting, etc.).
- Exposure to steam
- When performing work that could cause deposited dust or metal fines to drop down onto the employee(s).
- Grinding, chipping, striking or cutting operations that cause flying sparks, chips or particles.
- While troubleshooting and/or performing maintenance on hydraulic, pneumatic, steam, or any other line that is under pressure.
- As required by the Job Safety Procedure or department rules.

5.8.17 When working in chemical areas where the procedure requires a chemical barrier suit, the face shield shall be equipped with a chin cup protector to enhance protection to the face and neck. In addition, goggles shall be worn under the face shield for added protection to the eyes.

5.8.18 Respiratory Protection

5.8.19 Only Cleveland-Cliffs Steel designated NIOSH approved respiratory protection shall be worn.

- If wearing a respirator is required, you must be medically evaluated, fit tested and properly trained.
- Facial hair or stubble shall be trimmed or shaved to ensure an adequate seal and proper function of the respirator
- Respirators must be stored per the manufacturers requirements
- Employees shall inspect their respirators prior to use.
- Employees shall conduct field verification (positive and negative) fit checks prior to entering the respiratory required work area.

5.8.20 Voluntary use of respiratory protection requires the employee to be provided a copy of Appendix D to Sec. 1910.134 (Mandatory) Information for Employees Using Respirators When Not Required under the Standard.

5.8.21 Hand Protection

- Before handling any object, substance, or tool, approved hand protection shall be selected and worn to provide the required level of protection.
- Hand protection shall be selected based on an evaluation of the performance characteristics of the equipment relative to the job tasks to be performed and the type of hazard/hazards associated with the tasks.
- Approved and designated cut resistant gloves shall be properly worn when the employee is within an arm's length of cut hazard from coils, metal strips, banding, scrap, etc. or as directed by the Job Safety Procedure or department rules.
- At a minimum, approved leather palmed puncture resistant gloves shall be properly worn when handling wire rope, wire slings or other materials with a potential puncture hazard or as directed by the Job Safety Procedure or Department Rules.
- Hand protection shall be designated in a Job Safety Procedure or by department rules and shall be worn as required.
- Hand protection shall be worn as designed by the manufacturer and shall not be altered from the original design.

5.8.22 Arm Protection

5.8.23 All employees wear Cut resistant sleeves when within arm's length of coils, samples, strip, scrap, or other cut hazards; or when directed by a Job Safety Procedure.

- Cut resistant sleeves are not required after a PPE hazard assessment has been performed and there is no exposure to cut hazard.
- Cut resistant sleeves shall be worn with the thumb through the thumbhole and finger(s) through the finger hole(s) and worn under gloves when required
- The Cut resistant sleeves must be extended above the elbow, where they shall be secured with the clips or in such a manner that the Cut resistant sleeves will remain in place.

5.8.24 Torso and Leg Protection

- Full length cut-resistant chaps shall be worn whenever the employee is within an arm's length of coils, metal strip, scrap, banding, or other similar cut hazards.
- Full length cut resistant chaps shall be worn when walking/working in designated coil fields or as required by a Job Safety Procedure.

- Cut-resistant aprons shall be worn when there is a potential to strike the torso against protruding metal strip, scrap, banding, or other similar cut hazards or as required by a Job Safety Procedure.

- Aprons shall not be worn when there is a potential of being caught in machinery.

5.8.25 High Heat Exposure Clothing

- Approved aluminized coat, or equivalent material, completely secured, shall be worn to protect the base of the neck, torso, arms and upper legs from radiant heat, molten metal, and metal red zones or as required by a Job Safety Procedure and/or department rules and shall extend at least 2 inches over the spats.

- Approved aluminized, or other equivalent material, spats shall be worn to protect from the top of the foot to the knee from radiant heat, molten metal and sparks or as required by a Job Safety Procedure.

- The spats may be worn under the outer garment or over the outer garment in the following manner:

  Non-Aluminized spats worn under approved flame-retardant pants or coveralls shall be worn over approved under garments to provide additional protection from the hot work hazards and to prevent skin irritation.

  Aluminized spats worn over approved issued uniform shall have a minimum of one inch of the pant leg blousing out and over the top of the main body section of the leggings

- Approved aluminized or equivalent material jacket with reflective tape with hood, completely secured and hood over helmet, shall be worn to protect the head, neck and torso of the railroad crew within 30 feet of torpedo cars transporting molten iron.

- The aluminized jacket requirements do not apply to burning or brazing with a hand torch or hand held welding or air arcing unless specifically required by a Job Safety Procedure.

- Approved aluminized neck shroud or equivalent material shall be properly worn in conjunction with an approved face shield and carbonex type hood when there is a molten metal splash hazard or as required by the Job Safety Procedure.

- Approved aluminized or equivalent material beehive type hood shall be worn when the combination of a face shield, aluminized shroud and carbonex type hood does not provide adequate protection from exposures to molten metal, sparks, radiant heat, flame and/or steam or as required by the Job Safety Procedure.
- Approved long cuff gloves with cinches when worn over the aluminized or equivalent material coat shall be cinched tight.
- Approved or equivalent material gloves without cinches shall be worn under the aluminized or equivalent material coat sleeves and the coat sleeves with Velcro closure or snaps shall be tightened or snapped over the gloves.

5.8.26 Minimum PPE

- Cleveland-Cliffs Steel issued uniform:
- FR ankle length pants, FR wrist length shirt (Hot metal uniforms pant Hot metal uniforms shirts in all department's where molten metal is present)
- Hard hat
- Safety eyewear
- Metatarsal boots with safety toe
- Appropriate gloves for the task
- Hearing protection where required

5.8.27 Coil fields or working within arm length of a coil

In addition to minimum PPE, when interacting with coils where there is a potential to strike against or be struck by protruding metal strip, scrap, banding, or other similar cut hazards or as required by a Job Safety Procedure.

- Cut resistant chaps
- Cut resistant bib/apron
- Cut resistant sleeves
- ANSI cut level 5 gloves
- Face shield

5.8.28 Hot metal PPE

In addition to minimum PPE, when interacting with molten metal or positioned in a designated molten metal red zone area, the following PPE is required:

- Base layer (Carbon armor, CarbonX, DRIFIRE)* Optional

- Aluminized or equivalent material Tap coat
- Aluminized or equivalent material Spats
- Aluminized or equivalent material Gloves
- CarbonX hood
- Aluminized or equivalent material neck drape
- Face shield
- Aluminized or equivalent material Beehive hood if job task requires based on the hazard assessment or Job Safety Procedure as required.

5.8.29 Hot Work

In addition to minimum PPE, when conducting Hot Work activities the following PPE is required:

- Double layer FR (FR welding jacket or leather welding jacket)
- Face shield / Welding helmet (attached to hard hat or integrated into the design)
- FR hood (if hot work is being performed above shoulder height)
- Hot work or welding gloves

5.8.30 Any employee within 6' shall wear the exact PPE as the employee performing the welding, burning, and cutting.

5.9 Fire Prevention and Firefighting

5.9.1 Include emergency response to fires

- In addition to the information below, sites are required to develop and maintain emergency action plans that include emergency response to fires.

5.9.2 Prevent Fires

5.9.3 Follow fire prevention rules for your area and be alert to potential fire hazards throughout the plant. Be aware that the danger of fires is higher in certain areas of the plant and special precautions must be taken. Know the proper way of responding to a fire and how to turn in an alarm or initiate the sites emergency notification procedure in the area where you are working. Know the emergency escape routes and the designated assembly points should evacuation become necessary.

- Always obey local smoking regulations.

- Do not allow rubbish or flammable materials to accumulate. Oily waste, rags, gloves, etc., shall always be placed in receptacles provided for them.
- Proper storage of flammable liquids, aerosol cans, etc.
- Change your clothes immediately if they become soaked with oil, gasoline, kerosene, naphtha, or other flammable or combustible materials. Stay far away from portable heaters, welding sparks, hot metal, and other sources of fire if your clothing has been exposed to flammable or combustible liquids.
- Do not light oil or gas furnaces, stoves, portable heater, or other heating equipment unless you have been properly instructed and authorized. Never deviate from specific written procedures when lighting furnaces, stoves, heaters. Etc.
- Flammable liquids (flash point under 100°F) may be used only where there are no open flames or other sources of ignition within any possible path of a vapor trail. Do not dispense a flammable liquid into another container unless the nozzle and container are properly grounded and labeled. Flammable liquids shall be disposed from approved safety cans only.

5.9.4 Firefighting Equipment

- Fire protection system shall not be disabled without written authorization and notification to affected employees in the area.
- Only operate firefighting equipment that you have been trained on.
- Ensure firefighting equipment is properly inspected and maintained
- Firefighting equipment must not be used for any purpose except to put out fires. Do not obstruct aisles or block the paths to fire plugs, extinguishers, hose stands, and other firefighting equipment.
- Fire extinguisher locations must be clearly marked and identified.
- Familiarize yourself with the location of the nearest fire extinguisher or fire hose in the area where you work.

5.10 Welding Burning and Cutting

5.10.1 For Additional information and full scope of requirements reference CCS_HSS_STD_009.1 Cutting, Burning, and Welding Safety Standard

5.10.2 Hot Work Permitting

- Specific areas in the plant will be designated for hot work such as burning, welding, and grinding. If an area is not designed and designated for hot work; a hot work permit must be filled out before hot work can begin. The permit may require the use of fire blankets, other means of spark containment, removal of fire hazards, air quality tests, fire watch, etc., to protect other employees and surrounding property.

- Supervision will designate an individual responsible for authorizing burning, welding, grinding, and other hot work operations in areas not specifically designed or approved for such operations. The work area must be inspected, all portions of the Hot Work Permit completed, and the hot work permit signed by the authorized employee.

5.10.3 Work must be shielded when welding or burning to protect others from the arc flash, or ultraviolet rays.

- If it is necessary for you to be in an area where welding or cutting is being done, exercise caution. Never look directly at the intense light generated by welding or cutting. Check your clothing to be sure you are not carrying sparks which might set your clothing afire. Grease and/or oil on your clothes are especially dangerous if you are working around oxygen. Oxygen can cause the grease or oil to ignite.

5.10.4 Always check burning equipment for leaks before use with a visual inspection and leak detection.

5.10.5 Gas and oxygen hoses need to have flashback prevention and anti-kink strain relief devices installed.

5.10.6 Cylinders Containing Compressed Gases

- Oxygen, fuel gas, and other compressed gases must be considered dangerous fire hazards because they support or increase the rate of combustion. When handling cylinders containing any kind of compressed gas, observe the following rules and specific instructions of your supervisor: If clothes are contaminated with grease, or oil, or solvents, they must be changed before performing any burning or welding.

5.10.7 When burning, the torch shall be extinguished when it becomes necessary to reposition yourself, the compressed gas cylinders or the hoses, around or over obstructions.

5.10.8 When burning, the torch shall be extinguished when it becomes necessary to remove the twist from the oxygen and fuel hoses.

5.10.9 Disposal of Propane and Calibration Gas Bottles.

- Depressurize each bottle to atmospheric pressure and clearly mark the bottle EMPTY with a Semi Permanent Marker. The bottles can then be placed into a trash disposal container or returned to the vendor for re-use.

5.10.10 Transporting

- Caps shall be in place on compressed gas cylinders unless they are in use. Always replace the caps on full or empty cylinders after regulators have been removed. It is especially important to have the caps in place while transporting cylinders to protect the valve.
- Compressed gas cylinders must be transported in special containers or carriers provided for that purpose. At a minimum the carriers shall have a retainer system to secure the cylinder from falling during transport. Torch carts shall have a divider between the oxygen and fuel gasses.
- Do not handle cylinders with crane slings or magnets. Use good judgment when handling or moving cylinders and do not lift beyond your capabilities.
- Compressed gas cylinders must always be securely tied off in a vertical position.
- Do not transport compressed gas cylinders in passenger elevators.

5.10.11 Storage

- Compressed gas cylinders shall be stored with regulators removed and the cylinder caps installed and tightened.
- Compressed gas cylinders shall not be stored near stoves, furnaces, near molten metal, portable heaters or in any area where they will be subjected to high temperatures. They must not be stored where they can make unexpected contact with electrical equipment or conductors if they should slip, roll or fall. Do not store cylinders in entrance/exit areas, or in stair wells.
- Oxygen cylinders must not be stored in a confined or enclosed space with fuel gas, liquid flammables, oils, or grease. A leaking cylinder can cause spontaneous combustion of these materials.
- Acetylene cylinders must always be stored vertically and used vertically with the valve end up.
- Oxygen shall be separated from fuel-gas cylinders or combustible materials at a minimum of 20 feet or by a noncombustible barrier at least five feet high having a one-half hour fire resistance rating.

5.10.12 Using Cylinders

- Never use oil or grease to lubricate any part of an oxygen, acetylene or other gas cylinder or regulator. Do not touch them if you have oil or grease on your hands or gloves.
- If a leaking cylinder is found, remove it to the outside immediately and keep it away from any flames or combustible materials. Notify your supervisor.

- Hoses for fuel gas-oxygen rigs - GREEN hose is for oxygen; RED hose is for all fuel gas. Never use compressed air to blow out these hoses. To prevent tripping hazards and hose damage, keep excess hose lengths coiled and lines arranged in orderly fashion.
- Never bring cylinders into, or store cylinders in confined spaces, unventilated rooms, or other closed quarters. Storage areas must be open or ventilated to prevent a build-up of gas.
- Hoses which are damaged shall be cut in two and taken out of service to prevent injury. Branching or using T-fittings in oxygen or fuel gas hoses is prohibited.
- Each user shall visually inspect hoses for wear and loose connections. If defects are found the hose shall be removed from service and not used.
- Prior to each use, the working end connections and fittings of the hose shall be tested for leaks by immersing or spraying the pressurized hose with an approved leak detection solution. If bubbles, or leaking is detected the hose shall be removed from service and not used.
- Wire brushes, scrapers, or other appropriate hand tools shall be used to clean a surface before or after burning, cutting, or making weld repairs.
- Oxygen, or welding shield gases (Such as Argon, CO2, etc.) shall not be used to clean surfaces before burning, cutting or making weld repairs.

5.11 Powered Hand Tools and Fixed Equipment

5.11.1 For Additional information and full scope of requirements reference CCS_HSS_STD_008.1 Tool Safety Standard

5.11.2 All powered tools and equipment must be inspected before each use.

- All tools must be physically and mechanically sound, and appropriate for the job.
- If any defects are detected, the tool must be removed from service immediately.
- Only properly trained and authorized personnel are permitted to operate these types of equipment.

5.11.3 Guards, shields or safety devices specifically designed for portable power tools must be installed, properly functioning, and in good condition before use.

5.11.4 Electric tools or equipment with broken three-prong grounding plugs must be taken out of service.

- All portable cord and plug electric tools must be connected to G.F.C.I. (Ground Fault Circuit Interrupter).
- Extension cords must be inspected for kinks, worn insulation, and exposed strands of wire before use.
- Extension cords must be protected from physical damage and installed to be out of walkways, stairways, aisles, and areas where they present a trip hazard.

5.11.5 Pneumatic Power Tools and Hose.

5.11.6 Pneumatic power tools must be connected only to designated plant air lines.

5.11.7 They shall be secured to the hose by a positive means to prevent the tool from becoming accidentally disconnected.

- By using safety clips, pins or retainers.
- Anti-whip connections shall be used to connect hoses.
- Automotive radiator type hose clamps are not permitted on air hoses.
- Never direct compressed air toward yourself or anyone else for any reason.
- Never hook up to an unidentified line.

5.11.8 Grinders

- Never use pedestal grinder or portable grinders without the use of face shield and approved eye protection.
- A pedestal grinder tool rest must not be more than 1/8" away from the grinding wheel and the upper tongue guard not more than 1/4" from the grinding wheel.
- Never use pedestal grinder that is not anchored to the mounting surface.
- You should not use or install any grinding wheel unless you have been properly trained in its use and authorized by your supervisor.
- Gloves and loose clothing shall not be worn when using a pedestal or bench grinder.

5.11.9 Hydraulic tools

- Hydraulic powered tools and jacks are required to be visually inspected before and after each use.
- The rated load shall be legibly and permanently marked in a prominent location on the jack.

- Hydraulic powered tools and jacks shall not be used in a manner that will exceed the rated load or any other capacity of the tool.

5.11.10 Powered hand/fixed tools

- Do not operate equipment that you have not been trained to use.
- Powered hand tools equipped with side handles shall be operated with both hands holding the tool to control kickback or twist.
- Do not use the tool if the handles are defective or missing.
- When using powered hand tools or fixed tools, the work piece shall be secured to prevent movement while cutting, drilling, grinding etc. Hands or parts of the body will not be used to secure the work piece.
- Gloves, and loose clothing shall not be worn when operating powered fixed equipment, such as drill presses, milling machines, lathes, pipe threaders or other rotating equipment, where the point of operation, ingoing nip points or caught-on hazards are accessible (within arm's reach) to the operator.
- Gloves are required before or after machining when handling any sharp and/or hot objects, such as drill bits, milling bits, cutting tools, etc. and when handling the work piece being machined.

5.11.11 Maintenance activities require the powered fixed equipment to be shut-off and LOTO and the employees performing the maintenance shall wear the appropriate gloves

5.12 Use and Care of Hand Tools

5.12.1 For Additional information and full scope of requirements reference CCS_HSS_STD_008.1 Tool Safety Standard

5.12.2 All hand tools must be inspected each time before use.

5.12.3 Never use a defective tool or leave defective tools where others might use them.

5.12.4 Never use tools and equipment for purposes for which they were not designed or intended.

5.12.5 Tools shall be transported in toolboxes, tool belts, tool pouches, etc. designed for such use. Do not carry hand tools in pants or shirt pockets unless designed for pocket carry.

5.12.6 Never throw tools, equipment, or parts from one location to another, from one employee to another, or from one level to another level.

5.12.7 Do not leave tools, equipment, or materials in elevated places from which they may fall or be knocked off.

5.12.8 Do not force tools beyond their capacity or use "cheaters" to increase their capacity.

5.12.9 Do not fabricate hand tools. Do not modify or in any way alter the design of existing hand tools.

5.12.10 Only self-retracting utility knives are permitted to be used for work duties. Unless a specific use of a non-retracting knife is defined in Job Safety Procedure.

- Do not use personal pocketknives as a tool.
- Always cut in the direction away from yourself.
- Wire stripping tools shall be used when preparing electrical wire.
- Alternate tools, other than open blade knives, shall be used to cut materials whenever possible.

5.12.11 Holding tools

- Hands shall not be used to hold or position a tool or object that is being hammered by another employee. Holding tools, jigs, or other positioning devices must be used for this task.
- Hands shall not be used to hold a chisel, punch, or any other tool that is being struck by a hammer. A holding tool, with a handle extension, specifically designed to hold a chisel, punch, etc. shall be used whenever striking or hammering.
- Hand Tools (i.e., channel locks, vice grips, pliers) not specifically designed to hold a chisel, punch or other hammered tools shall not be used for this purpose.

5.13 Industrial Vehicles: Operation and Care

5.13.1 For Additional information and full scope of requirements reference CCS_HSS_STD_007.1 Mobile Equipment Safety Standard

5.13.2 Industrial Vehicles includes all powered industrial trucks (PIT), fork trucks, tractors, platform lift trucks, motorized personnel carts, material handling wheeled or tracked Industrial vehicles and other specialized industrial trucks powered by electric motors or internal combustion engines used exclusively in the industrial setting. The term "Industrial Vehicle" will be used to mean all of the above.

5.13.3 Only employees authorized and trained are permitted to operate or ride in Industrial Vehicles.

5.13.4 All Industrial Vehicles that are 8 feet or wider shall be equipped with a backup camera.

- Large Industrial Vehicles that are 8 feet or wider which are short term rentals (less than 2 weeks) that are not equipped with a backup camera shall require a spotter.

5.13.5 At the beginning of each work shift, operators shall inspect and test their assigned Industrial Vehicle to determine if it is in safe operating condition.

- A daily checklist shall be completed and signed by the operator.

5.13.6 If any inadequacies in the operation, nonfunctioning safety devices or other deficiencies effecting safe operation of the Industrial Vehicles are recorded or noted at inspection, the operator will make immediate notification to the appropriate manager or designee.

- Pre-operational check list should have critical and non-critical items identified, if any critical items are identified as deficient, the equipment shall be taken out of serviced and repaired before use.

- If pre-operational check list does not have identified critical items, then all items are critical.

- The defective equipment shall not be operated until the repairs are made.

5.13.7 Authorized Industrial Vehicle operators shall abide by all traffic regulations and be alert for pedestrians.

5.13.8 Do not stay in the cab or truck while loading or unloading unless necessary for the operation of the industrial vehicle.

5.13.9 Unattended Industrial Vehicles shall have the engine shut off and parking brake set or block the wheels to prevent unexpected movement or in accordance to written Job Safety Procedure.

5.13.10 Industrial Vehicle operators must not permit unauthorized riders on their Industrial Vehicles.

5.13.11 Riders are not permitted to ride in the back of pickup trucks or other Industrial Vehicles that do not have specifically approved seats and seat belts.

5.13.12 Do not jump off of a moving Industrial Vehicle.

5.13.13 Do not ride in an Industrial Vehicle with unsecured loads.

5.13.14 When riding in Industrial Vehicles always keep your body parts inside the running lines of the Industrial Vehicle.

5.13.15 Pedestrians must be aware of plant Industrial Vehicle movement when walking through buildings or yards.

5.13.16 Do not assume the Industrial Vehicle operator can see you. Be prepared for sudden turns or the Industrial Vehicle backing up.

5.13.17 Areas where industrial vehicles are required to back into buildings, or have limited clearance and visibility must have a hazard assessment conducted to determine the need for controls to eliminate employees from being in the line of fire (guarding, light systems or use of a spotter, etc.)

5.13.18 If a Spotter is used, they shall wear a high-visibility vest for identification and have an air horn or other device to warn unauthorized people away from area.

- The Industrial Vehicle operators shall maintain visual and/or radio communication with the Spotter before initiating any movement of the Industrial Vehicle.
- If visual contact and/or radio communication is lost or restricted, no movement shall occur until contact and/or radio communication is restored.
- The Industrial Vehicle operator shall not move the Industrial Vehicle until given direction to do so by the Spotter and the Spotter is a minimum of 10 feet away from the equipment.
- A Spotter shall assure that all equipment and people are in the clear before giving direction to move the Industrial Vehicle.
- Signs shall be posted at each truck door. The sign shall indicate the door number, the open height of the door, sound horn prior to entering and or spotter is required or not.

5.13.19 Employees working within mobile equipment, shall be trained on the movement capabilities of the equipment to include the swing radius, blind spots, etc. Whenever possible, maintain a minimum distance of 10 feet from the mobile equipment while it is moving.

- If the minimum 10ft distance cannot be maintained, three-part communication must be established between employees working in an area and the operator of the powered industrial vehicles.

5.13.20 Operators of plant Industrial Vehicles are not to transport loads which are unstable or above the rated capacity of their Industrial Vehicles.

5.13.21 Mobile cranes (Excluding: carry decks type crane) are not to be used to transport materials on the hook to and from the job site.

5.13.22 Never use a fork lift or similar Industrial Vehicle as a working platform or allow yourself to be hoisted from one level to another unless a specially designed platform is provided and you have been authorized to use the Industrial Vehicle in this way. The platform must be secured to the fork lift, and the fork lift operator must remain at the controls at all times while the platform is in use.

5.13.23 When a powered industrial truck is left unattended, the load lifting device shall be fully lowered, controls neutralized, power shut off and brakes set. Wheels shall be blocked if the truck is parked on an incline.

5.13.24 When an Industrial Vehicle is being refueled or serviced, the motor must be shut off.

5.13.25 The Industrial Vehicle being refueled must be attended the entire time during the fueling process.

- All fuel loading nozzles on Cleveland-Cliffs Steel property shall have the trigger hold down device removed.
- Do not smoke or use cell phone while re-fueling.
- No object shall be placed in the handle that will defeat the automatic shut-off at any time during the fueling.

5.13.26 Cleveland-Cliffs Steel employees shall use approved rolling step platforms with handrails to climb onto and off truck and trailer beds.

5.13.27 Operators shall use access ladders and provided steps and/or ladders to get on or off the equipment.

5.13.28 Do not jump from the Industrial Vehicle to the ground.

5.13.29 Slow the Industrial Vehicle down and give adequate warning by sounding the horn or audio warning alarm signal when entering or exiting buildings, or when approaching corners, blind spots, cross aisles, pedestrians, or where employees are working.

5.13.30 Industrial Vehicles shall not be parked closer than ten feet from the outer rail of the nearest railroad track.

5.13.31 Operators shall be aware of overhead crane movements. Maintain a safe distance with your Industrial Vehicle when crane movements are being made.

5.13.32 When following behind large Industrial Vehicles (heavy haul, tractor/trailers, coil trucks, dump trucks, flush trucks, spray trucks, sweeper trucks, front end loaders, etc.) stay back far enough to allow you to see the mirrors of the equipment you are following at all times.

- A minimum following distance of 50 feet shall be maintained behind moving large Industrial Vehicles and at stop signs.

5.13.33 Seat belts must be worn by Industrial Vehicle operators and passengers during operation. If the seat belt is damaged or missing, report it to your supervisor immediately and do not operate the vehicle.

- In the event of an Industrial Vehicle tip over, seat belts shall not be released until the Industrial Vehicle motion has stopped. Operators should never attempt to jump free of an Industrial Vehicle that is tipping over.

5.13.34 Motorized Utility Industrial Vehicles (Cushman Carts, Golf Cart, Gators etc.)

- Motorized utility Industrial Vehicles used for the transportation of employees, tools, parts and materials shall be equipped with seat belts for the operator and all passengers when supplied by the manufacturer.
- Operators and passengers shall keep all body parts inside the utility Industrial Vehicle while in motion.

5.14 Aerial and Scissor lifts

5.14.1 For Additional information and full scope of requirements reference CCS_HSS_STD_006.1 Aerial Lifts Safety Standard

5.14.2 Leased, rented or purchased aerial platforms shall be provided with Operator Controls (upper directional controls) at the platform, and minimally shall: Include an enabling device/control which:

- Automatically returns to the "off" or "neutral" position when released, if used to control any movement of the aerial platform. (Self-Centering type Controllers)
- Be protected against activation other than that initiated by the operator.
- Be clearly marked.
- Operator protection in the form of a physical guard, pressure sensing device or cage to prevent the operator from being pinned between an overhead obstruction and the controls of the Boom-Supported Elevating Work Platform.
- A presence sensing device (JLG - Skyguard, Genie – OPA, etc.) which will, at a minimum, sound the horn and stop all functions if the operator contacts the presence sensing device.

5.14.3 Leased, rented or purchased aerial platforms shall be equipped with clearly marked emergency lowering means readily accessible from ground level.

5.14.4 It is not permitted to operate the elevated platform with employees on the platform from the lower controls except to lower in an emergency situation.

5.14.5 Inspections

5.14.6 Pre-use inspection shall be performed prior to using the aerial platform prior to each operators use. The inspection shall be in accordance with items specified for owners and users of the aerial platform.

5.14.7 Annual Inspection shall be performed by a person qualified as a mechanic on the specific make and model of the aerial platform. The inspection shall be in accordance with items specified by the manufacturer.

5.14.8 The operating manual and maintenance manual shall be provided and shall be stored in the weather resistant storage compartment on the aerial platform.

5.14.9 Prior to operating an aerial platform, the operator shall be properly trained by a qualified trainer and shall be familiar with the controls and operations of the specific aerial platform being used.

5.14.10 Conduct a work zone inspection to evaluate potential hazards associated with the area in which the platform is to be used

5.14.11 All employees in the aerial lift platform and those serving as ground personnel must be trained to operate the aerial platform.

5.14.12 Minimum training must include safe operator training on the type of aerial work platform / scissor lift.

- (Including but not limited to an explanation of electrical, fall and falling object hazards; recognizing and avoiding unsafe conditions in the work environment, instructions for correct operation of the lift, demonstrations of the skills and knowledge needed to operate an aerial lift; when and how to perform inspections; any manufacturer requirements) as well as the proper selection and use of fall protection when using an aerial platform / scissor lift.

5.15 Use of Tape for Hazard Demarcation

5.15.1 Red danger tape shall be used to limit access to areas where an imminent hazard has been identified or where hazardous activity is taking place.

5.15.2 Only Authorized Employees may enter Red danger tape areas. For the purpose of this section the term “Authorized Employee” means:

- Employees that have been assigned the task of eliminating the hazard.

5.15.3 All red tape must be tagged and identify the following:

- Name and contact information of installer
- Date of installation
- Reason for installation

5.15.4 Yellow caution tape shall be used to identify hazards or activities that do not have imminent danger.

- You may proceed with caution through yellow caution tape zones if you have a specific need to do so and are aware of the hazard.

5.15.5 All yellow tape must be tagged and identify the following:

- Name and contact information of installer
- Date of installation
- Reason for installation

5.16 Walkways, Work Areas, Roadways, Stairs and Doors

5.16.1 Use stairways and walkways as provided. Do not take short cuts through stocking areas, over run-out tables or conveyors, or through any posted restricted areas. Go around or use cross-over walkways where they have been provided. Do not climb over handrails or equipment.

5.16.2 Designated storage/stocking areas shall be provided with adequate walkways to permit passage through and/or access to the materials in the storage/stocking areas.

5.16.3 When walking on or alongside roadways, to and from the gates, to your locker rooms or to your work location use designated walkways or approved routes.

5.16.4 Use handrails when going up or down stairs. If carrying an object, one hand must be free for the handrail. Walk, do not run. Do not go up or down more than one step at a time.

5.16.5 Do not descend stairs backwards unless the Job Safety Procedure for the job conditions requires it.

5.16.6 When walking along conveyor ramps and inclines maintain your balance and use handrails to assure that you do not come in contact with moving machinery or belts.

5.16.7 Hazardous locations shall be identified and precautions shall be taken to restrict access to unauthorized personnel.

5.16.8 All gates, doors or access points to the identified Hazardous Locations shall be posted with sign/signs that will communicate the following:

- The specific hazard present.
- Who is permitted to enter.
- Procedures to be followed to enter.
- Additional PPE/equipment required to enter.

5.16.9 Designated coil fields / coil staging areas shall be clearly delineated by high visibility paint, high visibility stanchions, and/or by chain, wire rope, rope, etc. In addition, permanent signs at entry points shall be posted.

- Only properly trained and authorized personnel with the proper PPE are permitted to enter designated coil fields / coil staging areas.

5.16.10 Each plant shall develop and maintain Job Safety Procedures for entering and exiting a designated coil field, slab yard or staging area etc. which is serviced by a cab-operated crane, RC crane, and / or mobile equipment.

5.16.11 Restricted Visibility Areas are locations where employees perform work and have restricted visibility from overhead cranes and / or mobile equipment. Examples are inside ladles, pits, under equipment, etc.

- Each department shall compile a list of designated Restricted Visibility Areas.
- Job Safety Procedures shall be developed, communicated for working within Restricted Visibility Areas which are serviced by a cab-operated crane, RC crane, and / or mobile equipment.

5.16.12 Inspection of Supported Walking and Working Surfaces.

- A documented monthly visual inspection including floor grating, floor plate, support structure, fasteners and welds etc.
- Immediately report any damage or defects associated with floor grating, floor plates, or associated support structures or securement/fasteners.
- Floor grating, floor plate, support structure, grating or plate fasteners and welds shall be given a physical inspection to be scheduled at a frequency not to exceed six months or immediately upon detection of damage, and/or substantial corrosion.
- Do not alter or modify floor grating, floor plate, support structure, grating or plate fasteners without authorization.

5.17 Excavations, Floors and Pit Openings

5.17.1 Unless authorized by your supervisor, do not start digging or excavating in any plant area and then, only after the completion of an excavation permit. Supervision must check with the plant Engineering Department for existence of pipes or conduits in the area to be excavated. Should the excavation come upon pipes, conduits, or red plastic tape, work must be stopped at once and supervision notified.

5.17.2 Excavation work 4 feet or deeper shall be considered a confined space and shall have a confined space permit or be dealt with appropriately.

- Every excavation which is four feet or deeper shall be continuously monitored with a gas monitor capable of monitoring at a minimum Oxygen, Carbon Monoxide, and L.E.L. (Lower Explosive Limit).

5.17.3 Employees making excavations, openings in floors or removing covers from sewers, manholes, valve pits, trenches, etc., are responsible for safeguarding them by erecting proper guards or barricades with signs.

- At night, warning lights shall be used to warn others of the danger.
- Deep trenches or excavations (over four feet) must be properly shored, sloped, or braced to guard against cave-in.

- All excavated material must be piled at a minimum of three feet back from the edge of the excavation or designed by a qualified person.

5.17.4 Floor openings, such as pits, chutes, trap doors, manholes, platform edges, and hatchways, shall be guarded by a floor opening cover of standard strength and construction, or standard railing with standard toe boards.

5.17.5 Never step or jump over excavations, trenches, manholes, etc. Observe all barricades. Never remove a barricade unless authorized to do so.

5.17.6 Report any unguarded excavation, trench, open manhole, shaft, etc. to your supervisor immediately.

5.18 Working at Overhead Locations

5.18.1 If you are required to work overhead, you shall protect employees and/or contractors below by designating a hazardous work area on the ground or at any level below the work activity where there is potential for falling objects. Red Danger Tape (with identification, i.e., department name, contractor name) and Overhead Work Warning Signs shall be erected to completely encompass and block access to the Red Zone hazardous work area.

5.18.2 Entry into the Red Zone shall not be permitted until the following conditions are met:

- Entry into the Red Zone is absolutely required to complete the planned jobs/tasks.
- A safety attendant must be in position to control entry into the Red Zone.
- The attendant shall not permit entry into the Red Zone until the overhead work is stopped and communications are established between the employees on the ground/lower level and the crew working above.
- Overhead work may continue after the communications have been established and the work procedures/protection are in place to protect the employees on the ground/lower levels.

5.18.3 A safety attendant is also required when entry into the Red Zone is not required but the hazardous work area cannot be completely encompassed with red danger zone tape.

- The overhead work area Red Zone entry permit must be completed, signed, and posted at the Red Zone entry along with all attached written procedures.
- A safety attendant assigned to control entry into the Red Zone shall wear a fluorescent safety vest for identification and have an air horn or other device to warn unauthorized people away from the area.

- Entry is permitted when the overhead work has stopped or completed and the "overhead" signs have been removed. If overhead work starts again, "overhead" signs and red danger tape shall be installed.

5.18.4 When jobs are planned, consideration must be given to overhead work and the potential for falling objects. Hole covers, nets, toe boards, screens, etc. must be considered and written in the preplan, JSA, and/or other work instruction.

5.18.5 The red danger tape shall be printed with Department or Contractor name, or signs may be attached to the tape to identify the Department or Contractor that established the Red Zone area.

5.18.6 Use approved ladders, scaffolding, or staging in good condition to reach overhead work.

- Report defects to your supervisor.
- Do not use improvised or makeshift arrangements.
- Loose materials, such as planks, scaffolding, pipe, bolts, nuts, tools, etc., must not be left overhead.
- Temporary scaffolding must be removed by authorized personnel at the conclusion of the job.
- Materials are not to be dropped or thrown to the ground but must be let down by hand lines or some other controlled method.

5.18.7 Overhead Work on Crane Runways

- Crane movements may present special hazards. The Crane Safety Standard, and other safe working procedures for the job being done must be followed while working on cranes or crane runways. This includes work on buildings, on top of tall bins, high machinery, and other areas where employees may be struck by the crane. See Crane Safety Standard for additional information.

5.18.8 Working on Roofs

- All work on roofs shall apply 100% fall protection for both edge protection and fall through protection. This includes traveling to the location on the roof where the work will be done. Exceptions to this rule will be:
- Roofs that have a certification by engineering that they are safe to walk on, and the work does not require edge protection.
- Office building roofs that are designed with edge protection.
- Roof access points, such as ladders or stairways, shall display signs stating "Access to Roof is prohibited without Department Authorization".

5.18.9 Working on Cranes

- Prior to commencing any preventative, breakdown, or shutdown maintenance on an overhead crane, a Red Pendant Flag (highly visible) must be lowered from the crane 10 to 15 feet above the floor. The pendant shall have "WARNING" displayed on both sides and shall easily be seen from the floor.
- Warning signs shall also be placed on the floor (i.e., "Caution Overhead Work") to alert others in the area of the work being performed on the crane overhead.
- The warning signs will be the maximum protection required if there is no potential for tools, parts, or materials to fall to the area below. Employees and contractors shall use caution when walking under any part of an overhead crane that has the red pendant "WARNING" flag displayed and warning signs on the floor indicating the crane is down for maintenance.
- A Red Danger Tape Zone (with identification, i.e., department name, contractor name) shall be erected to completely encompass and block access to work areas on the ground when there is a potential for tools, parts or materials to fall from the crane during the maintenance activity. Entry into the Red Zone shall be prohibited during the maintenance activity.

5.19 Ladders, Scaffolding and Staging

5.19.1 Extension Ladders

- Always inspect ladders before use. Defective ladders shall be tagged and immediately removed from service. Notify your supervisor for a replacement.
- Extension ladders are required to be inspected annually and documented.
- Extension ladders must be labeled with load capacity clearly marked and visible
- Portable metal ladders including aluminum shall not be approved for use.
- Never paint or use painted wooden ladders. Paint will hide cracks, knots, rot, or other defects.
- Straight portable ladders and extension ladders shall extend at least three feet above the top access level and be placed so the distance from the base of the ladder to the wall or other supporting structure is about one-quarter the length of the ladder from the floor to the top support point. These ladders are to be tied in place.
- Both rails of the extension ladder must be tied off to a structure capable of stabilizing and supporting the ladder from falling. If the ladder cannot be tied off it must be held by a coworker whenever someone is working on the ladder.

5.19.2 When working from straight, extension, or non-self-supporting portable ladders and over 4 feet from the ground you must wear a full body harness fall arrest system and be tied-off to a proper anchor point unless the following conditions are met:

- The worker can maintain a 3-point touch, 2 hands and one foot, two feet and one hand, or two feet and the midline of the body. Examples are:
- Both feet and 1 hand - on the ladder, belt buckle or midline of the body must be between the rails of the ladder, and the shoulders below the top rail. Any stretching for position requires repositioning of the ladder.
- Both legs and body leading against the ladder. The belt buckle/midline of the body must be between rails. Any stretching for position perpendicular to the ladder requires repositioning of the ladder. Feet must be firmly on the ladder and the belt buckle/midline of the body must be resting on the ladder. The shoulders must be below the top rung. Worker may use two hands for short duration work (changing light bulbs, opening hand valves, etc.).

5.19.3 Step ladders

- Step ladders are required to be inspected annually and documented.
- Step ladder must be labeled with load capacity clearly marked and visible
- Shall be fully opened and locked.
- Never stand on top of a step ladder.
- Work from a point at least two feet or two steps from the top.

5.19.4 When climbing any ladder (portable or stationary),

- Hold on with both hands and always face the ladder.
- Use a hand line to raise or lower tools that you will need.
- Never exceed the maximum intended load of the ladder.

5.19.5 Scaffolding & Staging.

5.19.6 Employees who perform work while on a scaffold shall be trained by a qualified person to recognize the hazards associated with the type of scaffold being used, the nature of any electrical hazards, fall hazards, and falling object hazards in the work area.

5.19.7 Any scaffold damaged or weakened from any cause shall be immediately repaired or replaced and shall not be used until repairs have been completed.

5.19.8 Scaffolds shall not be loaded in excess of the working load for which they are intended.

5.19.9 Tools, materials, and debris shall not be allowed to accumulate in quantities to cause a hazard when working on a scaffold.

5.19.10 All scaffold planking must be approved and identified as scaffold grade.

5.19.11 Access to a scaffold shall be by secured ladder, or an equivalent safe access shall be provided. Climbing the side of scaffolding is not permitted.

5.19.12 Scaffolding greater than four feet in height must be equipped with handrails, mid-rails, toe boards, and be tightly planked.

5.19.13 Fall protection equipment including a full fall arrest system and retractable lanyard shall be worn and connected to an approved anchorage point or lifeline when working on any scaffold platform greater than four feet in height and not equipped with standard top rails and mid-rails or is not tagged

5.19.14 A scaffold tag signed by a competent person is required prior to allowing personnel to work on scaffolds. The tag certifies proper construction and that safety features are in place. The scaffold inspection checklist must be completed before accessing the scaffold.

5.20 Safe Storing, Loading and Manual Handing of Material

5.20.1 Follow the safe practice in your department for blocking materials to prevent rolling or falling. Check blocking to make sure that removing material will not result in a spill or shifting in other parts of the pile.

5.20.2 Avoid overloading shelves and overhead storage areas. Never store materials on shelves, roofs, or cabinets unless they are rated, and load posted.

- In operating areas shelves, cabinets, lockers, toolboxes, etc. must be secured to prevent tip-over.

5.20.3 Storage capacity must be marked on all shelving designed for industrial storage.

5.20.4 Items in storage that weigh 50 pounds or more should be secured to a pallet and accessible to a forklift or other mechanical means for safe handling and storage.

5.20.5 Employees are not permitted to climb on piled sheets, slabs, scrap, coal, coke, plates, coils, pipe, or other material unless it is required by their job duties and documented in a Job Safety Procedure.

5.20.6 Loading & Unloading

5.20.7 Know the safe load limits and the approved methods of securing loads of piled materials. Never load any material handling equipment such as trailers, trucks, buggies, elevators, etc., beyond its safe limit. Tie or band material if necessary to prevent shifting.

5.20.8 Always check the condition of the floor of trucks and railroad cars for holes or weak spots. Report defective cars or trucks to your supervisor before working in them.

5.20.9 Truck beds or railroad car beds that contain debris (i.e.: paper, plastic, dunnage, etc.) must be cleaned to allow inspection of the integrity of the floor before beginning work.

5.20.10 Employees shall not walk or work on a truck bed or in a railcar while stepping on paper, plastic, or any other debris.

5.20.11 Only properly trained and authorized personnel are permitted to load or unload tank cars and trucks containing flammable liquids. Open flames, spark producing devices and unprotected electrical devices must be removed from the area before proceeding with the loading or unloading of flammable liquids. Specific job procedures must be developed for loading and unloading of each chemical.

5.20.12 Stay away from all tank cars or trucks if you are not trained and equipped to work with the potentially hazardous chemical that they might contain.

5.20.13 Manual Material Handling

- No employee will lift more than 50 pounds.

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7 Revision History

Rev.	Date	Section	Paragraph	Summary of change	Authorized by
1	11-14-2022	Entire document supersedes all previous	Entire document supersedes all previous	Initial issue	K. D. Berard

APPENDIX G

Subsurface Utility Clearance Management Program

SUBSURFACE UTILITY CLEARANCE MANAGEMENT PROGRAM

CORPORATE HEALTH AND SAFETY DIRECTOR	:	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	:	**01/2019**
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APPENDICES

Appendix A – Roux Subsurface Utility Clearance Checklist/ Utility Verification/Site Walkthrough Record

Appendix B – Private Utility Technology Applications and Considerations

1. PURPOSE

Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C., and Remedial Engineering (collectively, "Roux") has instituted the following program for completing proper utility mark-outs and for conducting subsurface clearance activities. This establishes a method to ensure, to the greatest extent possible, that utilities have been identified and contact and/or damage to underground utilities and other subsurface structures will be avoided. For the purpose of this program, a structure is defined as any underground feature that may present a potential source(s) of energy, such as, but not limited to, utility vaults, bunkers, piping, electrical boxes, wires, conduits, culverts, utility lines, underground tanks, and ducts.

2. SCOPE AND APPLICABILITY

The Subsurface Utility Clearance Management Program applies to all Roux employees, its contractors, and subcontractors. Employees are expected to follow this program for all intrusive work involving Roux or other personnel (e.g., contractors/subcontractors) working for Roux unless the client's requirements are more stringent. Intrusive work activities can include, but are not limited to, digging or scraping the ground surface, including, but not limited to, excavation; test pitting or trenching; soil vapor sampling or the installation of soil borings, soil vapor monitoring points and wells, or monitoring wells; and drilling within concrete slabs on grade.

Deviation from the program, regardless of the specific work activity or location, must be pre-approved based on the client's site knowledge, experience, site conditions, and additional documentation on the site. Any exceptions shall be documented through the Roux Subsurface Utility Clearance Variance Form located within the Roux Health & Safety Online Application or through OKTA. Approval is required by the Project Principal (PP) and the Operations Manager (OM) in consultation with the Office Health and Safety Manager (OHSM) or Corporate Health and Safety Director (CHSD) prior to mobilization. Depending on the work location, more stringent federal, state, local, or client requirements may apply. It is the responsibility of the Project Team to identify such requirements prior to mobilization.

3. PROCEDURES

3.1 Before Intrusive Activities/Job Planning Process

Prior to intrusive work at a site, the Project Manager (PM) shall ensure that the notification of the State One Call or equivalent service (Nationwide-811) is completed a minimum of 48-72 hours (One-Call State Law Directory) before intrusive work activities (this timeline excludes Saturdays, Sundays, Legal Holidays and 811 observed holidays). This notification is required by law for all states. State-specific/local laws related to utility location may vary. The project team is responsible for understanding requirements that may affect their work site.

Obtain, review, and field verify relevant historical site data that may include: as-builts/site plans; easement/right-of-way information; historical aerial photos/development plans; local/state permitting records; previous site investigation/boring logs; and/or interviews with site representative/client. Interviews with site or client personnel should ask the following:

- Employee(s) Name and Relationship with the site;
- Types of utilities, including structure and location of utilities on-site;
- Depth of known utilities; and

- Any other relevant information as it pertains to the site.

Prior to intrusive work activities, information pertaining to the site should be included in Roux's Subsurface Utility Clearance Checklist and Utility Verification/Site Walkthrough forms. This form is located within the Roux Health & Safety Online Application or through OKTA.

If there is the potential for unexploded ordinances or munitions, consultation with your OM and CHSD is required prior to site operations.

3.1.1 Project Kick-Off Meeting

During the project kick-off meeting for intrusive activities, the PM will review the Roux Subsurface Utility Clearance Checklist, Utility Verification / Site Walkthrough Record (Appendix A) and the below bullet points with the project field team:

- Confirm that the State One Call or equivalent is received and that the ticket number is confirmed, reviewed, and valid for the time of work. If intrusive work activities are not conducted during this valid time period, the One Call ticket must be renewed, and the site must be remarked;
- Review the work scope to be performed with the site owner/tenant to determine if it may impact any utilities;
- Determine the need for utility owner companies to be contacted or to have their representatives on site;
- Where mark-outs terminate at the property boundary, consider the use of private utility locating / (e.g., Radio Frequency Detection, Electromagnetic Induction), Ground Penetrating Radar (GPR) , and other applicable geophysical inspection services. The use of private utility locating firms, however, does not eliminate the legal requirement for the subcontractor (e.g., driller, excavation firm) to submit a request for Public Utility Mark-outs. Also, the information provided by the service may be inaccurate and unable to locate subsurface utilities and structures in urban areas, landfills, urban fill areas, below-reinforced slabs, etc. They should not be relied upon as the only means of performing utility clearance;
    - A mark-out is defined as the process of contracting with a competent and qualified company to confirm the presence or absence of underground utilities and structures. This process will clearly mark out and delineate identified utilities so that intrusive work activities can be performed without causing disturbance or damage to the subsurface utilities and structures. After utility mark-outs are completed, soft Digging must completed prior to intrusive work. Section 3.4 Preferred Methods of Clearing the Subsurface (Pre-Clearing) outlines requirements for pre-clearing techniques in order of preference.
- Documented description of the dig site, which is included in the project's Health and Safety Plan (HASP), and one call report will be maintained in the field and distributed amongst Roux personnel, its contractors, and subcontractors; and
- Documentation of the actual placement of mark outs in the field shall be collected using dated pictures, videos, and/or sketches with distance from markings to fixed objects. All documentation shall be maintained within the project file.

3.2 Utility Mark Out

- Ensure the Mark-out / Stake-out Request Information Sheet (or one-call report) is complete and accurate for the site, including address and cross streets, and review for missing utilities. Ensure ticket life is still valid for work.

  - Note: utility mark-out organizations do not have contracts with all utilities, and it is often necessary to contact certain utilities separately, such as the local water and sewer authorities, local transportation departments, and railroad operators. In the event the Project Teams anticipate subsurface work will impact public utilities, railroad operations, or public roadways, coordination with the utility owners/operators is required.

- Have written confirmation prior to mobilizing to the site that the Project Team or Roux personnel performing the intrusive activity has correctly completed the mark-out notification process, including requesting mark-outs, waiting for mark-outs to be applied to ground surfaces at the site, and receiving written confirmation of findings (via fax or email) from utility operators for all known or suspected utilities in the proposed area of intrusive activity, and provided utility owner written confirmation to Roux personnel for review and project files documentation.
- Do not begin any intrusive activity until all utility mark-outs have been completed (i.e., Did all utilities mark-out the site?) and any unresolved mark-out issues are finalized. Perform a site walk to review the existing utilities and determine if the utility locators have located said utilities.

  (Note: The Tolerance Zone is defined as three feet from the outside edge of any subsurface structure.)
- For non-subscribing utility owners or if public one-call service is not available, perform due diligence and request further information regarding utility type, construction details, location, and burial depth directly from public service providers/utility owners. Request utility mark-out by each public service provider/utility owner as applicable. Confirm contact and response by each public utility owner on the Subsurface Utility Clearance Checklist.
- If utilizing a Private Mark out, ensure the contractor has a plan regarding what types of technology will be used based on Table 1 in Appendix B: Private Utility Technology Applications and Considerations. If possible, it is recommended that multiple technologies be used to sweep each location/work area. Use a tracer wire to locate the utility (when tracer wires are present). Record the results of the private utility mark-out on the Utility Verification/Site Walkthrough Record form.

3.3 Site Visit/Utility Walkthrough

Before mobilization with the subcontractor or during the pre-work safety tailgate with the subcontractor, perform a site walkthrough after utility mark-outs have been completed to determine whether additional potential hazards are present and look for visible signs of utilities that may be present. Outlined below are considerations regarding a site walk before intrusive activities. Before initiating any intrusive work, verify that the utilities marked on-site align with the information provided in the One Call response notification/ticket and with site plans and documents. If any discrepancies arise, address them promptly to ensure accuracy and do not start intrusive work until they are rectified.

- Identify overhead utilities that may impede equipment mobilization or work zones to ensure adequate Occupational Safety and Health Administration (OSHA) clearance distance(s), as specified within the site-specific Health and Safety Plan (HASP) and 29 CFR 1926.1408 Table A.

The presence of any of the following may indicate potential subsurface structures:

- Locations of buildings, equipment, and features like area lights, signs, sprinkler systems, phones, drains, natural gas meters, manholes, etc.;
- Warning tape, which is often a sign of underground services;
- Material like pea gravel, sand, or other non-native materials can indicate the presence of tanks or lines or any deviations from the established native soil or backfill conditions;

- Red concrete, which is often used for electrical duct banks;
- Evidence of damaged utilities, such as piping materials, insulation, or odors present in the work area; and
- Other utilities, including fire hydrants, electrical transformers, pipeline markers, valve covers, steam lines, valve box covers, clean-outs, etc.

By observing the path between the main service line and the connection point (e.g., a utility meter at the exterior of the site building), it may be possible to determine the likely routing of on-site utilities. However, this method should not be relied upon solely, and proper risk mitigation strategies should be in place before proceeding with any ground disturbance activities. Look outside your work zone for other potential utilities that may cross through your work zone.

For sites with potential underground storage tanks present (UST), the following guidance applies:

- Identify if the product piping is either rigid or flexible.
- Conduct a visual examination of the tank field, observation wells, dispensers, vent stacks, and UST fill points to determine their location.
- Locate and become familiar with the emergency shutoff button/switch, if present.
- Determine the orientation, arrangement, and location of the tanks, as well as their size and capacity, through the examination of visible features at grade, such as fill ports and extractor covers, and by consulting any available as-built drawings.

Before commencing any subsurface intrusive work, field staff should thoroughly address any discrepancies in utility company mark-outs or the absence of mark-outs.

3.3.1 Project Management-Field Personnel

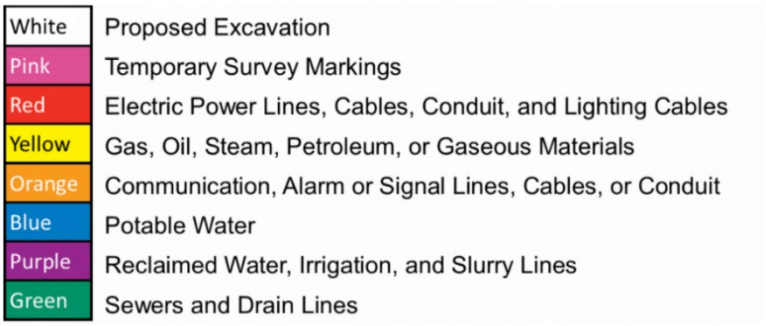
Whenever possible, it is advisable to assign the same project personnel to both utility location and clearance tasks as well as intrusive activities. This continuity ensures that site knowledge and utility information gathered during the clearance phase remain up-to-date. Having this historical perspective helps minimize the risk potential of utility strikes.

In cases where maintaining the same personnel throughout the project isn't feasible, a thorough knowledge transfer regarding site utilities, locations, clearance results, and proposed intrusive activities becomes essential. The PM must ensure that there is a successful handoff of information when there is a change in field personnel.

3.3.2 Utility Markings

The utility marking color code includes various uniform colors. The following APWA uniform color code (ANSI Z535.1) is provided below. While certain government agencies or large industrial facilities may use additional colors, Roux's policy is to consider any unlisted paint marking or pin flag color as a subsurface utility marking unless proven otherwise.

If utilities or subsurface anomalies are identified but their type or classification remains uncertain, it is advised to employ pink paint or pin flag (Temporary Survey Marking) for marking. Once the utility type is definitively established, the pink marks should be updated to accurately represent the correct type of utility.

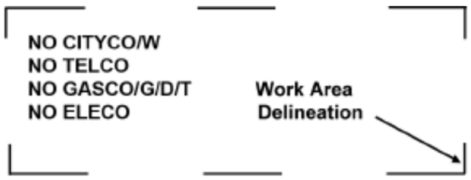


Understanding the markings left by locators during the 811 process is crucial for avoiding utility-related issues. Typically, these markings are done when Roux staff members are not physically present on-site. To enhance understanding/accuracy, it is advisable for staff to be present during the 811 process or engage in conversations with locators, both public and private, while on-site. Additionally, utility marks must adhere to the proper standards outlined in the Uniform Color Code.

Common Abbreviations

Source: Common Ground Alliance

Facility Identifier		**Underground Construction Descriptions**		**Infrastructure Materials**	
CH	Chemical	C	Conduit	ABS	Acrylonitrile - Butadiene - Styrene
E	Electric	CDR	Corridor	ACP	Asbestos Cement Pipe
FO	Fiber Optic	D	Distribution Facility	CL	Cast Iron
G	Gas	DB	Direct Buried	CMC	Cement Mortar Coated
LPG	Liquefied Petroleum	DE	Dead End	CML	Cement Mortar Lined
PP	Petroleum Products	JT	Joint Trench	CPP	Corrugated Plastic Pipe
RR	Railroad Signal	HP	High Pressure	CMP	Corrugated Metal Pipe
S	Sewer	HH	Hand Hole	CU	Copper
SD	Storm Drain	MH	Manhole	CWD	Creosote Wood Duct
SS	Storm Sewer	PB	Pull Box	HDPE	High Density Polyethylene
SL	Street Lighting	R	Radius	MTD	Multiple Tile Duct
STM	Steam	STR	Structure (vaults, junction inlets, lift station)	PLA	Plastic (conduit or pipe)
SP	Slurry System	T	Transmission Facility	RCB	Reinforced Concrete Box
TEL	Telephone			RCP	Reinforced Concrete Pipe
TS	Traffic Signal			RF	Reinforced Fiberglass
TV	Television			SCCP	Steel Cylinder Concrete Pipe
W	Water			STL	Steel
W	Reclaimed Water "Purple"			VCP	Vertrified Clay Pipe



3.4 Preferred Methods of Clearing the Subsurface (Pre-Clearing)

At least one of the methods listed below shall be carried out during pre-clearing activities. The Project Team is responsible for evaluating risks associated with the Scope of Work to determine which method is selected. If none of the following pre-clearing activities are performed, a Subsurface Utility Clearance Variance must be submitted to the OM. This Subsurface Utility Clearance Variance must provide clear lines of evidence that there are no utilities present within the intrusive work zone. Examples include demolition permits of the site, utility closure documents indicating no live utilities on-site, as-builts, site history, etc.

The following approaches shall be considered and implemented based on the Scope of Work.

- ***Soft Digging***
  - This is the preferred method of utility clearance when clearing higher-risk utilities. Soil should be cleared through the use of a vacuum truck/equivalent, an accompanying air knife (preferred), or a water lance to break up and loosen the soil for removal with the vacuum.
- ***Hand Digging***
  - Soil should be broken up and removed using a shovel or other appropriate hand tools without excessive force. Limit the use of dig bars or other tools that, if used incorrectly, can significantly damage utilities.
- ***Hand Augering***
  - The hand auger must be turned slowly using even hand pressure without excessive force. Rounded edge augers are preferred. Hand augers should not be used in pea stone/pea gravel where utilities may be present and could potentially be damaged by the hand auger. The abrupt absence of soil recovery in a hand auger could indicate utilities as pea gravel or sand may have spilled out of the auger (exception: native soil conditions that typically result in poor hand auger recoveries). If any resistance is encountered while operating the hand auger for pre-clearance, the equipment will be removed, and the exploratory test hole will be visually inspected by onsite personnel for any obstructions or indications of subsurface structures.

3.4.1 Guidance for Tools and Equipment

Personnel performing pre-clearance activities shall keep tools and equipment in safe working order and be properly inspected before use. If tools or equipment are broken, they will be tagged and removed from service. The following specify additional guidelines regarding tools and equipment:

- Hand-digging tools must have a non-conductive handle, such as fiberglass, wood, or composite, or fully insulated handles and potential contact surfaces.
- Blades on shovels and post-hole diggers should have rounded or blunt edges.
- Pick axes or pointed spades should not be used for physical clearance.
- Crowbars, pinch-bars, or pry bars should not be used to break hardened soil or backfill except when authorized by the Site Supervisor (SS). This should only be used to loosen materials like bricks or larger stones.

- Electric-powered equipment must have ground fault protection.
- Should there be refusal or difficulty with advancing hand tools, the contractor shall stop work and notify the Roux SS or Site Health and Safety Officer (SHSO) immediately.

3.5 During Intrusive Activities

3.5.1 Concrete/Paving Surface Removal

Remove any surface coverings (i.e., pavement, brush, debris, etc.) to ensure workers have clear visibility of the work area and subsurface conditions. Avoid mechanical jackhammering over known lines unless they are de-energized, locked-out/tagged-out, and potential repairs are planned or if the utility has been completely disconnected prior. When cutting or coring, go only as far as needed to penetrate the surface cover. When removing a large surface area, begin at the perimeter of the removal zone. This initial step helps identify any utilities passing through the work zone. For extensive areas, using a concrete saw might not be practical. Instead, heavy equipment is often employed. During this process, a designated spotter should guide the heavy equipment. Their role is to watch for warning signs of utilities. It's crucial that the heavy equipment does not have "teeth" that could potentially pass through the surface and damage utilities.

3.5.2 Pre-Clearance Procedures

Install pre-clearance exploratory test holes using one of the techniques, as outlined in Section 3.4, for the first 5-ft below land surface (BLS) at each location before conducting intrusive mechanized activities. Should utilities be located at a greater depth than 5-ft BLS consult with the OM, OHSM and CHSD regarding adjustments to the pre-clearance requirements to go greater than 5-ft BLS. Some Clients may require greater than 5-ft BLS for pre-clearance test holes; Project teams should be aware of such Client requirements prior to work.

Pre-clearance exploratory test holes should be defined in the SOW/proposal provided to the client to prevent project delays and to allow adequate time for the PM and PP to evaluate alternative approaches for the project. Alternative approaches will need to be pre-approved by the OM through a Subsurface Utility Clearance Variance.

Both single-point and three-point clearance are acceptable as long as the following criteria are met below. For single-point clearance, the exploratory test hole is advanced at the exact location of the proposed borehole. If three-point clearance is performed, it must be done in a triangular pattern around the proposed borehole and in a configuration that would not allow utilities to enter the borehole.

- The size of the pre-clearance exploratory test hole should be, at a minimum, twice the diameter of any downhole tool or boring device.
- For direct push applications (CPT, Geoprobe®, etc.), the borehole clearance diameter shall be at least 125% of the diameter of the largest tool being pushed through the subsurface (e.g., tip, rod, sampler, etc.), to the minimum required depth.
- For excavations, all utilities need to be marked and then exposed by soft-digging or by hand following the protocols in this program. Pre-clearing for excavations may be performed by the "moat" technique (i.e., soft Digging around the perimeter). In these cases, dig in small lifts (<12" for first 5 feet) using a dedicated spotter.)
- For Tolerance Zone work, unless otherwise agreed upon with the Utility Operator, work within the tolerance zone requires verification by means of pre-clearance test holes specified in Section 3.4 to expose the utility. Once structures have been verified, a minimum clearance of three feet must be maintained between the utility and any powered equipment. If considered a high-risk utility, additional requirements may be necessary and required by the Operator of the utility. Consultation with the OM and CHSD may be appropriate.

The PM, field team lead, or personnel performing oversight is to:

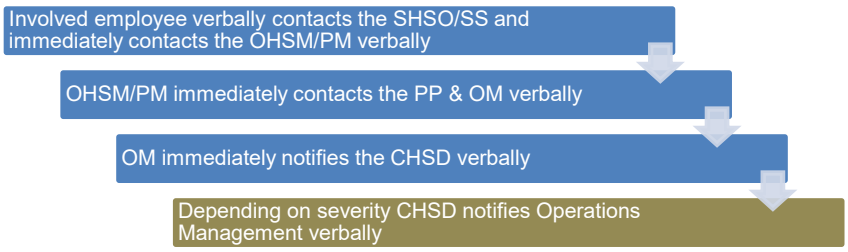
- Ensure the mark-out remains valid. (In certain states, there are limits regarding the duration of time after the mark-out was applied to the ground surface work can be started or interrupted.) Additionally, the mark-outs must be maintained, documented, and in many cases, refreshed periodically to be considered valid. This will be accomplished through calls to the one call center.
- Ensure intrusive activities are only performed within the safe boundaries of the mark-out as detailed in the One-Call Report.
- Halt all work if intrusive activities have resulted in the discovery of an unmarked utility. Roux personnel shall notify the facility owner/operator and the one call center. All incidents such as this will be reported as per Roux Incident Investigation and Reporting Management Program.
- Halt all work if intrusive activities must take place outside of the safe boundaries of a mark-out and only proceed after new mark-outs and subsurface utility clearance are performed.
- Halt the intrusive activities and immediately consult with the PP if an unmarked utility is encountered.
- Complete any loss reports associated with subsurface utility strikes as necessary.
- If a utility cannot be found as marked, Roux personnel shall notify the facility owner/operator directly or through the one-call center. If the facility operator is not responsive, then the one-call center must be notified. Following notification, the excavation/mechanical intrusive work may continue unless otherwise specified in state law.
- Contractors/subcontractors must contact the one-call center to refresh the ticket when the excavation continues past the life of the ticket. State law dictates ticket life. Project teams must be aware of their state-specific requirements.

3.6 Stop Work Authority

Each Roux employee has Stop Work Authority that he or she will execute upon determination of any imminent safety hazard, emergency situation, or other potentially dangerous situation, such as hazardous weather conditions. This Stop Work Authority includes subsurface clearance issues such as the adequacy of a mark-out or identification during intrusive operations of an unexpected underground utility. Authorization to proceed with work will be issued by the PM/PP in consultation with the OHSM after such action is reviewed and resolved. The PM will initiate and execute all management notifications and contact emergency facilities and personnel when this action is appropriate.

3.7 Reporting Utility Incidents

Roux field personnel engaged in any utility strike (e.g., subsurface/aboveground) must promptly stop work, shutdown any equipment and get to a safe location at the Site. Then notify the PM to discuss the incident. In case of injuries, field personnel must call 911 or the local emergency services number and then inform the PM. Additional notifications shall follow Roux's Incident Notification Process. Depending on the utility strike additional notifications shall be made to utility operators and/or clients/site contacts.



Appendix A
Roux Subsurface Utility Clearance Checklist

Appendix A

Roux Subsurface Utility Clearance Checklist/Utility Verification/Site Walkthrough Record

Roux Subsurface Utility Clearance Checklist ***Date of Revision: 3/2024***

Work site set-up and work execution

ACTIVITY	Yes	No	N/A	COMMENTS INCLUDING JUSTIFICATION IF RESPONSE IS NO OR NOT APPLICABLE
Daily site safety meeting conducted, SPSAs performed, JSAs reviewed, appropriate work permits obtained (if applicable).				
HASP is available and reviewed by site workers / visitors.				
Subsurface Utility Clearance Procedure has been reviewed with all site workers.				
Mechanical intrusive work activities may not be performed at any location without authorization from the Roux Site Supervisor (SS). Clearance activities may not be performed at any location unless the SS is physically present.				
Work area secured; traffic control established as needed. Emergency shut-off switch located. Fire extinguishers / other safety equipment available as needed.				
Utility mark-outs (public / private) clear and visible. Provide Excavator's Stake-Out Reference Number / Request Date / Time.				
Tolerance zone work identified. Intrusive work activities cannot be performed in areas that are in direct conflict with any markings made by public or private locators.				
Unless the PP & OM authorizes it, all boreholes and test pit locations must be physically cleared before using mechanized equipment. Required minimum physical clearance depths and diameters are as follows: • Physically clear to a depth of 5 feet bls. • The size of the pre-clearance exploratory test hole must be, at a minimum, twice the diameter of any downhole tool or boring device. • For direct push applications (CPT, Geoprobe®, etc.) the borehole clearance diameter shall be at least 125% to the diameter of the largest tool being pushed through the subsurface (e.g., tip, rod, sampler, etc.).				
Work execution plan reviewed and adhered to (ground disturbance methods, clearance depths, any special utility protection requirements, or any other execution requirements; especially for Tolerance Zone work).				

Mechanical intrusive work is prohibited within 3-feet distance in all directions from subsurface structures that will be intentionally exposed during pre-clearance. Any removal of material within 3-feet of the subsurface structure may only proceed by hand using non-conductive tools/compressed air if authorized by state law and the owner/operator of the utility.				
All equipment onsite must maintain the appropriate horizontal distance from any point on the equipment to the nearest overhead electrical power line. Refer to site-specific HASP and local/utility company requirements.				
Verbal endorsement received from Roux PM and OM for any required field deviations to work execution plan.				

Key Reminders for Execution

The Subsurface Utility Clearance Protocol should be referenced to determine all requirements while executing subsurface work. The bullet points below are intended as general reminders only and should not be relied upon solely.

- The size of the pre-clearance exploratory test hole must be at a minimum twice the diameter of any downhole tool or boring device to minimum required depth of 5 feet bls.
- For direct push applications (CPT, Geoprobe®, etc.) the borehole clearance diameter shall be at least 125% of the diameter of the largest tool being pushed through the subsurface (e.g., tip, rod, sampler, etc.), to the minimum required depth of 5 feet bls.
- The tolerance zone is defined as three feet plus half of the diameter or half of the greatest dimension (for elliptical sewers, duct banks, and other non-cylindrical utilities) of a utility and three feet from the outside of any subsurface structure.
- For excavations, all utilities need to be marked and then exposed by hand, following the protocols in this program. Pre-clearing for excavations may be performed by the “moat” technique (i.e., soft digging around the perimeter). In these cases, dig in small lifts (<12” for first five feet) using a dedicated spotter.) For Tolerance Zone work, unless otherwise agreed upon with the Utility Operator, work within the tolerance zone requires verification by means of hand-dug test holes to expose the utility. Once structures have been verified, a minimum clearance of three feet must be maintained between the utility and any powered equipment.

Utility Verification/Site Walkthrough Record

Employee Name:_____

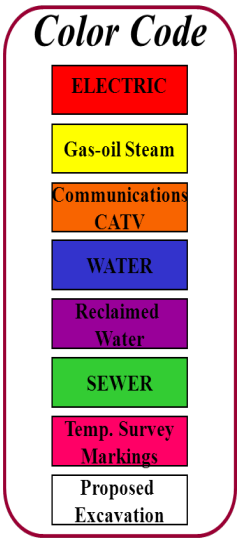
Date: _____

Instructions: For each utility suspected at the job site, indicate the location on the job site, approximate burial depth, and means of detecting the utility. Leave blank if that utility is not believed to be present.

Utility	Description of Utility Location Identified Onsite	Approx. Depth (bls)	Method / Instrumentation used to determine Utility Location	Utility Owner Response (Date/Time)	Mark Out Indicates (Clear / Conflict)
Electrical Lines					
Gas Lines					
Pipelines					
Steam Lines					
Water Lines					
Sanitary and Stormwater Sewer lines					
Pressured Air-Lines					
Tank Vent Lines					
Fiber Optic Lines					
Underground Storage Tanks					
Phone Lines/ Other					

* bls - below land surface

Site Sketch Showing Utilities:



Other Comments / Findings:

Completed by: _____

Signature: _____ Date: _____

Appendix B
Private Utility Technology Applications and Considerations

Appendix B – Private Utility Technology Applications and Considerations

Technology ⇒ Utility/Object ⇓	Radio Frequency Electro-Magnetic Detector (connection to utility, or induction without connection)	Radio Frequency Electro-Magnetic Detector (passive sweep)	Ground Penetrating Radar (GPR)⊙	Acoustic Plastic Pipe Locator	Beacon, Sonde or Conductive Rodder Insertion	EM-61 (time domain electromagnetics) Ξ	
Power/Instrument Line (Energized/Signaled) □	❋ G	G	G	R	R	G	
Power Line (Non-energized) □	❋ G	R	G	R	R	G	
Sewer/Water Line (Metallic) □	❋ G	Y	G	Y	G	G	
Sewer/Water Line (Non-metallic)	R	R	G	G	❋ G	R	
Instrument / Telecomm Lines (Non-energized)	❋ G	R	G	R	R	Y Only if metallic	
Hydrocarbon Transmission Line (Pipeline)◆ □	❋ G	R	G	R	R	G	
Metallic/Non-Metallic Line (with Tracer Wire)	❋ G	Y	G	Y	Y	G metallic	Y non-metallic
Metallic/Non-Metallic Line (without Tracer Wire)	G metallic	R non-metallic	R	❋ G	Y	Y	G metallic	R non-metallic
Metal or Fiberglass UST	R	R	❋ G	R	R	G metallic	R non-metallic

Additional Considerations

Technology ⇒ Variable ⇓	Radio Frequency Electro-Magnetic Detector	Ground Penetrating Radar (GPR)⊙	Acoustic Pipe Locator	Beacon, Sonde, or Conductive Rodder Insertion	EM-61 Ξ
Moist Soil	G	Y	G	G	G
Dry Soil	Y	G	Y	G	G
Clay	Y	R	G	G	G
Concrete w/Rebar	R	Y	G	G	R
Long Horizontal Profile	G	G	G	G	G
Short Horizontal but Deep Vertical Profile	Y	G	R	R	G
Access to Line✚	G	N/A	G	G	G
No Access to Line✚	G (induction or passive)	G	R	R	G
	R (direct connect)				G
Ferrous Metal	G	G	G	G	G
Non-ferrous Metal	Y	G	G	G	G
Adjacent or crossing conductive utility(ies)	Y	N/A	N/A	N/A	Y

Each site will be unique. Do not use this table as the sole criteria for technology selection. Use it as a starting point to assess available, applicable technology(s).

❋ Indicates best technology for given object. Site structures, rebar in concrete, shallow groundwater tables, perched storm water, etc. can significantly affect performance and reliability of any electro/magnetic method. Other utilities which cross or are adjacent to the target line can cause the EM signal to bleed or jump to the other utility line.

□ Metallic lines that have power running through them or can be connected to a tracer signal generator.

◆ Natural gas pipeline locating technicians must be trained/certified (in the U.S. requires DOT and Office of Pipeline Safety standards, other regions may have similar certification or requirements).

⊙ Most sensitive to interpretation. The skill, training and experience of operator are critical.

Ξ Emerging technology with limited availability.

✚ Access: induce unique electronic signature, apply acoustical impulse or insert conductive rodder/beacon/sonde.

Green Generally, an applicable technology **Yellow** May or may not be applicable **Red** Not generally applicable

APPENDIX H

Heavy Equipment Exclusion Zone Policy

HEAVY EQUIPMENT EXCLUSION ZONE MANAGEMENT PROGRAM

CORPORATE HEALTH AND SAFETY DIRECTOR	**:**	**Brian Hobbs, CIH, CSP**
EFFECTIVE DATE	**:**	**01/2019**
REVIEWED DATE	**:**	**03/2024**
REVISION NUMBER	**:**	**3**

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1. PURPOSE

The Exclusion Zone Management Program aims to establish the minimum clearance distance that must be maintained between workers and heavy equipment while equipment is in operation (i.e., engaged or moving). The intent is to have no personnel or equipment entering the Exclusion Zone while the equipment is in operation or moving to ensure that Roux and Subcontractor employees are unnecessarily exposed to the hazards of the equipment.

2. SCOPE AND APPLICABILITY

This Management Program applies to all Roux Associates, Inc. and its affiliated companies, Roux Environmental Engineering and Geology, D.P.C., and Remedial Engineering (collectively, "Roux") employees and their subcontractors performing fieldwork and are potentially exposed to heavy equipment. Heavy equipment includes, but is not necessarily limited to, excavation equipment, drill rigs, vacuum trucks, forklifts, lull telehandlers, man lifts, bobcats, delivery trucks, etc.

3. PROCEDURES

As specified in the following sections of this program, Exclusion Zones must be established and maintained during activities involving the movement/operation of heavy equipment. The Exclusion Zone requirements apply to all personnel on the site but are primarily focused on personnel required to work near the equipment. The exclusion zone is in effect when heavy equipment is moving or engaged (e.g., movement of an arm or bucket of an excavator, rotation of an auger, lifting of a load with a forklift, raising/lowering of a man lift, etc.).

1. The Exclusion Zone must meet the following minimum requirements:
   - A minimum distance of 10 feet from all heavy equipment and loads being moved by the equipment;
   - Greater than the swing/reach radius of any moving part on the heavy equipment (i.e., for large equipment, this may mean an exclusion zone distance larger than 20 feet);
   - Greater than the fall zone of equipment and their contents; and
   - Greater than the tip-over distance of the heavy equipment.

   The size of the Exclusion Zone will need to be determined on a task-specific basis considering the size of the heavy equipment in use and the task being performed. Prior to all heavy equipment operations, the Exclusion Zone(s) distance must be specifically identified in the Job Planning Process and incorporated in the pre-job tailgate meeting with the subcontractor(s), including any updates to our Job Safety Analysis (JSA).
2. The spotter (or another authorized individual) is responsible for enforcing the Exclusion Zone and not conducting any other task. The spotter should be positioned immediately outside of the Exclusion Zone within a clear line of sight of the equipment operator. The spotter must signal the operator to stop work if anyone or anything has the potential to enter or compromise the Exclusion Zone. The operator should stop work if the spotter is not within their line of sight. If a spotter must be within the Exclusion Zone, they must be in a designated area outside the swing/tip radius, fall zone, line of fire of lifted loads, etc. If multiple pieces of equipment are being used, one spotter may be adequate so long as there is a clear line of sight and the spotter can control the zone(s). Radios would be required since hand signals would not be adequate if two pieces of equipment are in operation at the same time in the Exclusion Zone.

3. If an individual must enter the Exclusion Zone, the designated Spotter must signal the Equipment Operator to stop the equipment. Once the equipment is no longer moving (e.g., movement of an arm of an excavator is STOPPED, lifting of a load with a forklift STOPPED, raising/lowering of a man lift is STOPPED, etc.), the operator must bring the boom/arm to the ground ensuring a “Zero Energy State” and DISENGAGE THE CONTROLS and STOP and SIGNAL BY “SHOWING HIS HANDS.” This signal will indicate that it is safe for the person to enter the limits of the Exclusion Zone to perform the required activity. The equipment must remain completely stopped/disengaged until all personnel exited the Exclusion Zone's boundaries and the designated Spotter has signaled by “SHOWING HIS HANDS” to the Equipment Operator that it is safe to resume operations.
4. When entering the limits of the Exclusion Zone, personnel must, at a minimum:
    - Establish eye contact with the operator and approach the heavy equipment in a manner that is in direct line of sight to the Equipment Operator;
    - Never walk under any suspended loads or raised booms/arms of the heavy equipment; and
    - Identify a travel path free of Slip/Trip/Fall hazards.
5. The Exclusion Zone should be delineated using cones with orange snow fences or solid poles between the cones, barrels, tape, or other measures. For work in rights-of-way, rigid barriers, such as Jersey barriers or temporary chain link fences, should be used. For certain types of widespread or moving/mobile equipment operations, such delineation may not be practicable around equipment or individual work areas. In such instances, it is expected that the entire operation will be within a larger secure work area or that additional means will be utilized to ensure the security of the work zone.

All subcontractors who provide heavy equipment operations to field projects must implement a program that meets or exceeds the expectations described above as well as any additional requirements that may be required on a client or site-specific basis. Logistics involving heavy equipment should be understood and discussed prior to the field event during the job planning phase.

3.1 Exceptions

It is recognized that certain heavy equipment activities may require personnel to work within the limits of the Exclusion Zone as specified in this program. Such activities may include certain excavation clearance tasks, drill crew activities, or construction tasks. However, any such activity must be pre-planned, emphasizing limiting the amount and potential exposure of any activity required within the zone. The critical safety steps to mitigate the hazards associated with working within the Exclusion Zone must be defined in the JSA and potentially other project-specific plans (i.e., critical lift plans, etc.), and approved by the Roux Project Principal (PP), Office Health and Safety Manager (OHSM) and client representative, if required, prior to implementation.

4. TRAINING

Many Roux projects have different requirements that are client-specific or site-specific in nature. However, all Roux employees are provided initial training, as well as annually thereafter, on our Heavy Equipment Exclusion zone policy.

5. STOP WORK AUTHORITY

All Roux employees and their subcontractors have stop-work authority. Upon initial hire, all Roux employees are provided initial safety orientation, including stop work authority. All Roux employees and subcontractors are encouraged to stop work whenever any task or operation presents unreasonable risk or employees are

unsure how to carry out work safely. This includes upon observing any questionable safety-related behavior or condition, they are to stop work immediately and discuss the behavior or condition with the individual(s) involved. Upon stopping work, the following actions will be taken:

- Notify the affected parties to include the Project Manager (PM) and Site Health and Safety Officer (SHSO);
- Work to correct the situation or not proceed until the situation is corrected by the PM or SHSO;
- Resume work only when told to proceed by either the PM or SHSO;
- The SHSO will document the Stop-Work intervention in the field logbook;
- Stop-Work interventions will be reported to the PP for review to ensure the interventions are closed; and
- The PP will share learnings from the interventions, as appropriate, throughout the firm, to demonstrate the importance of the Stop-Work interventions.

Please note: Any form of retribution or intimidation directed at any individual or company for exercising their right to issue a stop work authority will not be tolerated.

APPENDIX D

Field Operating Procedures

Field Operating Procedures - Acknowledgment Form

Project Number: 4395.0005B000 Project Name: Smokes Creek PDI

My signature below certifies that I have read and understand the procedures specified in Field Operating Procedures (FOPs) 032.2, 040.1, 046.0, 054.2, 076.0, and Standard Operating Procedure (SOP) 19901.

Date	Name (print)	Signature	Company

FIELD OPERATING PROCEDURES

Management of Investigative-Derived Waste (IDW)

March 2026 Revision 0

FOP 032.2

MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

PURPOSE

The purpose of these guidelines is to ensure the proper holding, storage, transportation, and disposal of materials generated from field investigation activities that may contain hazardous wastes. Investigation-derived waste (IDW) includes the following:

- Drill cuttings, discarded soil samples, drilling mud solids, and used sample containers.
- Well development and purge waters and discarded groundwater samples.
- Decontamination waters and associated solids.
- Soiled disposable personal protective equipment (PPE).
- Used disposable sampling equipment.
- Used plastic sheeting and aluminum foil.
- Other equipment or materials that either contain or have been in contact with potentially impacted environmental media.

Because these materials may contain regulated chemical constituents, they must be managed as a solid waste. This management may be terminated if characterization analytical results indicate the absence of these constituents.

PROCEDURE

1. Contain all investigation-derived wastes in Department of Transportation (DOT)-approved 55-gallon drums, roll-off boxes, or other containers suitable for the wastes.

2. Contain wastes from separate borings or wells in separate containers (i.e. do not combine wastes from several borings/wells in a single container, unless it is a container used specifically for transfer purposes, or unless specific permission to do so has been provided by the Roux Field Team Leader. Unused samples from surface sample locations within a given area may be combined.

3. To the extent practicable, separate solids from drilling muds, decontamination waters, and similar liquids. Place solids within separate containers.

4. Transfer all waste containers to a staging area. Access to this area will be controlled. Waste containers must be transferred to the staging area as soon as practicable after the generating activity is complete.

5. Pending transfer, all containers will be covered and secured when not immediately attended.

6. Label all containers with regard to contents, origin, date of generation, using Roux's IDW container label (sample attached). Use indelible ink for all labeling.

7. Complete the Investigative Derived Waste Container Log (sample attached) as waste containers are labeled in order to track and inventory project waste. Leave a copy of the log with the site manager or fax copy to the owner/operator as necessary.

8. Collect samples for waste characterization purposes, or use boring/well sample analytical data for characterization.

9. For wastes determined to be hazardous in character, **be aware of accumulation time limitations**. Coordinate the disposal of these wastes with the plant manager/owner/operator, if applicable.

10. Upon NYSDEC Project Manager approval, dispose of investigation-derived wastes as follows:

- Soil, water, and other environmental media for which analysis does not detect organic constituents, and for which inorganic constituents are at levels that meet the Site's cleanup objectives, may be spread on the Property or otherwise treated as a non-waste material. Disposal quantity and on-site location will be documented on Project Field Books and in the project report submittal.

- Soil, water, and other environmental media in which organic compounds are detected or metals are present above the Site's cleanup objectives will be disposed off-site in accordance with applicable state and federal regulations. Disposal quantity and off-site location will be documented on Project Field Books and in the project report submittal.

- Personal protective equipment, disposable bailers, and similar equipment may be disposed as municipal waste, unless waste characterization results mandate otherwise.

WASTE STORAGE MANAGEMENT

Hazardous materials generated on site should be temporarily stored in a secure location that is under the control of the owner/operator or does not allow for vandalism (i.e., within a locked building structure or within a locked fenced in area). A waste-staging area should be designated on-site by the Project Manager in conjunction with the owner/operator.

ATTACHMENTS

Investigation Derived Waste Container Log (sample)
Investigation Derived Waste Container Label (sample)

REFERENCES

None

INVESTIGATION DERIVED WASTE CO

Project Name: Location:

Project Number: Personnel:

Container		Contents	Date		Staging Location	Date Sampled	Co
Number	Description		Started	Ended			

SAMPLE

Prepared By:

Signed:

IDW Container Label (sample):

ROUX

Project Name:
Project Number:

Container I.D.:
Contents/Matrix:
Estimated Quantity:
Date of Generation:
Date of Sample Collection:

Contact Name:
Contact Phone Number:

FIELD OPERATING PROCEDURES

Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

March 2026 Revision 0

FOP 040.1

NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

PURPOSE

This procedure is to be used for the decontamination of non-disposable and non-dedicated equipment used in the collection of environmental samples. The purpose of this procedure is to remove chemical constituents from previous samples from the sampling equipment. This prevents these constituents from being transferred to later samples, or being transported out of controlled areas.

HEALTH AND SAFETY

Nitric acid is a strong oxidizing agent as well as being extremely corrosive to the skin and eyes. Solvents such as acetone, methanol, hexane and isopropanol are flammable liquids. Limited contact with skin can cause irritation, while prolonged contact may result in dermatitis. Eye contact with the solvents may cause irritation or temporary corneal damage. Safety glasses with protective side shields, neoprene or nitrile gloves and long-sleeve protective clothing must be worn whenever acids and solvents are being used.

PROCEDURE – GENERAL EQUIPMENT

Bailers, split-spoons, steel or brass split-spoon liners, Shelby tubes, submersible pumps, soil sampling knives, and similar equipment will be decontaminated as described below.

1. Wash equipment thoroughly with non-phosphate detergent and potable-quality water, using a brush where possible to remove any particulate matter or surface film. If the sampler is visibly coated with tars or other phase-separated hydrocarbons, pre-wash with acetone or isopropanol, or by steam cleaning. Decontamination will adhere to the following procedure:

a. Rinse with potable-quality water; if the sampling equipment is very oily and use of a solvent is necessary, rinse with pesticide-grade isopropanol.

b. Rinse with potable-quality water;

c. Rinse with deionized water demonstrated analyte-free, such as distilled water;

d. Air dry; and

e. Store in a clean area or wrap in aluminum foil (shiny side out) or new plastic sheeting as necessary to ensure cleanliness.

2. All non-dedicated well evacuation equipment, such as submersible pumps and bailers, which are put into the well, must be decontaminated following the procedures listed above. All evacuation tubing must be dedicated to individual wells (i.e., tubing cannot be reused). However, if submersible pump discharge tubing must be reused, the tubing and associated sample valves or flow-through cells used in well purging or pumping tests will be decontaminated as described below:

a. Pump a mixture of potable water and a non-phosphate detergent through the tubing, sample valves and flow cells, using the submersible pump.

b. Steam clean or detergent wash the exterior of the tubing, sample valves, flow cells and pump.

c. Pump potable water through the tubing, sample valve, and flow cell until no indications of detergent (e.g. foaming) are observed.

d. Double rinse the exterior of the tubing with potable water.

e. Rinse the exterior of the tubing with distilled water.

f. Store in a clean area or wrap the pump and tubing assembly in new plastic sheeting as necessary to ensure cleanliness until ready for use.

3. All unused sample bottles and sampling equipment must be maintained in such a manner that there is no possibility of casual contamination.

4. Manage all waste materials generated during decontamination procedures as described in the Roux Field Operating Procedure for Management of Investigation Derived Waste.

PROCEDURE – SUBMERSIBLE PUMPS

Submersible pumps used in well purging or purging tests will be decontaminated thoroughly each day before use as well as between well locations as described below:

Daily Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes.

3. Rinse: Operate the pump in a basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

4. Disassemble pump.

5. Wash pump parts with a non-phosphate detergent solution (i.e., Alconox). Scrub all pump parts with a test tube brush or similar device.

6. Rinse pump with potable water.

7. Rinse the inlet screen, the shaft, the suction interconnection, the motor lead assembly, and the stator housing with distilled/deionized water.

8. Rinse the impeller assembly with 1% nitric acid (HNO_3).

9. Rinse the impeller assembly with isopropanol.

10. Rinse the impeller assembly with distilled/deionized water.

Between Wells Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes.

2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes.

3. Rinse: Operate the pump in a basin of potable water for 5 minutes.

4. Final rinse the pump in distilled/deionized water.

ATTACHMENTS

None

REFERENCES

Roux FOPs:
032 Management of Investigation-Derived Waste

FIELD OPERATING PROCEDURES

Sample Labeling, Storage, and Shipment Procedures

March 2026 Revision 0

FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

PURPOSE

The collection and analysis of samples of environmental media, including soils, groundwater, surface water, and sediment, are the central activities of the field investigation. These samples must be properly labeled to preserve its identity, and properly stored and shipped in a manner that preserves its integrity and chain of custody. This procedure presents methods for these activities.

SAMPLE LABELING PROCEDURE

1. Assign each sample retained for analysis a unique 9-digit alphanumeric identification code or as indicated in the Project Work Plan. Typically, this code will be formatted as follows:

Sample I.D. Example: GW051402047	
GW	**Sample matrix** GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
05	Month of sample collection
14	Day of sample collection
02	Year of sample collection
047	Consecutive sample number

2. Consecutive sample numbers will indicate the individual sample's sequence in the total set of samples collected during the investigation/sampling event. The sample number above, for example, would indicate the 47th sample retained for analysis during the field investigation, collected on May 14, 2002.

3. Affix a non-removable (when wet) label to each sample container. The following information will be written on the label with black or blue ink that will not smudge when wet:

   - Project number
   - Sample ID (see Step 1 above)
   - Date of sample collection
   - Time of sample collection (military time only)
   - Specify "grab" or "composite" sample with an "X"
   - Sampler initials
   - Preservative(s) (if applicable)
   - Analytes for analysis (if practicable)

4. Record all sample label information in the Project Field Book and on a Sample Summary Collection Log (see attached samples), keyed to the sample identification number. In addition, add information regarding the matrix, sample location, depth, etc. to provide a complete description of the sample.

SAMPLE STORAGE PROCEDURE

1. Immediately after collection, placement in the proper container, and labeling, place samples to be retained for chemical analysis into resealable plastic bags.

2. Place bagged samples into an ice chest filled approximately half-full of double bagged ice. Blue ice is not an acceptable substitute for ice.

3. Maintain samples in an ice chest or in an alternative location (e.g. sample refrigerator) as approved by the Roux Field Team Leader until time of shipment. Periodically drain melt-water off coolers and replenish ice as necessary.

4. Ship samples on a daily basis, unless otherwise directed by the Roux Field Team Leader.

5. Maintain appropriate custody procedures on coolers and other sample storage containers at all times. These procedures are discussed in detail in the Project Quality Assurance Project Plan, Monitoring Plan or Work Plan.

6. Samples shall be kept in a secure location locked and controlled (i.e., locked building or fenced area) so that only the Project Field Team Leader has access to the location or under the constant visual surveillance of the same.

SAMPLE SHIPPING PROCEDURE

1. Fill out the chain-of-custody form completely (see attached sample) with all relevant information. The white original goes with the samples and should be placed in a resealable plastic bag and taped inside the sample cooler lid; the sampler should retain the copy.

2. Place a layer of inert cushioning material such as bubble pack in the bottom of cooler.

3. Place each bottle in a bubble wrap sleeve or other protective wrap. To the extent practicable, then place each bottle in a resealable plastic bag.

4. Open a garbage bag (or similar) into a cooler and place sample bottles into the garbage bag (or similar) with volatile organic analysis (VOA) vials near the center of the cooler.

5. Pack bottles with ice in plastic bags. At packing completion, cooler should be at least 50 percent ice, by volume. Coolers should be completely filled, so that samples do not move excessively during shipping.

6. Duct tape (or similar) cooler drain closed and wrap cooler completely in two or more locations to secure lid, specifically covering the hinges of the cooler.

7. Place laboratory label address identifying cooler number (i.e., 1 of 4, 2 of 4 etc.) and overnight delivery waybill sleeves on cooler lid or handle sleeve (Federal Express).

8. Sign the custody seal tape with an indelible soft-tip marker and place over the duct tape across the front and back seam between the lid and cooler body.

9. Cover the signed custody seal tape with an additional wrap of transparent strapping tape.

10. Place "Fragile" and "This Side Up" labels on all four sides of the cooler. "This Side Up" labels are yellow labels with a black arrow with the arrowhead pointing toward the cooler lid.

11. For coolers shipped by overnight delivery, retain a copy of the shipping waybill, and attach to the chain-of-custody documentation.

ATTACHMENTS

Soil/Sediment Sample Summary Collection Log (sample)
Groundwater/Surface Water Sample Summary Collection Log (sample)
Wipe Sample Summary Collection Log (sample)
Air Sample Summary Collection Log (sample)
Chain-Of-Custody Form (sample)

REFERENCES

None

ROUX

SOIL/SEDIMENT
SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks *- Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufacturers info & date.*

MS/MSD/MSB *- Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for in the samples collected the same day.*

Field Blank *- Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.*

Investigation Derived Waste (IDW) Characterization samples *- One composited sample from all drums of each fluid and soil. Please note number of drums and labels on collection log.*

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
5. BD - Blind Duplicate - indicate location of duplicate.

SAMPLE

ROUX

GROUNDWATER/SURFACE WATER SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks *- Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufacturers info & date.*

MS/MSD/MSB *- Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for in the samples collected the same day.*

Field Blank *- Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.*

Investigation Derived Waste (IDW) Characterization samples *- One composited sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.*

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. FD - Field Duplicate.
5. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
6. BD - Blind Duplicate.

SAMPLE

ROUX

WIPE SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. FD - Field Duplicate.
4. FB - Field Blank.
5. RS - Rinsate.
6. No Matrix Spike, Matrix Spike Duplicate or Matrix Spike Blanks for wipe samples.
7. Rinsates should be taken at a rate of 1 per day during wipe sampling. Only take when reusable equipment is used.
8. Wipe sample FB collected by wiping unused glove and any other sampling equipment coming into contact with sampled surface) with prepared gauze pad and place in sample jar. Take at a rate of 1 FB per 20 samples.
9. Wipe sample FDs taken adjacent to original sample at a rate of 1 FD per 20 samples.
10. **EH :** Extract and Hold

SAMPLE

ROUX

AIR SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. SC - Summa Canister.
3. TB - Tedlar Bag (quantity).
4. No Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blanks, Field Duplicates, Field Blanks or Rinsates collected for air samples.

SAMPLE

ROUX

CHAIN OF CUSTODY RECORD

Project No.	Project Name					Number of Containers	VOCs	SVOCs	Metals					REMARKS
Samplers (Signature)														
No.	Date	Time	comp	grab	Sample Identification									

Possible Hazard Identification:
☐ Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal:
☐ Return to Client ☐ Disposal by Lab ☐ Archive _____(mos.)

Turnaround Time Required:
Normal ☐ Rush ☐

QC Level:
I ☐ II ☐ III ☐ Project Specific (specify): _____

Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	REMARKS:
Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	

SAMPLE

FIELD OPERATING PROCEDURES

Sediment Sample Processing from Vibracore Sampling

March 2026 Revision 0

FOP 049.1

SEDIMENT SAMPLE PROCESSING FROM VIBRACORE SAMPLING

PURPOSE

This guideline presents a method for processing sediment samples collected via Vibracore sampling. If modifications to this FOP are deemed necessary, they should be documented in the Project Field Book, Variance Log (sample attached) and discussed in reports summarizing field activities and analytical results.

HEALTH & SAFETY REQUIREMENTS

In addition to compliance with the Project Health and Safety Plan, the following safety guidelines will be followed during sediment sampling from a sample vessel:

1. A minimum of two and a maximum of three persons shall be in the sampling vessel at all times.
2. All personnel shall wear U.S. Coast Guard-approved personal flotation devices (PFDs) while in the sampling vessel.
3. The sampling vessel shall be capable of deploying Vibracoring apparatus and providing sufficient room for all Vibracoring operations. Sampling boat must also be properly sized to operate in the typical water depths and conditions anticipated at the project site.
4. The sampling vessel operator will be familiar with U.S. Coast Guard safety procedures for operating a boat.
5. Sampling will be conducted when weather conditions allow for safe operation of the sampling vessel and the potential of capsize due to strong current is minimized.

SEDIMENT PROCESSING SAMPLING PROCEDURE

Collection of subsurface sediment from beneath a deep body of water will be accomplished with a sampling vessel (e.g., boat) using Vibracore sampling equipment.

1. Decant off any free-standing water, as necessary; care should be taken to retain the fine sediment fraction during this procedure. Place the core tube liner on a poly sheeting - covered surface of the sampling vessel.

2. A Roux field geologist or qualified drillers helper will manage and open the Vibracore sample liner.
3. Sample description will be performed using the Unified Soil Classification System in accordance with the Roux FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).
4. Samples designated for volatile organic analysis will be collected directly from the liner before homogenization to minimize volatilization of contaminants.
5. Thoroughly homogenize the remaining sediment by gently mixing the retrieved sediment with the stainless-steel spoon in a disposable mixing tray or stainless-steel mixing bowl. Decant off any free-standing water, as necessary.
6. Transfer the sediment using dedicated stainless-steel tools into pre-cleaned bottles provided by the analytical laboratory.
7. Label, store and ship the samples in accordance with Roux's FOP for Sample Labeling, Storage and Shipment Procedures.
8. Record field measurements, such as weather conditions, depth to sediment, thickness of surface sediment, sample location, sample appearance/odor, types of sediment present, sample depth interval and other pertinent information in the Project Field Book and on the Sediment Sample Collection Log form (sample attached).
9. Any PPE or mixing equipment will be disposed of or cleaned prior to the next sampling location.

REQUIRED EQUIPMENT

- Personal protective equipment (PPE) (if applicable)
- Disposable mixing tray
- Stainless steel spoons
- Flat-bottomed boat
- Plastic sheeting
- Knife
- Laboratory-provided bottles
- Cell phone
- Field forms
- Project Field Book

ATTACHMENTS

Figure 1; Vibracore Sampler

Sediment Sample Collection Log (sample)
Variance Log (sample)

ROUX FOPS:

040.1 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
046.0 Sample Labeling, Storage and Shipment Procedures
054.2 Soil Description Procedures Using the Unified Soil Classification System (USCS)

FIGURE 1

VIBRACORE SAMPLER

SOIL / SEDIMENT SAMPLE COLLECTION LOG

PROJECT INFORMATION

Project Name:

Project No.:

Client:

SAMPLE DESCRIPTION

I.D.:

Matrix: ☐ SOIL ☐ SEDIMENT ☐ SOLID WASTE

Location:

SAMPLE INFORMATION

Date Collected:

Time Collected:

Date Shipped to Lab:

Collected By:

Sample Type: ☐ POINT ☐ GRAB ☐ COMPOSITE

Sample Collection Method: ☐ BOTTOM SAMPLER / DREDGE ☐ CORE SAMPLER ☐ STANDARD SPLIT SPOON ☐ HAND AUGER ☐ SS SPOON / TROWEL ☐ OTHER

SAMPLING INFORMATION

Weather:

Air Temperature:

Field Test	Result
pH	
Temp. (^{o}C / ^{o}F)	
Spec. Cond. (uS / mS)	
Other (units)	

LOCATION SKETCH

(not to scale, dimensions are approximate)

EXACT LOCATION (if applicable)

Northing (ft)	Easting (ft)	Surface Elevation (fmsl)

SAMPLE DESCRIPTION (USCS, visual, olfactory):

SAMPLE ANALYSIS (depth, laboratory analysis required):

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

Variance No.: _____

Date of Issue: _____

Page: _____ of _____

Project Name:

Project Number:

Project Location: Date:

- Variance Log -

I. Summary of Nonconformance or Change: (completed by field team leader)

II. Variance Requested: (completed by field team leader)

III. Justification for Variance: (completed by field team leader)

IV. Applicable Document / Work Plan: (completed by field team leader)

Requested By: Date:

Project Manager Approval: Date:

FIELD OPERATING PROCEDURES

Soil Description Procedures Using The Visual-Manual Method

March 2026 Revision 0

FOP 054.2

SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

PURPOSE

This guideline presents a means for insuring consistent and proper field identification and description of collected soils during a project (via, split-spoon (barrel) sampler, hand auger, test pit etc.). The lithology and moisture content of each soil sample will be physically characterized by visual-manual observation in accordance with ASTM Method D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). When precise classification of soils for engineering purposes is required, the procedures prescribed in ASTM Method D2487 (Standard Practice for Classification of Soils for Engineering Purposes [Unified Soil Classification System, USCS]) will be used. The method of soil characterization presented herein describes soil types based on grain size, liquid and plastic limits, and moisture content based on visual examination and manual tests. When using this FOP to classify soil, the detail of description provided for a particular material should be dictated by the complexity and objectives of the project. However, more often than not, "after the fact" field information is required later in the project, therefore, every attempt to describe the soil as completely as possibly should be made.

Intensely weathered or decomposed rock that is friable and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil. The soil classification would be followed by the parent rock name in parenthesis. Projects requiring depth to bedrock determinations should always classify weathered or decomposed bedrock as bedrock (i.e., landfill siting). The project manager should always be consulted prior to making this determination.

PROCEDURE

Assemble necessary equipment and discuss program requirements with drilling contractor.

1. Calibrate air-monitoring equipment in accordance with the appropriate Roux's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect desired soil sample in accordance with appropriate Roux FOP (i.e., split-spoon sampling, hand augering, test pitting etc.).

3. Shave a thin layer off the entire length of the sample to expose fresh sample.

4. Photograph and scan the sample with a photoionization detector (PID) at this time, if applicable, in accordance with Roux's Screening of Soil Samples for Organic Vapors During Drilling Activities FOP.

5. Describe the sample using terminology presented in the Descriptive Terms section below.

6. Record all pertinent information in the Project Field Book and Field Borehole Log (sample attached) or Field Borehole/Monitoring Well Installation Log (sample attached).

7. After the sample has been described, place a representative portion of the sample in new, precleaned jars or self-sealing plastic bags for archival purposes (if required). Label the jar or bag with the sample identification number, sample interval, date, project number and store in a secure location.

8. If the soil is to be submitted to a laboratory for analysis, collect the soil sample with a dedicated stainless steel sampling tool, place the sample into the appropriate laboratory-supplied containers, and store in an ice-chilled cooler staged in a secure location in accordance with Roux's Sample Labeling, Storage and Shipment Procedures FOP.

9. All remaining soil from soil sample collection activities shall be containerized in accordance with Roux's Management of Investigative-Derived Waste (IDW) FOP and/or the Project Work Plan.

DESCRIPTIVE TERMS

All field soil samples will be described using the Unified Soil Classification System (USCS) presented in Figures 1 and 2 (attached). In addition to ASTM Method D2488, Method D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (a.k.a., Standard Penetration Test, STP), when implemented, can also be used to classify the resistance of soils. In certain instances, it is desirable to supplement the USCS classification with a geologic interpretation of the soil sample that is supported by the soil descriptive terms presented in this section. The project manager should be consulted when making any geologic interpretation. Field test methods are provided to assist field personnel in classifying soil and are identified by a bold blue **FTM** and shaded. Classification of sampled soils will use the following ASTM descriptive terms and criteria:

- **Group Name** (USCS, see Figure 2)
- **Group Symbol** (USCS, see Figure 2) – only use if physical laboratory testing has been performed to substantiate. The USCS can be applied to most unconsolidated materials, and is represented by a two-letter symbol, except Peat (Pt).
  - The first letter includes: G (gravel), S (sand), M (silt), C (clay), and O (organic).
  - The second letter includes: P (poorly graded or uniform particle sizes), W (well graded or diversified particle sizes), H (high plasticity), and L (low plasticity).
  - Examples:
    - GW = well graded gravels and gravel-sand mixtures, little or no fines
    - GP = poorly graded gravels and gravel-sand mixtures, little or no fines
    - GM = silty gravels, gravel-sand-silt mixtures

- GC = clayey gravels, gravel-sand-clay mixtures
- SW = well graded sands and gravelly sands, little or no fines
- SP = poorly graded sands and gravelly sands, little or no fines
- SM = silty sand, sand-silt mixtures
- SC = clayey sand sand-clay mixtures
- ML = inorganic silts, very fine sands, rock flour, silty or clayey fine sands
- CL = inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
- OL = organic silts and organic silty clays of low plasticity
- MH = inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts (very rare)
- CH = inorganic clays of high plasticity, fat clays
- OH = organic clays of medium to high plasticity
- Pt = peat, muck, and other highly organic soils

- **Angularity** (ASTM D2488; Table 1)
  - Angular – particles have sharp edges and relatively planar sides with unpolished surfaces
  - Subangular – particles are similar to angular description but have rounded edges
  - Subrounded – particles have nearly planar sides but have well-rounded corners and edges
  - Rounded – particles have smoothly curved sides and no edges
- **Particle Shape** (ASTM D2488; Table 2)
  - Flat – particles with width/thickness > 3
  - Elongated – particles with length/width > 3
  - Flat and Elongated – particles meet criteria for both flat and elongated
- **Moisture Condition** (ASTM D2488; Table 3)
  - Dry – absence of moisture, dusty, dry to the touch
  - Moist – damp, but no visible water
  - Wet – visible free water, usually soil is below water table
- **Reaction with Hydrochloric Acid (HCL)** (ASTM D2488; Table 4)
  - None – no visible reaction

- Weak – some reaction, with bubbles forming slowly
- Strong – violent reaction, with bubbles forming immediately

- **Consistency of Cohesive Soils** (ASTM D2488; Table 5)
  - Very soft – squeezes between fingers when fist is closed; easily penetrated several inches by fist (SPT = 2 or less)
  - Soft – easily molded by fingers; easily penetrated several inches by thumb (SPT = 2 to 4)
  - Firm – molded by strong pressure of fingers; can be penetrated several inches by thumb with moderate effort (SPT = 4 to 8)
  - Stiff – dented by strong pressure of fingers; readily indented by thumb but can be penetrated only with great effort (SPT = 8 to 15)
  - Very stiff – readily indented by thumbnail (SPT = 15 to 30)
  - Hard – indented with difficultly by thumbnail (SPT >30)
- **Cementation** (ASTM D2488; Table 6)
  - Weak – crumbles or breaks with handling or slight finger pressure
  - Moderate – crumbles or breaks with considerable finger pressure
  - Strong – will not crumble or break with finger pressure
- **Structure (Fabric)** (ASTM D2488; Table 7)
  - Varved – alternating 1 mm to 12 mm (0.04 – 0.5 inch) layers of sand, silt and clay
  - Stratified – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Laminated – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Fissured – contains shears or separations along planes of weakness
  - Slickensided – shear planes appear polished or glossy, sometimes striated

- Blocky – cohesive soil that can be broken down into small angular lumps which resist further breakdown
- Lensed – inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
- Homogeneous or Massive – same color and appearance throughout

- **Inorganic Fine-Grained Soil Characteristics** (ASTM D2488; Table 12)

  Several field tests can be performed to determine the characteristics of fine-grained soils (material passing the No. 40 sieve), such as dry strength, dilatency, and toughness. These field testing methods are described below.

  - **Dry Strength** (ASTM D2488; Table 8)

    FTM (Dry Strength): Select enough material and moisten with water until it can be molded or shaped without sticking to your fingers (slightly below the sticky limit) into a ball about 1 inch in diameter. From this ball, form three balls about ½ inch in diameter and allow to dry in air, or sun, or by artificial means (temperature not to exceed 60° C (140° F). Soil containing natural dry lumps about ½ inch in diameter may be used in place of molded balls, however the dry strengths are usually lower. Test the strength by crushing the dry balls or lumps between your fingers using the descriptions below.

    - None – the dry specimen crumbles with the slightest pressure of handling
    - Low – the dry specimen crumbles with some finger pressure
    - Medium – the dry specimen breaks into pieces or crumbles with considerable finger pressure
    - High – the dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
    - Very High – the dry specimen cannot be broken between the thumb and a hard surface

  - **Dilatency** (ASTM D2488; Table 9)

    FTM (Dilatency): Place enough material in your hand to form a ball approximately ½ inch in diameter and moisten with water until it can be

molded or shaped without sticking to your fingers (slightly below the sticky limit). Smooth the ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other several times. Note the reaction of water appearing on the surface of the soil. The soil is said to have given a reaction to this test if, when it is shaken, water comes to the surface of the sample producing a smooth, shiny appearance. Squeeze the sample between the thumb and forefinger and note the reaction as follows:

- None – no visible change in the specimen
- Slow – water slowly appears on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
- Rapid – water quickly appears on the surface of the specimen during shaking and disappears upon squeezing

- **Toughness** (ASTM D2488; Table 10)

FTM (Toughness): Following the dilatency test above, shape the test specimen into an elongated pat and roll by hand on a smooth surface or between palms into a thread about 1/8 inch in diameter. Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch (e.g., near the plastic limit). Note the pressure required to roll the thread near the plastic limit as well as the strength of the thread. After the thread crumbles, lump the pieces together and knead the lump until it crumbles. Describe the toughness as follows:

- Low – only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and very soft.
- Medium – medium pressure is required to roll the thread to near the plastic limit. The thread and the lump are soft.
- High – considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump are firm.

Using the results of the dry strength, dilatency, and toughness test described above, classify the soil according to the following:

Soil Symbol	Dry Strength	Dilatency	Toughness
Silt (ML)	None to low	Slow to rapid	Low or thread cannot be formed
Lean clay (CL)	Medium to high	None to slow	Medium
Elastic Silt (MH)	Low to medium	None to slow	Low to medium
Fat Clay (CH)	High to very high	None	Low to medium high

- **Plasticity** (ASTM D2488; Table 11)

  Two field test methods can be used to determine plasticity of fine-grained soils (material passing the No. 40 sieve): the roll or thread test and the ribbon test. Each test is described below.

  FTM (Roll or Thread Test): As with the toughness test above, mix a representative portion of the soil sample with water until it can be molded or shaped without sticking to your fingers (slightly below the sticky limit). Place an elongated cylindrical sample on a nonabsorbent rolling surface (e.g., glass or was paper on a flat surface) and attempt to roll it into a thread approximately 1/8 inch in diameter. The results of this test are defined below (non-plastic to high plasticity).

  FTM (Ribbon Test): Form a roll from a handful of moist soil (slightly below the sticky limit) about ½ to ¾ inches in diameter and about 3 to 5 inches long. Place the material in the palm of your hand and, starting at one end, flatten the roll between your thumb and forefinger to form the longest and thinnest ribbon possible that can be supported by the cohesive properties of the material before breaking. If the soil sample holds together for a length of 6 to 10 inches without breaking, the material is considered to be both highly plastic and highly compressive (Fat Clay, CH). If the soil cannot be ribboned, it is non-plastic (Silt, ML or MH). If it can be ribboned only with difficulty into short lengths, it has low plasticity (Lean Clay, CL). Use the following terms to describe the plasticity of soil:

- Nonplastic (ML or MH) – a 3 mm (0.12 inches) thread cannot be rolled at any water content
- Low Plasticity (CL, ML, or MH) – the thread can barely be rolled, and crumbles easily
- Medium Plasticity (CL) – the thread is easy to roll and not much time is required to reach the plastic limit before crumbling
- High Plasticity (CH) – it takes considerable time rolling and kneading to reach the plastic limit; the thread can be rolled several times before crumbling

Note: A soil with as little as 20% clay will behave as a clayey soil. A soil needs 45% to over 60% medium to coarse sand to behave as a sandy soil. In a soil with 20% clay and 80% sand, the soil will behave as a clayey soil.

- **Relative Density of Cohesionless (Granular) Soils**
  - Very loose – easily penetrated 30 cm (1.2 inches) with 13 mm (0.5 inch) rebar pushed by hand (SPT = 0 to 4)
  - Loose – easily penetrated several cm with 13 mm (0.5 inch) rebar pushed by hand (SPT = 4 to 10)
  - Medium dense – easily to moderately penetrated with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = 10 to 30)
  - Dense – penetrated 0.3 m (1 foot) with difficulty using 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = 30 to 50)
  - Very dense – penetrated only a few cm with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = >50)
- **Color** (use Munsel® Color System, as necessary)
- **Particle Size** (see Figure 3)
  - Boulder – larger than a basketball
  - Cobble – grapefruit, orange, volleyball
  - Coarse Gravel – tennis ball, grape

- Fine Gravel – pea
- Coarse Sand – rock salt
- Medium Sand – opening in window screen
- Fine Sand – sugar, table salt
- Fines (silt and clay) – cannot visually determine size (unaided)

- **Gradation**
  - Well Graded (GW, SW) – full range and even distribution of grain sizes present
  - Poorly-graded (GP, SP) – narrow range of grain sizes present
  - Uniformly-graded (GP, SP) – consists predominantly of one grain size
  - Gap-graded (GP-SP) – within the range of grain sizes present, one or more sizes are missing

- **Organic Material** – Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread of the toughness test will be spongy.
  - PEAT – 50 to 100 percent organics by volume, primary constituent
  - Organic (soil name) – 15 to 50 percent organics by volume, secondary organic constituent
  - (Soil name) with some organics – 5 to 15 percent organics by volume, additional organic constituents

- **Fill Materials** – All soils should be examined to see if they contain materials indicative of man-made fills. Man-made fill items should be listed in each of the soil descriptions. Common fill indicators include glass, brick, dimensioned lumber, concrete, pavement sections, asphalt, metal, plastics, plaster etc. Other items that could suggest fill include buried vegetation mats, tree limbs, stumps etc. The soil description for a fill material should be followed by the term "FILL", i.e., for a sandy silt with some brick fragments the description would be "SANDY

SILT (ML), with brick fragments (Fill)". The size and distribution of fill indicators should be noted. The limits (depth range) of fill material should be determined and identified at each exploration location.

- **Other Constituents/Characteristics**
  - Additional constituents and/or pertinent soil characteristics not included in the previous categories should be described depending on the scope and objectives of the project. Observations that may be discussed include:
    - Oxide staining
    - Odor
    - Origin
    - Presence of root cast
    - Presence of mica
    - Presence of gypsum
    - Presence of calcium carbonate
    - Percent by volume of cobbles & boulders with size description and appropriate rock classification
  - Other pertinent information from the exploratory program should be recorded, if it would be useful from a biddability/constructability perspective. The conditions that should be listed include caving or sloughing, difficulty in drilling and groundwater infiltration.

SOIL DESCRIPTIONS

Generally, soil descriptions collected during most investigations are not intended for civil engineering (construction) purposes, but rather for hydrogeologic and contaminant transport purposes. As such, the ASTM visual-manual assessments are somewhat limited in that they are only performed in order to indicate important information about potential hydraulic properties of a soil. Soil descriptions should be concise, stressing major constituents and

characteristics, and should be given in a consistent order and format. The following order is recommended:

- Soil name. The basic name of the predominant grain size and a single-word modifier indicating the major subordinate grain size (i.e., mostly clay with some silt). The feel test can be used to determine the texture of the soil by rubbing some moist soil between your fingers; sand feels gritty, silt feels smooth, and clays feel sticky. The terms representing percentages of grain size to be used include:
    - Trace – particles are present, but estimated to be less than 5%
    - Few – 5 to 10%
    - Little – 15 to 25%
    - Some – 30 to 45%
    - Mostly – 50 to 100%
- Color (using Munsell® charts, as necessary). Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. It the sample contains layers or patches of varying colors (e.g., mottled), this shall be noted and all representative colors shall be described. The color shall be described for moist samples, however if the color represents a dry condition, it must be stated as such in the log. Generally, colors become darker as the moisture content increases and lighter as the soil dries. Examples include:
    - Some fine-grained soils (OL, OH) with dark drab shades of brown or gray, including almost black, contain organic colloidal matter.
    - In contrast, clean, bright looking shades of gray, olive green, brown, red, yellow, and white are associated with inorganic soils.
    - Gray-blue or gray- and yellow-mottled colors frequently result from poor drainage.
    - Red, yellow, and yellowish brown result from the presence of iron oxides.

  - White to pink may indicate considerable silica, calcium carbonate, or aluminum compounds.

- Field moisture condition as dry, moist, or wet;
- Gradation or Plasticity. Granular soils (i.e., sands or gravels) should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soils (i.e., silts and clays) should be described as non-plastic, low, medium, or high, depending on the results of the manual evaluation for dry strength, dilatency, toughness, and plasticity discussed previously.
- Consistency/Density. An estimate of consistency of a cohesive soil or density of a granular soil, usually based on the SPT results (see Descriptive Terms section of this FOP);
- Soil Structure or Mineralogy. Description of discontinuities, inclusions, and structures, including joints, fissures, and slickensides.
- Odor. Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum, chemical, etc.), it should be noted in the log.
- Other important geologic information such as consolidation, gravel size and shape, visible internal structure, root holes, mica, odors, etc.

The first step when describing soil is to determine if the sample is predominantly fine-grained or coarse-grained (see Figures 3 and 4). Coarse-grained soils are relatively easy to identify, however descriptions of fine-grained soils can be more difficult, requiring additional field tests to assist the field geologist arrive at the proper soils classification (see **FTMs** under Descriptive Terms above). These tests are explained in detail in the ASTM Standard D2488 and briefly herein. Generally, the differentiation between silt and clay is based on plasticity and "texture". However, tests for dry strength and dilatency, along with plasticity,

can be very helpful and are recommended in the ASTM Standard. If additional tests are performed, in addition to plasticity, to classify the fines, record them with the soil description on the logs. Doing this will assist the reader (i.e., Project Manager) to follow the logic used to describe a soil (e.g., medium plasticity, low dry strength = elastic silt [MH]; not a lean clay [CL]).

Fines described in the classification should be modified by their plasticity (e.g., non-plastic fines, low plasticity fines, etc.) reserving the words "silt" and "clay" for the soil name.

In summary, adhering to the ASTM Standard and the guidelines outlined in this FOP will provide uniformity in soil descriptions provided by all field personnel. Prior to mobilization to the field, field staff should make sure to have laminated copies of the ASTM Standard flow charts and tables as well as this FOP (as necessary). Some examples of complete soil descriptions are as follows:

Coarse-grained Soil

POORLY GRADED FINE SAND w/ SILT: Dark grey, wet, mostly fine sand with some non-plastic fines, some iron-stained mottling, laminated, medium dense

Fine-grained Soil

LEAN CLAY: Dark reddish/brown, moist, mostly fines, medium plasticity, firm, no dilatency, medium dry strength, root holes.

Soil/Fill (option 1) – visual evidence of fill

FILL: Black, moist, mostly fines with some fine sand, slag, cinders, metal, brick, non-plastic, loose when disturbed, strong odor

Soil/Fill (option 2) – no visual evidence of fill, suspected reworked material

FILL (reworked): Black, moist, mostly fines with some fine sand and few coarse angular gravel, non-plastic, hard, loose when disturbed, mild odor

BORING AND MONITORING WELL INSTALLATION LOGS

Currently, Roux utilizes WinLoG software to construct subsurface logs and a template of the log is included in this FOP as an example. One of the most important functions of a boring/monitoring well installation log, besides transmitting the soil description, is to indicate where the "data" (soil samples) were collected, giving the reader an idea of how reliable or representative the description is. On each sample log, depths of attempted and recovered or non-recovered interval are shown. Odor, if noted, should be considered subjective and not necessarily indicative of specific compounds or concentrations.

Remember: all field logs should be NEAT, ACCURATE, and LEGIBLE. Don't forget that the well completion diagram completed for each well requires details of the surface completion (i.e., flush-mount, stick-up etc.). It is the responsibility of the field staff to double-check each log (i.e., soil names, classifications, well construction details etc.) prior to implementing into a final report. A registered professional (i.e., professional engineer, PE or professional geologist, PG) must review each log and will be ultimately responsible for its content and accuracy.

REQUIRED EQUIPMENT

- Knife
- Engineer's rule/measuring tape

- Permanent marker
- Pre-cleaned wide-mouth sample jars (typically provided by the driller)
- Pre-cleaned wide-mouth laboratory sample jars (provided by the laboratory)
- Stainless steel sampling equipment (i.e., spoons, spatulas, bowls etc.)
- 10x hand lens
- Hydrochloric acid
- ASTM D2488 flow charts (preferably laminated)
- ASTM D2488 test procedures (Tables 1 through 12) (preferably laminated)
- Camera (disposable, 35 mm or digital)
- Munsell soil color chart (as necessary)
- Project Field Book/field forms

ATTACHMENTS

Figure 1; Field Guide for Soil and Stratigraphic Analysis
Figure 2; USCS Soil Classification Flow Chart (modified from ASTM D2488)
Figure 3; Illustration of Particle Sizes
Figure 4; Grain-Size Scale (Modified Wentworth Scale)

Field Borehole Log (sample)

REFERENCES

American Society for Testing and Materials, 2008a. *ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.*

American Society for Testing and Materials, 2010. *ASTM D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).*

American Society for Testing and Materials, 2009a. *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*

State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1996. *Soil & Rock Logging Classification Manual (Field Guide), by Joseph C. de Larios.*

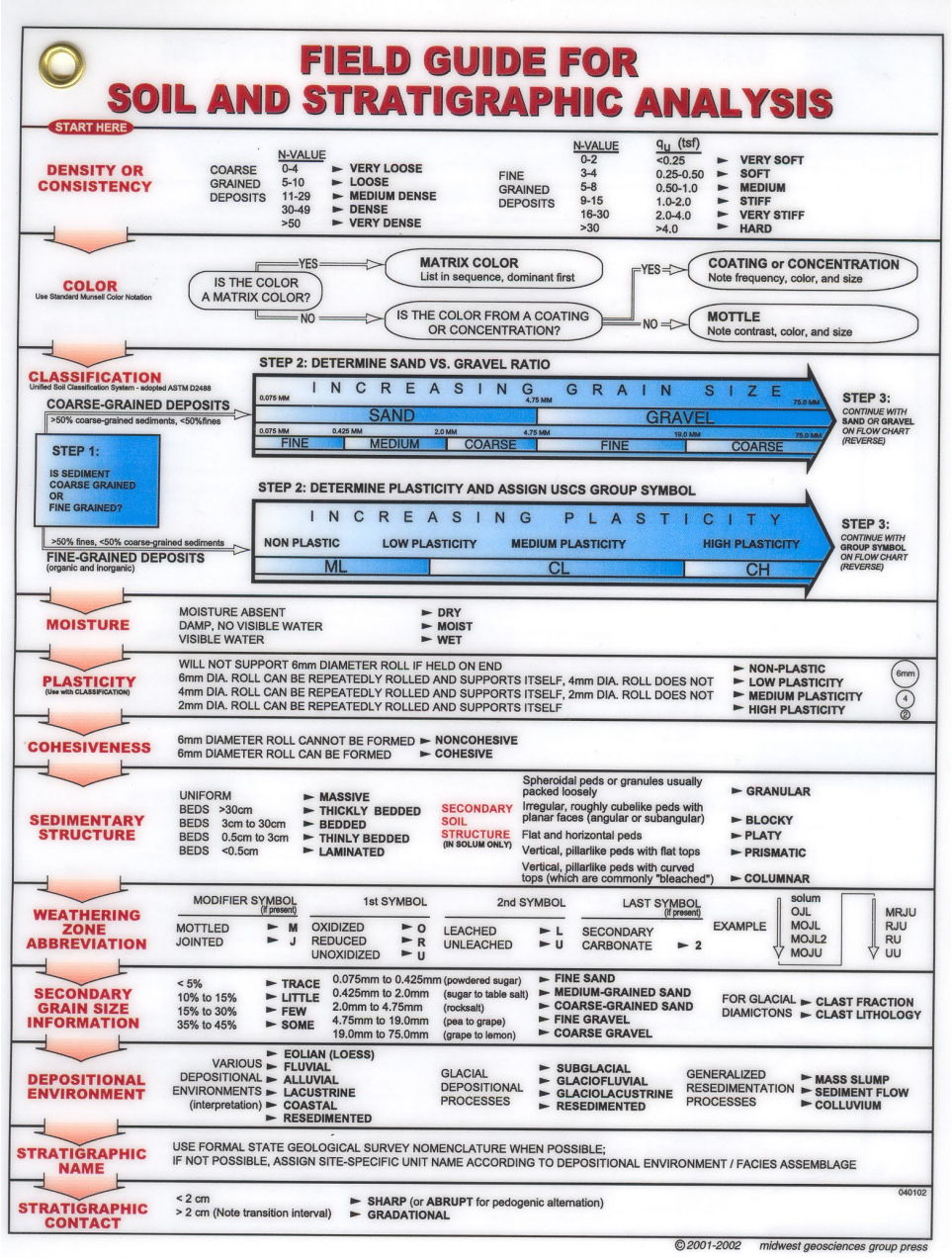
Roux FOPs:

010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
015 *Documentation Requirements for Drilling and Well Installation*
025 *Hand Augering Procedures*
032 *Management of Investigation-Derived Waste*
046 *Sample Labeling, Storage and Shipment Procedures*
047 *Screening of Soil Samples for Organic Vapors During Drilling Activities*
058 *Split-Spoon Sampling Procedures*
065 *Test Pit Excavation and Logging Procedures*

SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 1

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 2

USCS SOIL CLASSIFICATION FLOW CHART (MODIFIED FROM ASTM D2488)

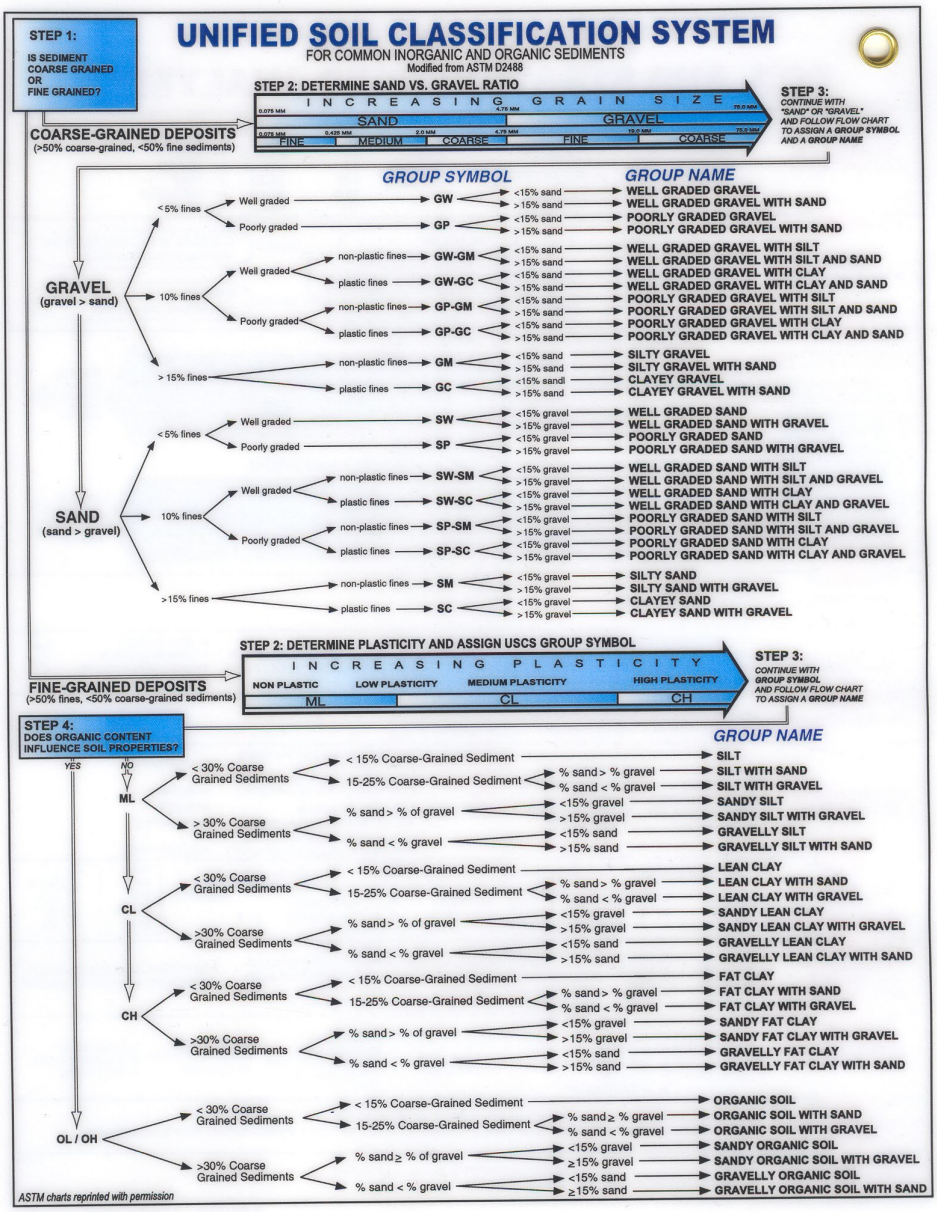


FIGURE 3

ILLUSTRATION OF PARTICLE SIZES

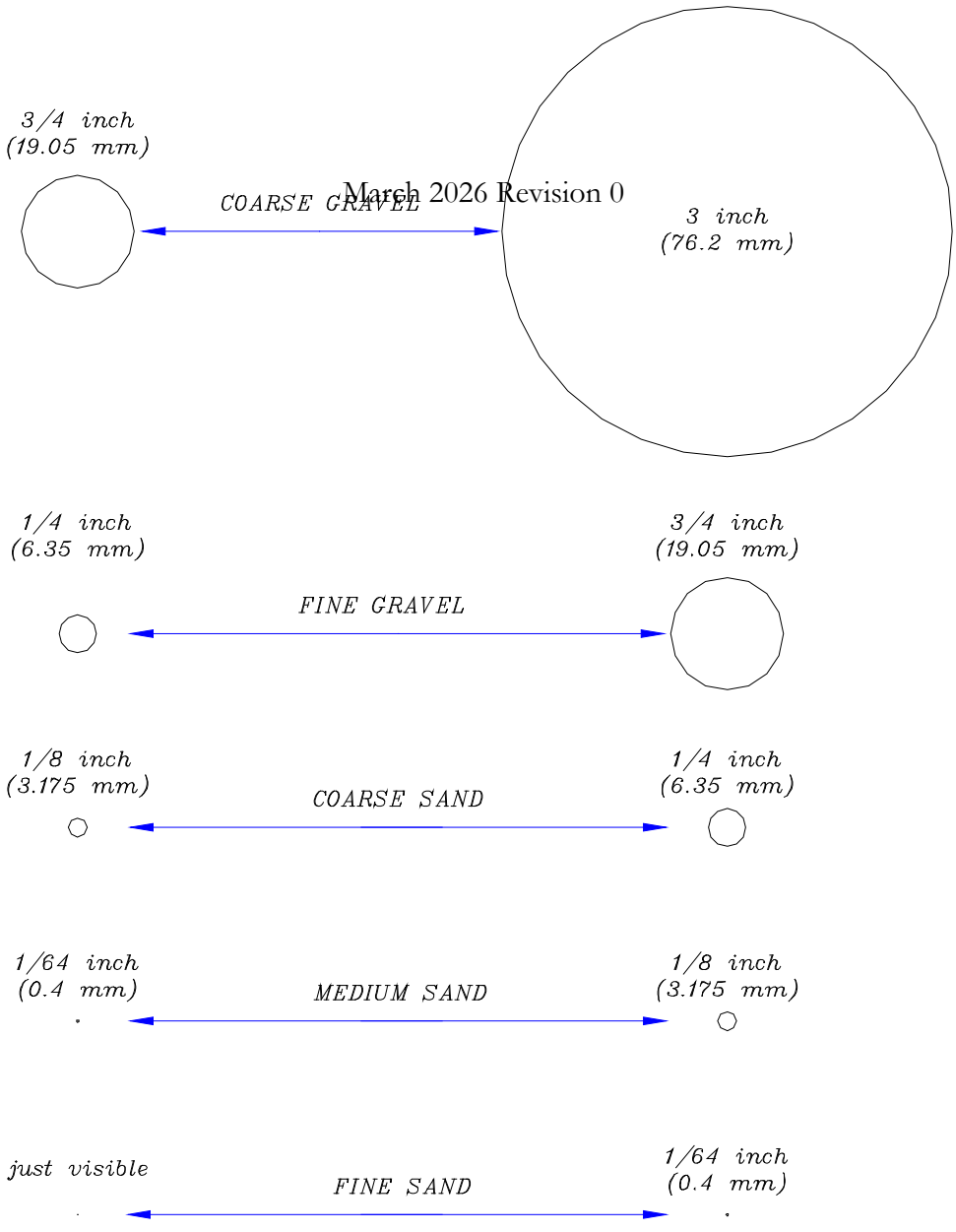


FIGURE 4

GRAIN-SIZE SCALE (MODIFIED WENTWORTH SCALE)

Grain size refers to the physical dimensions of particles of rock or other solid. This is different from the crystallite size, which is the size of a single crystal inside the solid (a grain can be made of several single crystals). Grain sizes can range from very small colloidal particles, through clay, silt, sand, and gravel, to boulders. Size ranges define limits of classes that are given names in the Wentworth scale used in the United States. The Krumbein *phi* (φ) scale, a modification of the Wentworth scale created by W. C. Krumbein, is a logarithmic scale computed by the equation: $\varphi = -\log_2(\text{grain size in mm})$.

φ scale	Size range (metric)	Size range (approx. inches)	Aggregate name (Wentworth Class)
< −8	> 256 mm	> 10.1 in	Boulder
−6 to −8	64–256 mm	2.5–10.1 in	Cobble
−5 to −6	32–64 mm	1.26–2.5 in	Very coarse gravel
−4 to −5	16–32 mm	0.63–1.26 in	Coarse gravel
−3 to −4	8–16 mm	0.31–0.63 in	Medium gravel
−2 to −3	4–8 mm	0.157–0.31 in	Fine gravel
−1 to −2	2–4 mm	0.079–0.157 in	Very fine gravel
0 to −1	1–2 mm	0.039–0.079 in	Very coarse sand
1 to 0	½–1 mm	0.020–0.039 in	Coarse sand
2 to 1	¼–½ mm	0.010–0.020 in	Medium sand
3 to 2	125–250 µm	0.0049–0.010 in	Fine sand
4 to 3	62.5–125 µm	0.0025–0.0049 in	Very fine sand
8 to 4	3.90625–62.5 µm	0.00015–0.0025 in	Silt
> 8	< 3.90625 µm	< 0.00015 in	Clay
<10	< 1 µm	< 0.000039 in	Colloid

In some schemes "gravel" is anything larger than sand (>2.0 mm), and includes "granule", "pebble", "cobble", and "boulder" in the above table. In this scheme, "pebble" covers the size range 4 to 64 mm (−2 to −6 φ).

ROUX

FIELD BOREHOLE LOG

PROJECT:		**Log of Boring No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: / COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES: Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION (ASTM D 2488)	REMARKS
							USCS Classification: Color, Moisture Condition, Primary Soil Type, Secondary Soil Type (<5% Trace, 5-10% Few, 15-25% Little, 30-45% Some), Structure (varved, stratified, thinly bedded, bedded, thickly bedded, laminated, fissured, blocky, lensed, massive), Consistency/Density (Standard Penetration Test, SPT), Weathering/Fracturing, Odor, Fill Materials (if present), Other	
							SURFACE ELEVATION (FMSL):	

ABANDONMENT:

Volume of cement/bentonite grout required:	$V = \pi r^2 \times 7.48 =$	gallons	borehole depth =	ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter =	ft.
Has bridging of grout occurred? ☐ yes ☐ no			borehole radius =	ft.
If yes, explain resolution:				
Method of installation:				

Project No:		Figure

FIELD OPERATING PROCEDURES

Surface and Subsurface Soil Sampling Procedures

March 2026 Revision 0

FOP 063.4

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods for sampling surface soil and subsurface soil samples for physical and chemical laboratory analysis during intrusive activities such as test pitting, hand augering, drilling, surface soil sampling etc. Typical health and safety related issues should be addressed in the Project Health and Safety Plan.

PRE-SAMPLING PROCEDURES

1. Review project objectives and the Project Health and Safety Plan (HASP).

2. Conduct tailgate health and safety meeting with project team and/or subcontractor(s) by completing the Tailgate Safety Meeting Form (sample attached).

3. Calibrate air-monitoring equipment in accordance with the appropriate Roux's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

4. Commence intrusive activities in accordance with specific Roux FOPs (test pitting, hand augering, drilling etc.) or as directed by the Project Work Plan.

5. Conduct air monitoring as required by the HASP, Project Work Plan, or Roux's FOP Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).

6. Decontaminate all non-dedicated stainless steel (or Pyrex glass) equipment in accordance with Roux's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures.

7. Collect soil samples in accordance with the following sections.

SURFACE SOIL/FILL SAMPLING PROCEDURES

Collection of surface soil/fill samples facilitates the evaluation of potential health risks to current site receptors that may be exposed to soil/fill via direct contact, incidental ingestion, or inhalation of airborne particulates. The following procedure is in accordance with NYSDEC sampling protocol of surface soil/fill material.

1. Collect all soil/fill samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

2. If the sample area is vegetated, then collect the surface soil/fill sample from 0 to 2 inches below ground surface (bgs) following removal of the sod.

3. If there is no soil present within the sample area (i.e., only slag, concrete, mixed with fines), excavate an area 12 inches by 12 inches by 6 inches deep, screen the material to less than 1/8 inch (No. 4 sieve), and submit the screened material for analysis. If there is not enough material to completely fill the sample jar, then expand the excavation 3 inches in all four directions screening the additional material. Expand the excavation in this manner until sufficient sample volume is obtained. Volatile organic analysis of surface soil/fill utilizing this method will yield negatively biased results and should not be performed.

SURFACE/NEAR-SURFACE/SUBSURFACE SOIL SAMPLING PROCEDURES

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls, EnCore™ Samplers, etc.), preferably constructed of stainless steel.

   Surface soil samples are typically collected from 0 to 6 inches below ground surface (bgs). Near-surface samples are typically sampled from 0 to 2 feet below ground surface (fbgs). Subsurface soils are typically sampled from

varying depths greater than 6-inches bgs based on field observations and as directed by the Project Work Plan.

2. Transfer samples for chemical (VOC, SVOC, Metals etc.) and physical (i.e., Atterberg Limits, Grain Size, Permeability etc.) analytical testing by direct grab (i.e., directly from the bucket of the excavation equipment, split-spoon sampler, hand auger etc.) using the dedicated (or decontaminated non-dedicated) sampling tools into appropriate laboratory-supplied containers and seal. The chemical or physical laboratory selected to perform the analysis should determine minimum sample volume for analysis.

3. Prepare collected samples in accordance with Roux's FOP: Sample Labeling, Storage, and Shipment Procedures. Do not allow the chemical soil samples to freeze during storage and shipping. It should be noted, ice is not required for physical soil samples and all physical soil samples should be kept at the collected soil moisture by securing with a tight sealing lid. Do not allow physical soil samples to gain or lose moisture from the collected soil moisture prior to analysis.

4. Record all sampling details (i.e., depth and location) in the Project Field Book; appropriate Roux log sheets depending on method of intrusion (i.e., drilling, test pitting, hand augering etc.); and on the Soil/Sediment Sample Collection Summary Log (sample attached).

PARAMETER-SPECIFIC PROCEDURES

1. Volatile Organic Compound (VOCs): After a fresh surface of the solid cohesive material is exposed to the atmosphere, sample collection should be completed in the least amount of time in order to minimize the loss of VOCs due to volatilization. Depending on soil cohesiveness and grain size(s), two different methods should be utilized as described below.

   a. **Cohesive soils** collected for VOC analysis should be sampled via USEPA Method 5035 using an EnCore™ Sampler (or equivalent) in a "closed-system-

purge-and-trap" process for the collection, preparation, and analysis of VOCs in soils, sediments, and solid waste.

The EnCore™ sampler is a sampling device that can be used as both a simultaneous coring tool for cohesive soils and a transport device to a support laboratory (field or off-site). The EnCore™ sampler is intended to be a combined sampler-storage device for soils until a receiving laboratory can initiate either immediate VOC analysis, or preserve extruded soil aliquots for later VOC analysis. It is meant to be disposed after use. The commercially available device is constructed of an inert composite polymer. It uses a coring/storage chamber to collect either a 5 g or 25 g sample of cohesive soils. It has a press-on cap with hermetically vapor tight seal and locking arm mechanism. It also has a vapor tight plunger for the nondisruptive extrusion of the sample into an appropriate container for VOC analysis of soil. An individual disposable EnCore™ sampler (or equivalent) is needed for each soil aliquot collected for vapor partitioning or methanol sample preparation. Upon soil sample collection, the EnCore™ sampler is stored at 4 ± 2EC until laboratory receipt within 48 hours. Upon laboratory receipt, soil aliquots are extruded to appropriate tared and prepared VOA vials.

Sample collection using EnCoreTM samplers will require:
2 EnCoreTM 5g samplers for low level analysis
1 EnCoreTM 5g sampler for medium level analysis
1 four ounce jar for percent total solids determination
T-handle for sampling

b. Transfer sufficient soil volume to fill the laboratory-supplied container (typically 4 ounces) by packing the soil sample with the sampling tool to the top of the container leaving no headspace. At no time should a gloved hand (i.e., latex, nitrile etc.) be used to pack the sample into the sample container as the sample may be compromised via cross-contamination.

2. All Other Parameters: All other parameters include, but are not limited to, Semi-VOCs (SVOCs), polychlorinated biphenyls (PCBs), herbicides, pesticides, total metals etc. Transfer sufficient soil volume to fill the laboratory-supplied container by packing the soil sample with the sampling tool to the top of the container. Unless otherwise indicated by the laboratory or the Project Work Plan, the sample jar for all other parameters does not have to be packed completely leaving no headspace as with the VOC containers.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Soil/Sediment Sample Collection Summary Log (sample)
Real Time Air Monitoring Log (sample)

REFERENCES

Roux FOPs:

006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*
046 *Sample Labeling, Storage and Shipment Procedures*
073 *Real-Time Air Monitoring During Intrusive Activities*

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

ROUX DAILY TAILGATE HEALTH & SAFETY CHECKLIST

Job Name: _____ Date(s): _____

Location: _____ Project Number: _____

Weather: M- T- W- TH- F-

- Tailgate meeting conducted at least once per day
- Involves everyone working at the Site
- Should familiarize everyone with work area & vicinity
- Work permit procedures
  Emergency access/exits & "muster" point
- Emergency contacts/phone #s, hospital/urgent care route
- Every worker on-site has Stop Work Authority
- Provide details of work planned for the day
- Review the Job Safety Analysis (JSA) and work hazards
- Required PPE for the planned work
- HASP is reviewed
- Ensure safety equipment is on Site
- Test required safety equipment (such as emergency stop controls)
- Can also include inspection of tools and equipment to be used

Instructions: Please only use form for Monday through Friday of one calendar week.

#	CHECKLIST ITEM	DATE M-	T-	W-	TH-	F-
1	The HASP (including emergency phone #s) has been reviewed & signed by Roux staff & subcontractors.					
2	Personnel are OSHA-40 hour HAZWOPER trained (if applicable).					
3	Emergency muster points known, urgent care and ER identified.					
4	Applicable JSAs have reviewed by subcontractors					
5	Roux personnel & subcontractors have discussed hazards associated with Site-specific work.					
6	Any potential slips, trips or fall hazards have been identified.					
7	All workers have appropriate PPE., and have signed in for the day (2nd Page).					
8	Fit for duty: No worker is under the influence of any drugs, alcohol or any other substance that can alter your ability to work safely.					
9	Critical equipment on-Site is noted and is in safe working order.					
10	Site control has been established and exclusion zone is identified (using safety cones or barricades to mark out work area).					
11	Appropriate permits have been obtained (if applicable).					
13	Lock Out / Tag Out procedures have been followed where applicable, for electric and water.					
14	Electrical power operated tools shall be properly grounded and used with a GFCI.					
15	Traffic Safety Control measures have been put in place where applicable.					
16	All vessels containing flammable/corrosive material are labeled and SDSs are available for all chemicals.					
17	Subsurface work : Drilling, trenching, etc. conducted according to required Protocol, including pre-field preparations, utility mark-out and "hand" clearing.					
18	Excavated soils are properly stored; excavations are properly shored/sloped and barricaded.					
19	Good housekeeping procedures are meet; food and beverages are consumed outside of the work area.					
20	A first aid kit, eye wash bottle/station, and fire extinguishers are available for use.					
21	No smoking signs are visibly posted in areas of potential flammable vapors.					
	Initial on right to verify that these actions have taken place. If the action does not apply, use N/A.					

Comments and Exceptions _____

NOTE: THIS IS A TWO-SIDED FORM; PLEASE COMPLETE BOTH SIDES

ROUX DAILY TAILGATE HEALTH & SAFETY MEETING LOG

Job Name _____ Date(s) _____

Location: _____ Project Number: _____

SUBCONTRACTORS: _____

Activities Planned _____

Name	Company	Mon.	Tue.	Wed.	Thur.	Fri.

SAMPLE

ROUX

SOIL/SEDIMENT
SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks *- Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per 20 samples of each matrix when non-dedicated equipment is utilized in accordance with DER-10.*

MS/MSD *- Collect at a frequency of 1 per 20 samples of each matrix in accordance with DER-10.*

Field Blank *- Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per 20 samples of each matrix.*

Investigation Derived Waste (IDW) Characterization samples *- Collect composite samples from all drums of decon fluids and soil at the frequency required by the disposal facility. Please note number of drums and labels on collection log.*

Notes:
1. See QAPP for sampling frequency and actual number of QC samples.
2. MS/MSD - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
3. BD - Blind Duplicate - indicate location of duplicate.

SAMPLE

Sample Summary Collection Logs - soil and sediment-REV.xlsx Page ____ of ____ Prepared By: _____

ROUX

REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

WEATHER CONDITIONS:

Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

Date	Personnel	Time	Air Monitoring Meter Measurement (Units)							Location/Activity/Comments
			PID (ppm)	LEL (%)	H2S (ppm)	O2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

SAMPLE

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

Copy of AIR - Real Time Air Monitoring Log.xls

Page ____ of ____

FIELD OPERATING PROCEDURES

"Before Going Into The Field" Procedure

March 2026 Revision 0

FOP 076.0

"BEFORE & AFTER" PROJECT PROCEDURES FOR FIELD PERSONNEL

PURPOSE

This procedure describes the required field and office activities to be preformed "before and after" project assignments by field personnel. Field activities may include, but are not limited to, drilling oversight, excavation contractor oversight, matrix sample collection (e.g., soil, sediment, groundwater, surface water, wipe, and/or air), third party oversight, and site reconnaissance to name a few. Office activities may include, but are not limited to, photocopying field book entries, completing all field forms, tabulating collected field and laboratory data, and preparation of report text.

The primary goal of this procedure is to eliminate delays and unnecessary budgetary "strain" due to a lack of preparedness and knowledge of the site by the field team members. This procedure also seeks to streamline the preparation and transfer of field information/data from field personnel to the Project Manager upon field work completion.

PROJECT ASSIGNMENT

During the initial meeting with the Project Manager, several questions should be raised by the field team member and answered by the Project Manager. A pad of paper and pen should be in hand to record all pertinent job information. At a minimum, the following questions should be answered:

1. *What is the job number?*
2. *Who is the client and the on-site representative (if applicable)?*
3. *What is the name of the project?*
4. *What are the job responsibilities and how should they be accomplished?*
5. *How much time do I have to complete the assigned tasks?*
6. *Are there any project required documents? What are they?*

Any deviation from the above questions should be approved by the Project Manager prior to contravention, not at the end of the day or following the project completion.

"BEFORE" CHECKLISTS

Checklists should be developed and used so that all of the required steps prior to going into the field are undertaken. A good checklist will include:

- Adequate review of the documents listed in this FOP
- Any documents, equipment, and supplies presented in this FOP
- Providing adequate notification to the laboratory (so that holding times are not exceeded) and to the owner of the site and the primary regulatory agency (usually in writing) that a round of sampling is to commence in order to facilitate sampling and allow for a sampling audit or split sampling.
- Specifying and documenting the equipment maintenance and calibration undertaken prior to going into the field relative to the sampling event.
- Checking and calibrating the equipment.
- Listing the documents, equipment, and supplies required to collect samples at the site as presented in this FOP.

Prior to going into the field, sampling personnel should reacquaint themselves with the sampling plan. The review is undertaken so that the required specific protocol such as sampling from the least to the most contaminated wells, knowing where quality control samples are to be taken, knowing the disposition of purge water, etc., is understood and followed.

The amount of equipment maintenance and calibration required prior to going into the field should be clearly specified in the presampling equipment maintenance and calibration checklists, which are based on the manufacturer's recommendations, sampling objectives, and prior experience. Maintenance and calibration performed before sampling must be

documented to provide evidence that the equipment was adequately maintained and calibrated and to keep a permanent record of equipment servicing and performance.

A list of all the documents, equipment, and supplies required for the sampling event should be prepared and used. It can be frustrating and time consuming to forget equipment and supplies, so some up-front preparation is warranted. The following sections provide a list of the documentation, equipment, and supplies, which should assist in preparing a site-specific equipment and supply checklist. Once prepared, the checklist and project requirements should be reviewed with the Project Manager.

"BEFORE" DOCUMENTATION SUMMARY

Prior to going into the field, the field team should review and understand all of the project documents including, but not limited to:

- The Health and Safety Plan (HASP)
- The Site Analytical Plan (SAP), Sampling Plan, or similar document
- The Quality Assurance Project Plan (QAPP)
- The Work Plan
- Project specific Field Operating Procedures and field forms
- Site Maps
- Equipment operation manuals
- Chain-of-Custody forms
- Shipping labels and custody seals
- Any reference materials (i.e., conversion tables, volume calculation, etc.). The Pocket Ref, Third Edition by Thomas Glover is a great source for the field.

If at any time, the field team does not understand the project required protocol, procedures, sample locations, etc.; the Project Manager should be consulted for clarification.

"BEFORE" EQUIPMENT SUMMARY

Prior to going into the field, the field team should review the following equipment checklist, noting that project specific equipment may not be included in this list:

- Water level indicator
- Pumps, sample tubing, flow controllers, power cord(s), batteries, compressors, generators, etc.
- Bailers (disposable, PVC, stainless steel, glass), rope
- Flow-through cell
- Field meters with adequate calibration solutions (pH/Eh meter, conductivity meter, dissolved oxygen meter, turbidity meter, batteries, etc.)
- Garden hose
- Explosive gas meter and/or photoionization detector (PID) with calibration supplies
- Complete set of hand tools including a sharp knife, screw drivers, pliers, hacksaw, flashlight, large pipe wrench, hammer, bolt cutters, and replacement locks
- Fish hook with weight and string
- Field filtering equipment and supplies
- Decontamination supplies, such as scrub brushes, Alconox®, distilled water, potable water, 5-gallon bucket, paper towels, aluminum foil
- 5-gallon bucket(s)
- Measuring cup
- Sample bottles/containers (with extras) and preservatives
- Stainless steel spoons, trowels, shovels
- Shipping containers (i.e., coolers)
- Clipboard
- Calculator
- Water resistant clock or watch with second hand
- First aid kit

"BEFORE" SUPPLIES SUMMARY

Prior to going into the field, the field team should review the following supplies checklist, noting that project specific supplies may not be included in this list:

- Laboratory grade non-phosphate detergent (Alconox®)
- Appropriate personal protective equipment appropriate to the contaminants of concern, such as nitrile gloves, Tyvek, boots, hardhat, safety glasses, hearing protection, etc.
- Bags of ice
- Plastic garbage bags
- Plastic sheeting
- Sufficient quantities of potable and laboratory grade deionized water for cleaning and equipment blanks
- Methanol
- Isopropyl alcohol
- Clean rags and paper towels
- Electrical tape, duct tape, and wide transparent tape
- Hand soap
- Regular, ballpoint, and indelible pens
- Hollow braid polyethylene rope

After providing adequate notification (lab, state and/or federal agencies), performing the presampling maintenance and calibration, obtaining the site and well keys, and packing the supplies and equipment, the field activities are ready to be performed.

"AFTER" – PROJECT FILE REVIEW & CREATION

It is the responsibility of each field crew member to review his/her own field notes and time sheet for accuracy and completeness. All errors to the field notes should be corrected, dated, and initialed for Project Manager review. Once reviewed by the field team member, the Project Field Book, all field forms, photographs, chain-of-custodies etc. must be

photocopied, scanned (if required), downloaded, etc. and then given to the Project Manager in an organized file folder in a timely manner. Avoiding delay during this step is critical, especially when there are severe time constraints for the project.

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

Atlantic Testing Laboratories, Limited (ATL)

Issue Date:	July 3, 2007
Prepared By:	T. Gavin
Reviewed By:	M. Remington
Revision Date:	April 28, 2011

1. POLICY STATEMENT

It is ATL's general policy to preserve the integrity of data, to ensure the precision and accuracy of results obtained in the sediment sample collection process, and to provide clear documentation of results, supporting data, and conclusions.

2. PURPOSE/IMPACT

This SOP presents a procedure for obtaining sediment samples by use of vibracore coring techniques.

3. AREAS AFFECTED

Drilling Division of ATL

4. IMPLEMENTATION

a. It is the responsibility of division management to ensure that the user is following the procedure(s) in accordance with the applicable SOP.

b. It is the responsibility of the direct supervisor to ensure the SOP is available to the user.

c. It is the responsibility of the user to use and adhere to the SOP.

5. QUALIFICATION REQUIREMENTS

a. The trainee must have 40-hour Hazwoper Training with a current 8-hour refresher prior to performing vibracore sampling in accordance with this SOP.

b. The trainee must have a minimum of 1 year experience working within ATL’s drilling division.

c. The trainee can perform vibracore sampling under the direct supervision of a trainer/evaluator.

d. Within six months the trainee must demonstrate proficiency following this SOP, through an internal evaluation documented on the training and evaluation checklist.

e. The trainer/evaluator shall have a minimum of three years’ experience following this SOP.

6. EQUIPMENT REQUIRED

a. Sampling Boat capable of deploying vibracoring apparatus and providing sufficient room for all vibracoring operations. Sampling boat must also be properly sized to operate in the typical water depths and conditions anticipated at the project site.

b. Mast or crane with a minimum height of 12 feet

c. Winch with a minimum of 3,000 pounds capacity

d. Rossfelder Model P-3 vibracore and 3-phase generator

e. Project specific tubing

   i. Tubing may consist of Lexan, CAB, or polycarbonate materials

   ii. Tubing diameters may range from 2 to 4 inches.

   iii. Tubing lengths can range from 1 to 20 feet.

f. Core Barrel of appropriate diameter and wall thickness for use with the vibracoring apparatus and tubing.

   i. A stainless steel nose cone with core catcher should be secured with either pop rivets or nuts and bolts into the bottom of the core barrel.

   ii. Alternately, aluminum coring tubes may be used without a core barrel and nose cone.

g. Minimum personal protective equipment (PPE) including but not limited to; hard hat, steel toe boots, life vests, safety glasses, ear plugs/muffs, and disposable gloves. The Site Specific Health and Safety Plan (HASP) should be reviewed prior to selecting appropriate PPE for the project.

h. Miscellaneous equipment and supplies – rivet gun, rivets (3/16-inch and 1/8-inch steel), nuts and bolts, 7/16-inch wrenches, 1lb hammer, punch, vice grips, hacksaw with course tooth blades, duct tape, end caps, reciprocating saw with blades, sump pump, 25-foot garden hose with nozzle, ½-inch ratchet with ¾-inch socket, ¾-inch wrench, drill with 1/8-inch bit, and a utility knife with carpet blades

i. Project specific decontamination material

7. STEP-BY-STEP DIRECTIONS FOR PERFORMING THE PROCEDURE

a. Don PPE in accordance with the site specific HASP.

b. All data from sediment core collection activities will be recorded on the ATL Vibracore Field Log (Attachment A) and/or a laptop based field application, depending on project specific requirements. Upon completion of sampling at one location, all data obtained during core collection activities will be entered into the field application.

c. Using the on-board Differential GPS system, maneuver the sampling vessel to within the sample tolerance distance of the preprogrammed target coordinates for each sample location and stabilize the vessel as necessary, using anchors or spuds. Navigation and spud operations should be conducted in accordance with the ATL Job Safety Analysis JSA-025 *located at 'P'-Drive Health & Safety/Job Safety Analysis* or in accordance with the Project Specific JSAs for navigation and spud operations.

   i. Confirm the location by examining the site map, bathymetry survey, and/or landmarks.

   ii. Record the following on the Vibracore Field Log and/or the field application:

      1. Date

2. Sample ID
3. Target Location
4. Water Depth
5. Time
6. Weather Conditions
7. Names of sampling crew members

d. Use a probe rod to probe the sediment surface to determine the sediment thickness and type.

   i. If the estimated sediment thickness in the probing area is greater than 6 inches, record the probing information in the field application and attempt to collect a core using the vibracore, as outlined in 6.f through 6.o.

   ii. If the estimated sediment thickness at the probing area is less than 6 inches, conduct additional probing of the sediment area within 3 feet of the target location for deeper sediments. If thicker sediment deposits are located, relocate the boat to the new coordinates and attempt to collect a core. If no deeper sediment deposits are encountered, a sediment grab sample may be collected using a ponar dredge.

e. Record the probing depth and sediment description in the Vibracore Field Log and/or the field application.

f. Clean the core barrel using a wash down pump, pressure washer or steam cleaner, as appropriate. Because of the direct contact with sample material, the core nose catcher assembly should be carefully decontaminated.

g. Mount a clean coring tube liner within the vibratory coring apparatus.

   i. Insert the coring tube into the vibracore barrel and attach the core catcher to the vibracore barrel with pop rivets or nuts and bolts. If aluminum tubing is utilized, eliminate this step.

   ii. Securely seat the core barrel or aluminum tubing in the vibracore head. The check valve must have a tight seal and be free of debris.

   iii. Attach the vibracore apparatus to the end of the cable so that it can be lowered to the mudline. Attach a steel safety line to the top of the vibracore apparatus in case the winch cable breaks or comes undone.

h. Lower the coring apparatus, with the core barrel or aluminum tube attached, slowly and vertically through the water column, until the mudline is reached. When the nose reaches the mudline, turn the vibracore unit on. Record the start time.

i. Advance the core into the sediment until either the desired depth or refusal is encountered, keeping the winch cable taut to keep the core tube vertical at all times.

   i. Refusal will be defined in accordance with project specific criteria, typically as the depth at which no additional penetration can be achieved in a one-minute period.

j. Measure and record the depth of core tube penetration into the sediments on the Vibracore Field Log and/or the field application.

k. Pull the vibracore apparatus upward out of the sediment using the winch and raise it to the surface. If the corer refuses to come free, the unit should be vibrated until it is extractable. The apparatus must be maintained in a vertical position during ascent to the surface and all subsequent handling through sediment core processing. Vibrating

the core while extracting could result in loss of recovered sediment and should be avoided as much as possible.

l. If an aluminum core tube is being utilized without a core catcher then place a cap on the bottom of the tube before it breaks the surface of the water to prevent loss of material.

m. Remove the core tube liner from the coring apparatus following the manufacturer's instructions. The core must be maintained in a vertical position during removal.

n. Estimate the recovered length of the sediment core and note it on the Vibracore Field Log and/or the field application.

   i. The length of the recovered sediment core will be measured directly within the recovered core tube.

   ii. The distance between the top of the sediment in the core tube and the bottom of the coring tube corresponds to the estimated length of the recovered core.

o. Compare the length of the recovered core with the core penetration depth to calculate the percent recovery, and assess the core. Recovery criteria are established for each project.

   i. If a compliant core is obtained, proceed to 6.p

   ii. If an insufficient amount of material is recovered, cap the top and put the core tube aside while additional attempts are made to meet recovery goals.

   iii. An additional attempt will be made at a minimum distance of 3 feet from previously attempted locations. The number of additional attempts will be project specific. If a compliant core is obtained, discard the non-compliant core as directed by the project specific IDW disposal practices.

p. Seal the core tube with caps and duct tape, and rinse the outside of the tube.

q. After a successful core recovery, enter required information onto the Vibracore Field Log and/or the field application:

   i. Time of recovery
   ii. Actual coordinates of the sample location
   iii. Estimated sediment depth
   iv. Core penetration depth
   v. Core percent recovery
   vi. Observations

r. Draw an arrow on the core tube with permanent marker to mark the top of the core. Using permanent marker, label the core with the sample ID, date, time, and recovery.

s. Store the core vertically, in a core tube cooler on ice. Keep the cores in the dark until they are transported to the field processing facility.

t. The cores may need to be cut prior to moving the vessel. The core may be cut using a decontaminated saw blade attached to a reciprocating saw and/or a razor blade. The core segment will be capped, labeled, and taped secure.

8. **QC/QA**

Internal quality system reviews will be performed to track or evaluate the effectiveness of the SOP, and management reviews will be performed to monitor its efficiency.

9. REVIEW

This SOP will be reviewed by the Geotechnical Quality Team on an annual basis, as directed by the Executive Team, or as driven by the SOP.

APPENDIX E

Quality Assurance Project Plan

Quality Assurance Project Plan
Niagara River Area of Concern

Pre-Design Investigation (PDI) Work Plan for Operable Unit OU-09 – Smokes Creek

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Former Bethlehem Steel Site
NYSDEC Site No. 915009

Tecumseh Redevelopment Site
2303 Hamburg Turnpike
Lackawanna, Erie County, New York

March 2026 (Rev. 0)
Period of Applicability: 2026-2030

Prepared for:

Tecumseh Redevelopment Inc.
200 Public Square, Suite 3400
Cleveland, Ohio 44114

U.S. Environmental Protection Agency
Great Lakes National Program Office
Remediation & Restoration, Section 1
11 W. Jackson Blvd. (G-9J)
Chicago, IL 60604

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Acronym List

AOC	Area of Concern
BUI	Beneficial Use Impairment
CAS#	Chemical Abstracts Service Registry Number
CLP	Contract Laboratory Program
COC	Contaminant of Concern
DOT	Department of Transportation
DQI	Data Quality Indicator
DQO	Data Quality Objectives
FOP	Field Operating Procedure
FSO	Field Safety Officer
FTL	Field Team Lead
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
IATA	International Air Transportation Association
ICAL	Initial Calibration
NYSDEC	New York State Department of Environmental Conservation
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram
MRL	Method Reporting Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
OSHA	Occupational Safety and Health Administration
Pace	Pace Analytical Services, LLC
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated biphenyl
PDF	Portable Document Format
PPE	Personal Protective Equipment
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	Standard Operating Procedures
SOW	Statement of Work
SVOC	Semi-volatile Organic Compounds
TCL	Target Compound List
TCLP	Toxic Characteristic Leaching Procedure
TOC	Total Organic Carbon
ug/kg	Microgram per Kilogram
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound
WMG	Wide Mouth Glass

Title and Approval Sheet

Quality Assurance Project Plan

Pre-Design Investigation (PDI) Work Plan for Operable Unit OU-09 – Smokes Creek

Approved by:_____ Date:_____
Thomas H. Forbes, P.E., Roux Operations Manager

Approved by:_____ Date:_____
Lori E. Riker, P.E., Roux QC Manager

Approved by:_____ Date:_____
Courtney Winter, USEPA GLNPO Project Manager

Approved by:_____ Date:_____
Crawford White, USEPA GLNPO QA Review

1 Introduction

This QAPP has been prepared in accordance with *USEPA Requirements for Quality Assurance Project Plans (EPA QA/R-5) (USEPA, 2001)* and the *Great Lakes Legacy Act (GLLA) Quality Assurance (QA) Considerations, Revision 1* (USEPA, 2023). The purpose of the GLLA QA Considerations is to establish specific QA and quality control (QC) considerations and requirements for GLLA projects as well as any effort wholly or partially funded under the Great Lakes Restoration Initiative (GLRI), which supports a management action related to contaminated sediments in a Great Lakes Area of Concern (AOC).

Roux Environmental Engineering and Geology, D.P.C. (Roux) has prepared this Pre-Design Investigation (PDI) Work Plan on behalf of Tecumseh Redevelopment Inc. (Tecumseh) for Operable Unit OU-9 Smokes Creek within the Corrective Measure Study (CMS) Area of the Tecumseh property.

1.1 Document Organization

This document format is generally consistent with USEPA Quality Assurance Project Plan Standard (CIO 2105-S-02.0) and the GLLA QA Considerations, Revision 1. QAPPs are approved by Roux's Operations Manager, Project QC Manager, and Field Team Lead (FTL) and are submitted to GLNPO for approval before field data collection begins. As detailed in the guidance, this QAPP is organized into the following four sections:

- Section 1 (Introduction) introduces the project, distribution list, and document approvals.
- Section 2 (Project Management) covers aspects of project management, objectives, and background information; identifies the roles and responsibilities of project personnel; defines the lines of communication; and identifies the objectives and technical approach to achieving the goals at the site.
- Section 3 (Data Generation and Acquisition) describes the design and implementation of measurement systems that will be used during the field investigation at the site and laboratory-based testing, as well as the sampling procedures, analytical methods, and data handling and documentation procedures. These elements are described further in the Work Plan). The Field Operating Procedures (FOPs) are included as Appendix D of the Work Plan. QC procedures, frequency requirements, acceptance criteria, and corrective action procedures are also provided in this section.
- Section 4 (Assessment and Oversight) describes the measures used to implement the QAPP and the procedures outlined in Section 3.
- Section 5 (Data Validation and Usability) describes the QA activities, including data validation and usability assessments, that are expected to occur after the data collection and assessment phase is completed for this project.
- Section 6 provides a list of the references cited in this QAPP.

1.2 Distribution List

Figure 1 illustrates the titles of and relationships between key project personnel. Table 1 is a distribution and contact list for the project.

2 Project Management

2.1 Project Organization and Responsibilities

2.1.1 Project Management

USEPA GLNPO Project Manager – As the USEPA GLNPO Project Manager, Courtney Winter is the primary USEPA contact for GLNPO and is responsible for all stages of the Smokes Creek GLLA project. In addition, all corrective actions will be reported to and approved by Ms. Winter.

NYSDEC Project Manager – As Project Manager for NYSDEC, Andrew Zwack is the primary NYSDEC contact for this project. NYSDEC is the state regulatory agency conducting technical review of work plans and reports and providing periodic oversight during investigations.

Roux Operations Manager – Thomas Forbes, P.E., is the Roux Operations Manager responsible for the overall program direction, coordination, and technical consistency on behalf of Tecumseh Redevelopment Inc. Mr. Forbes' responsibilities include review and final approval of technical project deliverables, schedules, contract changes, and labor allocations for each task and the resolution of problems that may arise on each task.

Roux Project Manager – As the Roux Project Manager, John Deth is responsible for the distribution and implementation of the QAPP; maintenance of the official approved QAPP; scheduling; personnel management; document preparation; document and data review; communication with USEPA and contractors; and Roux budgeting. Mr. Deth will coordinate with the USEPA GLNPO Project Manager, Roux Operations Manager, Roux QA Manager, and other Roux staff and subcontractors (as appropriate). The Roux Project Manager will be the primary point of contact and control for matters concerning the Smokes Creek project.

2.1.2 Quality Assurance

USEPA GLNPO QA Review Point of Contract – Christian Bako is a member of the USEPA GLNPO QA review team and will be the primary USEPA GLNPO point of contact for QA review. Mr. Bako is also responsible for assembling comments to the QAPP from the USEPA GLNPO QA review team.

USEPA GLNPO QA Lead and Data Manager – Crawford White will be responsible for review and approval of this QAPP. Mr. White will communicate with the Roux QA Manager on QA/QC-related concerns. The USEPA GLNPO QA Lead and Data Manager will also have the discretion to conduct external performance and system audits of field and laboratory activities. The USEPA Data Manager will serve as the point of contact on any data management and validation-related activities. Mr. White will also communicate with Roux on the upload of data to the Great Lakes Sediment Database (GLSED).

Roux QC Manager – To provide QC oversight, Lori Riker, P.E., will serve as the Roux QC Manager for this project. Ms. Riker is responsible for reviewing, updating, implementing, and administering the QA Program and QAPP. The Roux QC Manager will be responsible for coordinating all procedures and tasks pertaining to QA/QC, including corresponding with the laboratory and data validator on issues relating to data quality; and reporting to the USEPA GLNPO QA Lead and Data Manager, Roux Operations Manager,

and Roux Project Manager. The Roux QC Manager will serve as the point of contact for the USEPA GLNPO QA Lead and Data Manager on quality-related matters. The Roux QC Manager will also be responsible for the review of data following validation to determine its usability for decision-making and reporting activities. Data review and QA/QC will be supported by additional qualified Roux staff. The Roux QC Manager will operate independently of all entities involve with field work, laboratory analysis, and reporting.

2.1.3 Field Team

Roux Field Team Lead – Richard Dubisz will be the Roux FTL for this project. The FTL will serve as the field activities coordinator for all Roux on-site activities and will be responsible for the daily direction of the team members (project field personnel) regarding Work Plan-specific tasks and the requirements outlined in the QAPP. Mr. Dubisz will coordinate with the personnel who will be sediment probing, collecting, and processing the sediment samples, and coordinate with Pace Analytical Services, LLC (Pace) for sample bottle deliveries and sample shipments. Additional responsibilities include providing training to the sample collection field staff; providing the initial technical review of deliverables and data collection activities; monitoring QC activities and responding to deficiencies identified in the field; collecting and storing original field documentation; overseeing maintenance of sampling equipment in a secure location; and monitoring field survey and sample collection tasks.

Roux Field Safety Manager – Paul W. Werthman will be the Roux Field Safety Manager (FSM), responsible for implementing the health and safety plan (HASP). Mr. Werthman will perform safety and health monitoring and support compliance with safety and health requirements, including those in Roux's project-specific HASP.

2.1.4 Analytical Laboratories

Pace Westborough will serve as the analytical laboratory for sediment chemical analyses and will coordinate analyses at other appropriate Pace laboratories. Patrick Filey, the laboratory project manager, will oversee the analyses of samples and will serve as point of contact for the Roux QC Manager. The Roux QC Manager will correspond with Pace on any analytical and data quality issues and coordinate with the laboratory regarding electronic data deliverables (EDDs). Table 2 summarizes the analytical methods and reporting limits for the project.

2.1.5 Data Validation

Chemistry data validation will include completeness and compliance checks, data assessment, and Stage 2A and 2B (Tier 1 and Tier 2) validations following Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (USEPA 2009), in conjunction with the USEPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review (USEPA 2020a, 2020b, 2020c) to assess compliance with the Work Plan and this QAPP.

Judy Harry of Data Validation Services (DVS) will be the third-party data validator for analytical data generated during this project. The Roux QC Manager is responsible for coordination and tracking of the documents submitted to the data validator and will act as the liaison between the laboratory and data validator on issues regarding analysis and data quality.

2.2 Background Information and Problem Definition

Information on the background of the site, including a brief site description, an overview of the site history, and a review of previous investigations can be found in the Work Plan. This PDI will aid in the design of sediment dredging in and bank soil restoration of Smokes Creek. Sediment samples along the creek bed and banks will be analyzed to determine sediment requiring removal to meet sediment cleanup objectives.

2.3 Project Description and Schedule

Field activities are described in detail in the Work Plan and summarized in the following subsections.

2.3.1 Sample Collection and Processing

Field sampling will occur as described in the Work Plan, which includes figures and tables of proposed sample locations and FOPs for sample collection and processing. Substantive deviations from the FOPs will be recorded in the Daily Log or field logbook as well as reported to the Roux Project Manager and USEPA GLLA Project Manager before the deviations take place.

2.3.2 Field Methods and Decontamination Procedures

Field methods for sample collection, handling, and documentation, as well as equipment decontamination procedures, are outlined in the Work Plan FOPs (see Appendix D).

2.3.3 Analytical Procedures

Details regarding sample documentation and delivery to the analytical laboratory are included in the Work Plan and field FOPs. Laboratory analyses for the project will be performed by the laboratory, as described in Section 2.1.4 of this QAPP.

Laboratory data will be of known and documented quality as specified by the applicable USEPA guidance documents. Laboratory data will be compliant with USEPA quality requirements, which require data to withstand independent review and confirmation.

There will be no deviation from the USEPA-approved methods unless approved by the USEPA GLLA Project Manager and USEPA QA Manager. If requested, Roux will draft project-specific improvements or modifications to the USEPA methods in coordination with the analytical laboratories.

Roux will be responsible for resolving data discrepancies with the laboratories and will inform the USEPA GLLA Project Manager and USEPA QA Manager of issues or delays.

2.3.4 Schedule

The schedule is described in Section 5 of the Work Plan.

2.3.5 Data Quality Objectives

Data quality objectives (DQOs) provide a qualitative and quantitative framework and series of planning steps based on the scientific method around which data collection programs can be designed. The use of DQOs ensures the following:

- The objectives of the investigation are clearly defined.

- The type, quantity, and quality of environmental data used in decision-making are appropriate for their intended application.
- Acceptable levels of decision error and performance goals are specified, such that the quantity and quality of data needed to support management decisions are provided.

The DQO process consists of the following seven steps (USEPA 2006), which are used during the planning of the site assessment process to validate the field activities and data collection operations, and to demonstrate that resulting data meet the project objectives:

1. State the problem.
2. Identify the goal of the study.
3. Identify the information inputs.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

Following these seven steps supports the project plan being carefully thought out and the data collected providing sufficient information to support the key decisions that must be made. The Work Plan summarizes the DQOs derived for the project.

2.3.6 Criteria for Measurement Data

The quality of laboratory data is assessed by precision, accuracy, sensitivity, completeness, representativeness, and comparability (collectively referred to as Data Quality Indicators, DQIs). Definitions of these DQIs and the applicable QC procedures are given in the following sections. Table 3 lists applicable quantitative goals for these DQIs.

2.3.7 Precision

Precision describes the reproducibility of measurements of the same parameter for a sample under the same or similar conditions. Specifically, it is a quantitative measure of the degree of variability of a group of measurements compared to the average value. Precision is evaluated most directly by recording and comparing multiple measurements of the same parameter made on the same sample under similar conditions. Standard deviation, coefficient of variation, range, and relative range are terms often used to express precision.

Precision is determined in the laboratory by assessing the relative percent difference (RPD) for laboratory sample duplicate and matrix spike (MS)/matrix spike duplicate (MSD) pairs, as shown in the following equation:

$$RPD = 100\% \times (\text{sample result} - \text{duplicate result}) / ((\text{sample result} + \text{duplicate result})/2)$$

Precision measurements can be affected by the nearness of a chemical concentration to the method reporting limit (MRL), and RPD values may be erroneously inflated in these instances. Parent and/or

duplicate results that are less than five times the MRL will be evaluated by calculating the difference between the results and using a control limit of plus or minus two times the MRL for solid matrices or plus or minus the MRL for aqueous matrices.

Field precision – Field precision will be assessed through the collection and analysis of field duplicates and MS/MSD sample aliquots. Field duplicates and MS/MSDs will be collected at a rate of 5%. Each field duplicate sample will be collected for the suite of chemical analyses designated for the original sample. The analytical DQO for field precision is plus or minus 50% RPD.

Laboratory precision – Precision in the laboratory will be assessed using laboratory duplicates and MS/MSD results. Table 3 presents the analytical DQOs for laboratory precision.

2.3.8 Accuracy

Accuracy is the comparison between experimental and known or calculated values, expressed as a percent recovery (%R), and measures the bias of a measurement system. Variations in accuracy result from a combination of random error (precision) and systematic error (bias), which are due to sampling and analytical operations. Sources of error include the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques.

Accuracy will be assessed at the laboratory through the analysis of laboratory control samples (LCSs), MS/MSDs, and surrogate spikes as appropriate to each method. The %R is derived from analysis of standards spiked into deionized water (the LCS) or into actual samples (MS or surrogate spike).

LCS and surrogate %R are calculated as follows:

$$\%R = 100\% \times (\text{measured value} / \text{true value})$$

MS/MSD %R is calculated using the following equation:

$$\%R = 100\% \times (\text{observed spiked sample concentration} - \text{unspiked sample concentration}) / \text{true concentration of spike}$$

One field sample in every 20 will be marked as an MS/MSD sample, and extra sample mass will be collected as needed. The level of recovery of an analyte in MS/MSD samples is dependent on the sample matrix, the method of analysis, and native concentrations. The concentration of the analyte relative to the detection limit of the method is also a factor. MS/MSD samples and surrogate spikes will be used to evaluate the effect of the sample matrix on the accuracy of the analytical data. Table 3 presents the analytical DQOs for LCS and MS %R. Table 4 presents the analytical QC sample frequencies.

2.3.9 Sensitivity

Sensitivity is the ability of the method or instrument to detect the contaminant of concern (COC) or other required data at the level of interest. Sensitivity is typically expressed in the form of method detection limits (MDLs) and MRLs.

- The MDL is the minimum concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is distinguishable from method blank results. The MDL

is determined from the replicate analyses of matrix spiked at a known and low-level concentration and evaluation of routine method blanks.

- The MRL is the minimum level of an analyte that can be reported with a specified degree of confidence. These values are adjusted for percent moisture, dilutions, and sample size on an individual sample basis.

Table 2 presents the target analyte MDLs and MRLs for the specified analyses. Non-detected sample results will be reported to the sample-specific MDLs. Detected results reported between the laboratory MDLs and MRLs will be J-qualified as estimated. Undetected results will be reported at the sample-specific MDL, adjusted for percent moisture, dilution, and sample aliquot size.

2.3.10 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

C = ((Number of acceptable data points) x 100) / (Total number of data points)

The completeness goal for all components of this project is 95%. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been rejected will not be considered valid for the purpose of assessing completeness.

2.3.11 Representativeness

Representativeness describes the degree to which sample data accurately and precisely represent a characteristic of the material being measured. Representativeness is a qualitative term that is evaluated to determine whether in situ and other field measurements are made and samples are collected in such a manner that the resulting data appropriately reflect environmental conditions. Representativeness will be established by the following procedures:

- Sampling procedures will adhere to those specified in the planning documents.
- Trip blanks will be collected to evaluate cross-contamination.

2.3.12 Comparability

Comparability is a parameter used to express the confidence with which one set of data may be compared with another. To achieve comparability in datasets, standard techniques will be used to collect and analyze representative samples and to report analytical results. The following items enhance the comparability of datasets:

- Two datasets with the same set of variables of interest
- The same or convertible units
- Similar analytical and QA procedures
- The measurements collected at a similar time
- Similar measuring devices

- The same rules for excluding certain types of observations for both samples

To verify that data derived from this field and laboratory effort are comparable to each other and to other data produced using USEPA methods or similar, the following procedures will be followed:

- Equivalent analytical methods will be used for all sample analyses (with the same analytical parameters and similar detection/reporting limits).
- Units of measure (e.g., micrograms per liter, micrograms per kilogram) will be the same for all reporting per analytical parameter.
- All samples will be handled and prepared in the same manner according to SOP 19901 Vibracore Sampling.

2.3.13 Quality Control

Field duplicates and MS/MSD samples will be collected and submitted to the analytical laboratories to assist in the evaluation of the quality of data resulting from the sampling program. Field QC samples will be collected in the same manner as normal field samples. QC samples will also be prepared and analyzed by the laboratories. Laboratory QC samples will include method blanks, LCSs, laboratory duplicates, and MS/MSDs. The QC program is described in detail in Section 3.5. Table 4 lists the frequency of field and laboratory QC sample analyses.

2.4 Special Training Requirements/Certification

For sample collection tasks, it is important that field crews and laboratory staff are trained in standardized data collection requirements so that the data collected are consistent among staff. Field crews will comprise individuals who are fully trained in the surveying, collection and processing of surface and subsurface sediment cores, decontamination protocols, and chain-of-custody procedures. In addition, field crews will be trained in appropriate health and safety regulations to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health.

The following subsections summarize training requirements for Roux personnel and subcontractors

2.4.1 Field Training

Documentation – Team members will be trained in appropriate procedures for field documentation. The Roux Project QC Manager will coordinate with the Roux FTL and Roux Project Manager to ensure documentation is transferred to an Roux internal project file folder on a real-time basis to the extent practical in an organized manner.

Sampling – Personnel operating core sampling equipment will be trained in the operation of the equipment. Staff performing sample collection will be trained in the methods of sample collection. Staff will further review the FOPs and sign the FOP Acknowledgement Forms to certify they have read and understand the procedures prior to conducting field work.

The Roux FTL will be responsible for providing training to the field staff responsible for sample collection and sample management activities and ensuring that the assigned field personnel are competent to properly conduct the sampling and document field activities in accordance with the Work Plan. Samples

will be logged by qualified personnel with experience logging sediment according to ASTM International (ASTM) Method D2487.

GPS – The Roux team, including the contractor implementing sample collection, will be trained in the proper use and operations of the GPS unit used to survey horizontal sampling locations and the water level gauge prior to the commencement of field work. The GPS training should include basic functions and capabilities of the unit, and the methods required to record location information to the level of accuracy required to meet the objectives of the project.

2.4.2 Health and Safety Training

Health and safety procedures and training requirements are documented in the HASP (Appendix C of the Work Plan). On-site personnel will review and sign the HASP prior to the start of work. All personnel who will participate in intrusive aspects of the field sampling program where contact with contaminated environmental media may occur must present to the Roux FTL a certificate of completion for an initial 40-hour hazardous waste operations and emergency response training course and the most recent certificate of completion for an 8-hour refresher course.

2.4.3 Laboratory Accreditation

Laboratories are required to hold National Environmental Laboratory Accreditation Program (NELAP) accreditation for analyses where accreditation is available.

2.5 Documents and Records

This section defines the records that are critical to the project, identifies information to be included in the reports, and describes the data reporting format and document control procedures to be used. Project information generated by Roux will be documented in a format that is usable by all project personnel. Specification of the proper reporting format, compatible with data validation, will facilitate clear and direct communication of the investigation. Project data and information will be tracked and managed from its inception in the field to its final storage area. The Roux QC Manager is responsible for updating and maintaining QAPP versions.

2.5.1 Document Control

Central project files will be maintained by Roux. Project records will be stored and maintained in a secure manner. Each project team member is responsible for filing necessary project information or providing it to the person responsible for the filing system. Individual team members may maintain files for individual tasks but must provide such files to the central project files upon completion of each task. Electronic copies of all documents will be maintained in the Roux central database and server and backed up regularly as part of routine file maintenance to be retained for the life of the project. All documents will be reviewed by the Roux QC Manager and approved by the Roux Operations Manager.

2.5.2 Field Documentation

Consistent with prior investigations performed to date, details associated with upcoming field activities will be documented. Specifically, such documentation requirements are summarized in the activity-specific

FOPs provided in Appendix D of the Work Plan. Ultimately, field documentation will be summarized in the future Remedial Design/Remedial Action (RDRA) Work Plan.

2.5.3 Laboratory Documentation

The analytical laboratories will be responsible for maintaining analytical logbooks and generating laboratory data. Raw laboratory data files and electronic and portable document format (PDF) data will be inventoried and maintained by the laboratory for the time period established by USEPA and the laboratory. Laboratory analytical data packages will contain the following information at a minimum: case narrative, completed chain-of-custody forms, QC summary forms, blank results, sample result forms with MDLs and MRLs, tune and calibration information, and raw data. The laboratories will provide EDDs, which will be in Roux's custom EQuIS format.

2.5.4 Data Submittals

The laboratories will submit final data reports and EDDs to Roux within 30 days of sample receipt. Final data will be submitted for validation by a third-party data validator subcontracted to Roux. A data usability assessment report (DUSR) will be included in the RDRA Work Plan submitted by Roux to GLNPO. Analytical reports and data validation reports will be included with these reports. The RDRA Work Plan will provide the findings of the PDI including, but not limited to, data tables and maps summarizing the results and analysis.

The Roux Project Manager will confirm that all Roux team members and subcontractors have the most current version of any planning documents or submittals. Prior to submitting any document to Roux, the subconsultant providing laboratory data will be responsible to Roux for the technical accuracy of the documents.

2.5.5 Project Data Assessment Records

Records of project assessments will be maintained by the Roux Project Manager and Roux Project QC Manager and may include field technical system audit checklists, field performance audit checklists, laboratory performance audit checklists, data validation reports, and internal reviewer sign-off.

3 Data Generation and Acquisition

Data generation and acquisition begins with the development of the rationale for locating and selecting environmental samples for analysis and ends with the generation and reporting of analytical data for those samples by the analytical laboratories.

3.1 Sampling Process Design

Section 3.2 of the Work Plan identifies the DQOs associated with the proposed scope of the sediment investigation to further understand the presence of Site COCs. Accordingly, the scope of the proposed investigations provided in the Work Plan was designed to achieve these DQOs.

3.1.1 Sampling Approach, Methods, and Rationale

The overall sampling approach to further understand the presence of Site COCs in sediment is provided in Section 3.6 of the Work Plan. This section contains sampling methods, locations, and laboratory analyses.

3.1.2 Parameters to be Tested and Frequency

As shown on Table 4 of the Work Plan, sediment samples will be analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), Target Analyte List (TAL) metals (including mercury), polychlorinated biphenyls (PCBs), cyanide, and total organic carbon (TOC). Figure 5 of the Work Plan shows the planned sample locations.

3.2 Sampling Method Requirements

The use of proper sampling equipment, strict controls in the field, and appropriate chain-of-custody and analytical procedures will reduce the potential for sample misrepresentation and the collection of unreliable analytical data.

Sampling methods and equipment and decontamination protocols are presented in the Work Plan. Appendix F of the Work Plan includes field forms and Appendix D includes FOPs for sample collection, processing, handling, packaging, shipping, and chain-of-custody. Attachment A of this QAPP includes laboratory SOPs.

Samples will be preserved and shipped to the laboratory as outlined in the Work Plan. The Roux Project QC Manager and Roux FTL will be responsible for ensuring that sampling and analysis activities adhere to the requirements of this QAPP, the Work Plan, and FOPs.

3.3 Sample Handling and Custody Requirements

The primary objective of sample handling and custody procedures is to create an accurate written record that can be used to trace the possession and handling of samples from the moment of their collection, through analysis, until their final disposition. Procedures for sample labeling, handling, and reporting of Roux's environmental samples will comply with USEPA-approved labeling and chain-of-custody protocols. FOP 046.0 describes specific protocols for sample labeling, storage, and shipment, provided in Appendix D of the Work Plan.

3.3.1 Sample Containers and Handling

Table 5 presents the required sample containers, sample preservation methods, and maximum holding times for the proposed analyses. Samples will be placed in appropriate sample containers and labeled. Certified, pre-cleaned sample containers will be obtained from the laboratories. These containers will meet and/or exceed USEPA standards for pre-cleaned containers (USEPA 1992). Samples will be packed and shipped in accordance with FOP 046.0, provided in Appendix D of the Work Plan. Enough ice will be used to ensure samples are maintained within the required temperature range in case sample delivery is delayed.

3.3.2 Documentation

Field efforts will be documented using field logbooks, field data collection forms, electronic-generated sample labels, sample chain-of-custody records, and custody seals. In addition, hard copies of this QAPP, the Work Plan, and the HASP will be kept on-site for the duration of the field effort. General information will be recorded in the field logbook daily, including personnel present at the site, sampling activities, and weather. Sample collection and processing information will be recorded on a sediment core sample collection log, provided in Appendix F of the Work Plan.

Sample labels will include sample identification number, date/time, analysis to be performed, preservation requirements, and sampler's initials. From the handwritten logbook, a chain-of-custody record will list all samples and requested analyses. Field logbooks and forms will be scanned daily (if possible) and saved electronically to the appropriate Roux internal project folder.

3.3.3 Sample Custody – Overview

To maintain and document sample custody, chain-of-custody procedures will be strictly followed. A sample is under custody under the following conditions:

- It is in the custodian's possession or view
- It is in a secure location (under lock) with restricted access
- It is in a container that is secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s)

By this definition, Roux field crew collecting the samples are responsible for care and custody of the sample until it is transferred to the shipping company (further described in Section 3.3.4).

3.3.4 Chain-of-Custody Records

Chain-of-custody records will be used to track all samples from the time of sampling to the arrival of samples at the laboratory and to final sample disposition. Each chain-of-custody form will be produced using a handwritten logbook. Every sample container being shipped, delivered, or picked up by the laboratory will contain a chain-of-custody record. Field personnel will retain a signed and dated hard copy and scanned electronic copy of the chain-of-custody, whereas the original chain-of-custody and other copies (if necessary) are enclosed in a waterproof enclosure within each shipping container. The laboratory, upon receiving the samples, will sign the original chain-of-custody and retain it in the project file.

When transferring the possession of samples, the individuals relinquishing and receiving will sign, print their name, date, and note the time on the record. This record documents the transfer of samples from the

custody of the sampler to that of another person, or the laboratory. Packaged samples will be accompanied by the chain-of-custody record, which identifies the contents. The sampler will retain a copy for the project file.

If applicable, the airbill number will be written on the chain-of-custody record retained by the field personnel. The Roux Project Manager is responsible for consistency of records and inclusion in the permanent project file.

3.3.5 Sampling and Packaging Procedures

Samples shipped to the laboratories will be packaged in compliance with current U.S. Department of Transportation regulations to avoid breakage or contamination. All sample caps will be tightened, and the exterior of all sample bottles wiped down. In preparation for shipment to the laboratories, all samples will be packaged in accordance with FOP 046.0, provided in Appendix D of the Work Plan.

3.3.6 Sample Shipping Procedures

All samples will be shipped from the field to Pace Westborough for analysis. Pace's Westborough laboratory is located at 8 Walkup Drive, Westborough, MA 05181. Patrick Filey is the point of contact for Pace; his contact information is listed in QAPP Table 1.

The following transfer of custody and shipment procedures will be followed:

- Samples will be accompanied by a completed, electronic-generated or handwritten chain-of-custody record. The sample IDs will be listed on the chain-of-custody record. When transferring the possession of samples, the individuals relinquishing (field team) and receiving (laboratory personnel) will sign and record the date and time on the record. This record documents transfer of custody of samples from the sampler to another person, to the laboratory, or to/from a secure storage area.
- Samples will be properly packaged for overnight shipment or same-day courier collection and dispatched to the laboratory for analysis, with a separate signed chain-of-custody record enclosed in each sample box or cooler. If the cooler is being shipped to the laboratory, it will be secured shut with clear packing tape over signed and dated custody seals to prevent tampering.
- All shipments will be accompanied by the chain-of-custody record identifying the contents.

3.3.7 Laboratory Chain-of-Custody Procedures

The laboratory chain-of-custody procedures and document control will be carried out according to the laboratory procedures detailed in each laboratory's QA manual and SOPs. The laboratory representative who accepts the incoming sample shipment will sign and date the chain-of-custody record to acknowledge receipt of the samples. Once the sample transfer process is complete, the laboratory is responsible for maintaining internal logbooks and records that provide a custody record throughout sample preparation and analysis.

If more than one laboratory handles the samples, custody of the samples is maintained between laboratory sample management personnel. Within each laboratory, the analysts will maintain custody of the sample while the analysis is being performed.

3.4 Analytical Methods Requirements

Analyses will be performed following the methods identified in Table 2. Detailed descriptions of the analytical procedures, including instrument method performance criteria and corrective actions, can be found in the laboratory SOPs (Attachment A).

3.5 Quality Control Requirements

QC is defined as the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the established requirements. Field and laboratory QC samples are collected during the field investigation and created in the laboratory to evaluate field and laboratory variability. This section of the QAPP identifies the QC procedures, checks, and samples that will be used during the project to monitor the quality of various aspects of the sampling events and laboratory methodology. Required analysis frequency, acceptance limits, and corrective actions are documented in this section of the QAPP.

3.5.1 Field QC Checks

Field QC checks are used to assess the reliability, repeatability, and statistical confidence of the data that are collected. They are designed to determine what effects activities such as sample collection, bottling, shipping, and storage have on sample integrity, and that samples available for analysis in the laboratory are representative of actual conditions on the Site. Field QC checks, which will be conducted in accordance with the applicable procedures (FOPs) and frequencies described in this QAPP and the Work Plan, include the following:

- **Rinsate blank** – One equipment rinsate blank per sample matrix and collection method will be collected per sampling method to assess and document the adequacy of the decontamination process. A rinsate blank is a sample of analyte-free water poured over or through decontaminated sampling equipment prior to collection of field samples. Rinsate blanks will be analyzed for the parameters in Table 4. Not required if disposable equipment is used.
- **Field duplicate** – A field duplicate is a second sample taken from the homogenized material that comprises the original sample. The purpose of a field duplicate sample is to evaluate the effectiveness of homogenization techniques and material heterogeneity for the site material and the variability of a given analysis. One field duplicate will be collected for every set (or partial set) of 20 samples collected per media. The precision goal for field duplicates for this project is ±50% RPD.
- **Field audit** – An audit of field activities (see Field Audit Checklist provided in Attachment B of this QAPP) to ensure work is being conducted as described in the Work Plan will be completed at least once during the field investigation. Field audits will be conducted by Mr. Paul Werthman and Mr. John Deth of Roux. Contact information for field audit personnel is included in Table 1.

3.5.2 Laboratory QC Checks

Internal laboratory QC procedures for the sample analyses are specified in the analytical methods and respective laboratory SOPs. These specifications include the types of QC checks required (method blanks, instrument blanks, LCSs, MS/MSDs, calibration standards, internal standards, surrogate standards, specific calibration check standards, and laboratory duplicate/replicate analysis), compounds and

concentrations to be used, and the QC acceptance criteria for these QC checks. The project QC acceptance criteria are in Table 3. Additional mass for matrix duplicate (MD)/MS/MSD analyses will be collected at a frequency of 5% of total samples. Details regarding the laboratory control limits and procedures for calculation of the appropriate QC statistics can be found in the laboratory analytical SOPs (Attachment A).

3.6 Instrument/Equipment Preventative Maintenance

This section describes procedures for testing, inspection, and maintenance of field and laboratory equipment.

3.6.1 Field Instruments/Equipment and Calibration

In accordance with the QA program, Roux and its subcontractors shall maintain an inventory of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and previous experience with the equipment.

The Roux FTL will be responsible for the preparation, documentation, and implementation of the preventive maintenance program. The equipment maintenance information will be documented on the instrument's calibration log. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in the manufacturer's instruction manuals.

All maintenance records will be verified prior to each sampling event. The Roux FTL will be responsible for verifying that required maintenance has been performed prior to using the equipment in the field. For this project, maintenance inspections will include the following activities:

- The responsible party for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. They will also abide by GLLA reporting standards (USEPA 2020d).
- Vibracore samplers and associated equipment will be inspected daily for misalignment, loose connections, and any other applicable mechanical problems.
- Photoionization detectors (PID) will be calibrated daily.

Any problems will be noted in the field logbook and corrected prior to continuing sampling operations.

3.6.2 Laboratory Instruments

In accordance with the QA program, the laboratory shall maintain an inventory of instruments and equipment, and the frequency of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The laboratory preventative maintenance program, as detailed in the laboratory QA Plan, is organized to maintain proper instrument and equipment performance and to prevent instrument and equipment failure during use. The program considers instrumentation, equipment, and parts that are subject to wear, deterioration, or other changes in operational characteristics, the availability of spare parts, and the

frequency at which maintenance is required. Any equipment that has been overloaded, mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The client will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data. The client will also be notified immediately regarding any delays due to instrument malfunctions that could impact holding or turnaround times.

Laboratories will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. Maintenance records will be checked according to the schedule on an annual basis and recorded by laboratory personnel. The Laboratory QA/QC Manager or designee shall be responsible for verifying compliance, as necessary.

3.6.2.1 Laboratory Instrument/Equipment Calibration

As part of their QC program, laboratories perform two types of calibrations. A periodic calibration is performed at prescribed intervals (e.g., balances, drying ovens, refrigerators, and thermometers), and operational calibrations are performed daily, at a specified frequency, or prior to analysis (i.e., initial calibrations) according to method requirement. Calibration protocols and frequency requirements are described in the laboratory analytical SOPs (Attachment A).

The Laboratory QA/QC Manager will be responsible for ensuring that the laboratory instrumentation is calibrated in accordance with specifications. Implementation of the calibration program will be the responsibility of the respective laboratory group supervisors. Recognized procedures (USEPA, ASTM, Standard Method, or manufacturer's instructions) will be used.

Physical standards (i.e., weights or certified thermometers) will be traceable to nationally recognized standards such as the National Institute of Standards and Technology (NIST). Chemical reference standards will be NIST standard reference materials or vendor-certified materials traceable to these standards.

The calibration requirements for each method and respective corrective actions will be accessible, either in the laboratory SOPs or in the laboratory's QA Plan for each instrument or analytical method in use. All calibrations will be preserved on electronic media.

3.7 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables that may directly or indirectly affect the quality of the project must be clearly identified and documented by field personnel. Typical examples of supplies and consumables include sample bottles, sample collection and processing equipment, and materials for decontamination activities.

Acceptance criteria must be consistent with overall project technical and quality criteria. If there are special requirements for supplies or consumables, a clear agreement should be established with the supplier (e.g., a specific concentration of calibration gas).

Only pre-cleaned, certified sample containers and lids will be used for the chemical analyses. The pre-cleaned sample containers will be provided by the laboratories with individual certification. Prior to use, Roux and its subcontractors' field staff will inspect sample containers and other project materials to verify their cleanliness and usability. Any observed deficiencies that may affect the quality of the sample data will be documented and reported to the Roux Project Manager. Roux will provide appropriate supplies (e.g., disposable tins, spoons) for homogenizing samples prior to filling the sample container.

3.8 Data Acquisition Requirements for Non-Direct Measurements

For this project, Roux and its subcontractors may acquire data from non-direct measurements (e.g., field observations during sample collection). In these instances, photographic documentation or field data sheets may be used to record the data.

Field observations are standard practice for many types of investigations. These data are used in a weight-of-evidence approach to substantiate direct measurement data. However, these data are generally not used as the only source for a decision point.

3.9 Data Management

Data management is a process for tracking data from generation in the field and/or laboratory to final use and storage. Once the data have been provided to Roux by the analytical laboratory, the data will be retrieved, recorded, reduced, assessed, tracked, and stored in the project-specific network folders, which are backed up at least once per day to a recordable media. Technical data, including field data, laboratory analytical results, and validation qualifiers, will be stored in EQuIS. The EQuIS database resides on individual Roux computers and the network server that is backed up daily. To certify that data are accurately recorded and stored, tracking systems will be implemented. The Roux Project QC Manager, Data Manager, and/or designee will conduct automated and manual QC checks to verify that data have been accurately recorded and appropriately stored. Corrective actions will be taken if data have not been properly handled. The progress of sample collection and processing will be monitored through the documentation of samples collected, processed, and shipped each day.

3.9.1 Field Measurements and Sample Collection

The field operating records to be used in this investigation will document field procedures and any measurements performed during the sampling effort. Section 2.5.2 of this QAPP discusses field operation records. The Roux FTL will compile the field data and provide it to the Roux personnel to review, reduce, and upload to the EQuIS database. Field data transferred from written records to the field data EDDs will be reviewed for accuracy and completeness before loading into the database. Field data that cannot be integrated into the database (e.g., photographs or logbooks) will be stored electronically in the project-specific network folders and/or in the paper project folders, along with supporting information such as author/creator of data, date, location, and a brief description. The Roux FTL and Roux Project QC Manager will be responsible for the storage of field data files, either stored electronically in the project-specific network folders or in the paper project folders.

3.9.2 Laboratory Reporting and Recordkeeping

The laboratories will prepare and submit data packages of the analytical and associated QA/QC results. Analytical data will be transmitted from the laboratories in PDF and EDD formats. Analytical laboratory reports submitted will be stored electronically in the project-specific network folders. Analytical data results received from the laboratory will be checked for completeness by comparing them to the chain-of-custody documentation and the work plans.

Each laboratory data package will include the following (as applicable):

- A cover letter
- Case narrative, including statement of samples received, description of any deviations from standard procedures, explanation of qualifications regarding data quality, and any other significant problems encountered during analysis
- A summary of sample results that will include the following information when applicable:
    - Field sample identification code and the corresponding laboratory identification code
    - Sample matrix
    - Date of sample preparation/extraction
    - Preparation and analytical batch identifications linking field samples to QC samples in accordance with the GLLA Data Reporting Standard
    - Date and time of analysis
    - Mass or volume used for preparation and analysis
    - Final dilution or concentration factors for the sample
    - Identification of the instrument used for analysis
    - MDLs and MRLs accounting for sample-specific factors (e.g., dilution and total solids)
    - Analytical results with reporting units identified (see Section 2.3.12 for reporting unit)
    - Data qualifiers and their definitions
- QA/QC summaries, including, but not limited to, the following:
    - Method blank results
    - Surrogate spike recoveries
    - Internal standard area counts
    - Second column confirmation RPD values
    - MS/MSD recoveries and RPD values
    - MD RPD values
    - LCS recoveries
    - Interference check samples

    - Serial dilutions

- Calibration data summary
- Original data, including
    - Sample extraction, preparation, and cleanup logs
    - Instrument run logs
    - Instrument tunes
    - Ion chromatograms
    - Enhanced spectra of detected compounds with reference spectra
    - Quantitation reports
- Field and laboratory chain-of-custody documentation pertaining to each sample delivery group analyzed

The Laboratory Project Manager or appropriate personnel assigned by the Laboratory Project Manager, as part of the data validation process, will confirm the documentation is complete and legible; qualitative identifications are accurate; calculations are accurate; results are expressed in the appropriate units and number of significant figures; and the required QC checks were run and met acceptance criteria. All pages in analytical data packages will be consecutively numbered. Review and approval of the data will be documented by the Laboratory Project Manager.

4 Assessment and Oversight

This section details the procedures used for implementation of this QAPP.

4.1 Assessment and Response Actions

After data are received from the laboratory, QC procedures will be followed to evaluate data quality. The Roux QC Manager will review the laboratory report to confirm the report contains a detailed case narrative, sample and quality control results, and signed chain-of-custody forms. review would verify that the correct methods and analytes reported for all sample results. Specific procedures will also be followed to assess data precision, accuracy, and completeness, as detailed in Section 5.

4.2 Compliance Assessment

Performance audits consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory performance audits will not be conducted as part of this study; however, laboratory audit reports will be made available to the Roux QC Manager upon request. The laboratory is required to have written procedures addressing internal QA/QC. The laboratory must ensure that personnel engaged in preparation and analysis tasks have appropriate training. As part of the audit process, the laboratory will provide written details of any method modifications planned for the consultant's review.

4.3 Response and Corrective Actions

The following sections identify the responsibilities of key project team members and actions to be taken in the event of an error, problem, or non-conformance of protocols identified in this document.

4.3.1 Field Activities

Oversight is the continual or frequent monitoring of the status of the project and the analysis of records to confirm that specified project requirements are fulfilled. Surveillance of study area activities will be performed by GLNPO and Roux. The Roux FTL or Project Manager will monitor field activities (including all subcontractor activities and sampling efforts) by continuous presence and weekly site inspections. Site inspections will include review of QAPP and FSP requirements for specific tasks being performed by field staff, at the time of the inspection, to ensure all activities are being completed in accordance with the QAPP and FSP. Roux will inform GLNPO of any deficiencies for immediate correction. The GLNPO project manager will monitor the project, including documentation of identified deficiencies and corrective action taken, through monthly progress reports and communication with Roux.

The Roux FTL, or designee, will be responsible for correcting equipment malfunctions during the field sampling effort. The Roux QC Manager will be responsible for resolving situations identified by the Roux FTL that may result in non-compliance with this QAPP. Corrective measures will be immediately documented in the field logbook and reported to the GLLA QA Team Member and Project Manager.

4.3.2 Laboratories

The laboratories are required to comply with their SOPs (Attachment A). The laboratory managers will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with

this QAPP. Laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

4.4 Reports to Management

QA reports to management include daily verbal status reports and weekly schedule project meetings, as well as discussion of data validation reports and final laboratory reports upon issuance. These reports will be the responsibility of the Roux QC Manager. Verbal status reports include updates from the Roux QC Manager to the Roux Project Manager or designee on laboratory reporting progress, data validation progress, and any issues resulting in data rejection. Updates will be given as needed in routinely scheduled project meetings.

The field activities performed and field data will be documented as described in the Work Plan Section 4, on project document forms included as Appendix F, including field activity daily logs (FADLs). The laboratory-based activities performed and sample results will be documented as described in the SOPs (Attachment A).

The Roux Project Manager will be responsible for preparation of all other reports not listed above followed by approval as detailed on the project organizational chart (QAPP Figure 1).

5 Data Validation and Usability

The purpose of this section is to state the criteria for deciding the degree to which each dataset has met its quality specifications. Validation and verification procedures that will be conducted during sample collection and data generation are presented below. Conformance to these procedures will certify the representativeness of the samples and that sample integrity is maintained from sample collection through analysis at the laboratory. Data generated by the laboratories will be submitted to Roux and assessed for completeness. Roux will track the analytical data packages and EDDs through the data validation process. The data will be reviewed by the Roux QC Manager following validation to determine its usability for decision-making and reporting activities. The third-party data validator will prepare a Data Usability Summary Report (DUSR).

The following two steps are required to document that project data quality standards are met:

1. **Data verification and validation** – Data verification and validation consist of evaluating the completeness, correctness, and conformance or contractual compliance of a dataset against the method standard, SOP, or contract requirements documented in the project QAPP.

2. **Data usability assessment** – Data usability assessment is the process of evaluating verified and validated data to determine whether they can be used for the purpose of the project.

5.1 Review, Validation, and Verification Requirements

Data generated during field and laboratory activities will be reduced, reviewed, and validated prior to reporting.

5.1.1 Data Reduction and Review

Raw data from any field measurements and sample collection activities will be appropriately recorded in the field logbook.

Laboratory data reduction procedures will be in accordance with each individual laboratory SOP (Attachment A). Table 2 lists laboratory methods to be followed in this investigation. For each of the methods, the laboratory project manager will complete a thorough inspection of all reports prior to release of the data. Following review and approval of the preliminary report by the laboratory project manager, final reports will be generated and signed by the laboratory project manager.

5.1.2 Data Validation

During the validation process, field and analytical data will be evaluated for project, method, and laboratory QC compliance, as applicable, and their validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers, will be entered into the project database, thus enabling this information to be retained or retrieved, as needed.

Completeness will be evaluated by auditing the data package for the following:

- Data Completeness

- Case Narrative
- Custody Documentation
- Holding Times
- Surrogate, Isotopic Dilution, and Internal Standard Recoveries
- Method/Preparation Blanks
- Matrix Spike Recoveries/Duplicate Correlations
- Blind Field Duplicate Correlations
- Laboratory Control Sample (LCS)
- Instrumental Tunes
- Initial and Continuing Calibration Standards
- Method Compliance
- Sample Result Verification

5.2 Validation and Verification Methods

Data evaluation will be performed by a third-party data validator using the most current methods and quality control criteria from the USEPA's Contract Laboratory Program (CLP) National Functional Guidelines for Organic Superfund Data Review (USEPA 2020a) and Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review (USEPA 2020b). The data review guidance will be used only to the extent that it is applicable to the SW-846 methods; SW-846 methodologies will be followed primarily and given preference over CLP when differences occur.

Data will also be evaluated by Data Validation Services (DVS), a qualified, independent data validation expert, for conformance to the applicable analytical methods, the laboratory SOPs, and guidelines described in this QAPP. The third-party data validator will apply qualifier flags to individual results based on their findings, using their best professional judgment, and consistent with the USEPA National Functional Guidelines qualifier definitions. Roux will review pertinent sampling and laboratory documentation to determine to what degree data have met their quality specifications as presented in this QAPP.

If concerns are identified during data collection, review, verification, or validation processes, the Roux QC Manager will work with the USEPA GLNPO project manager, and, if needed, analytical laboratories to develop an appropriate resolution. Findings or QC concerns will be included in the DUSR prepared by the third-party data validator. The Roux Project Manager, after consultation with the Roux QC Manager, will be responsible for any corrective action identified during the data validation process. Initiation of laboratory corrective actions will be the responsibility of the Roux Project Manager and/or Roux QC Manager.

5.3 Usability/Reconciliation with Data Quality Objectives

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity requirements, as described in Section 2.3 and Table 3 of this QAPP. Data that do not meet the

specified requirements and the QA requirements in the analytical methods will be discussed in the data validation summaries and incorporated into the summary report for this project.

The RD/RA Work Plan will summarize the findings from the field study, including but not limited to, data tables and maps summarizing the findings of the investigation. Qualifiers assigned by the validator will be applied to the database and included in all database exports, including tables in the reports.

Any sources of sampling or analytical error will be identified as early as possible during collection activities so that corrective action can be quickly implemented. Data that are not deemed usable to support or address the project decision-making process will be identified and the potential need for additional sampling will be discussed with the Roux Project Manager and USEPA GLLA Project Manager. A disclaimer will be included on each page of any table generated from the data and included in a report if the use of the data obtained from any sampling event should be limited for any reason. Data qualified as estimated during validation will be considered usable for the DQOs of this project.

6 References

NYSDEC 2021. *Final Statement of Basis, Corrective Measures Selection, Bethlehem Steel (Tecumseh Redevelopment, Inc.) Site*. November 2021.

NYSDEC 2010. *DER-10/Technical Guidance for Site Investigation and Remediation*. May 3, 2010.

TurnKey Environmental Restoration, LLC in association with Benchmark Environmental Engineering & Science, PLLC (TurnKey-Benchmark) 2019. *Corrective Measures Study Report, Tecumseh Redevelopment Site, Lackawanna, New York*. Revised May 2019.

USEPA 2020a. *National Functional Guidelines for Organic Superfund Methods Data Review.* Office of Superfund Remediation and Technology Innovation. USEPA-540-R-20-005. November 2020.

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USEPA 2023. *Quality Assurance Project Plan Standard.* IT/IM Directive Standard. Issued by the USEPA Chief Information Officer, Pursuant to Delegation 1-19. Directive No: CIO 2105-S-02.1. August 2023.

USEPA 2023. *GLLA QA Considerations*. August 2023.

TABLES

1. Project Distribution and Contact List
2. Sediment Analytes, Methods, and Target Reporting Limits
3. Laboratory Data Quality Indicators
4. Field and Laboratory Quality Control Sample Analysis Frequency
5. Sample Containers, Holding Times, and Preservation

TABLE 1
PROJECT DISTRIBUTION AND CONTACT LIST

QUALITY ASSURANCE PROJECT PLAN

QAPP Recipient	Title/Role	Organization	Telephone Number	Email Address
Courtney Winter	USEPA GLNPO Project Manager	USEPA GLNPO	312-353-5657	Winter.Courtney@epa.gov
Christian Bako	USEPA GLNPO QA Review Point of Contact	USEPA GLNPO	312-886-6787	Bako.Christian@epa.gov
Crawford White	USEPA GLNPO QA Lead and Data Manager	USEPA GLNPO	312-886-4698	White.Crawford@epa.gov
Andrew Zwack	NYSDEC Project Manager	NYSDEC	716-851-7220	andrew.zwack@dec.ny.gov
Thomas Forbes	Roux Operations Manager	Roux	716-864-1730	tforbes@rouxinc.com
John Deth	Roux Project Manager	Roux	716-863-0333	jdeth@rouxinc.com
Lori Riker	Roux QC Manager	Roux	716-474-7510	lriker@rouxinc.com
Richard Dubisz	Roux Field Lead	Roux	716-998-4334	rdubisz@rouxinc.com
Paul W. Werthman	Roux Field Safety Manager	Roux	716-997-9584	pwwerthman@rouxinc.com
Timothy Gavin	Area Manager	Atlantic Testing Laboratories	315-386-4578	tgavin@atlantictesting.com
TBD	Vibracore Sampling Lead	Atlantic Testing Laboratories	TBD	TBD
Marshall Wilson	Bathymetric Survey Lead	360 Land Survey	716-587-8380	mwilson@360landsurvey.com
Patrick Filey	Laboratory Project Manager	Pace Analytical	716-392-3932	patrick.filey@pacelabs.com
Judy Harry	Validation Project Manager	Data Validation Services	518-251-4429	harry@frontiernet.net

Acronyms:

USEPA = United States Environmental Protection Agency
GLNPO = Great Lakes National Program Office
NYSDEC = New York State Department of Environmental Conservation
QAPP = Quality Assurance Project Plan
QA = Quality Assurance
QC - Qualtiy Control
DVS = Data Validation Services
TBD = To be determined

ROUX

TABLE 2
SEDIMENT ANALYTES, METHODS, AND TARGET REPORTING LIMITS

QUALITY ASSURANCE PROJECT PLAN

Parameter	Analytical Method [1]	Laboratory MDL [2]	Laboratory MRL [2]
TCL VOCs	EPA 8260D	Worksheet 1 (ug/kg)	Worksheet 1 (ug/kg)
TCL SVOCs	EPA 8270E	Worksheet 2 (ug/kg)	Worksheet 2 (ug/kg)
TAL Metals	EPA 6010D	Worksheet 3 (mg/kg)	Worksheet 3 (mg/kg)
Mercury	EPA 7471B	0.05216 mg/kg	0.08 mg/kg
Total Cyanide	EPA 9010C/9012B	0.212 mg/kg	1 mg/kg
PCB Aroclors	EPA 8082A	Worksheet 4 (ug/kg)	Worksheet 4 (ug/kg)
TOC	EPA 9060A(M)	0.01%	0.01%

Notes:
1. Test Methods for Evaluating Solid Wastes, USEPA SW-846, Update III, 1991.
2. Worksheets provided by Pace Analytical

Acronyms:
MDL = Method detection limit
MRL = Method reporting limit
ug/kg = microgram per kilogram
VOCs = Volatile organic compounds
SVOCs = Semi-volatile organic compounds
RCRA = Resource Conservation and Recovery Act
PCBs = Polychlorinated biphenyls
TOC = Total organic carbon

QAPP Table 2 - Worksheet 1

Date Created: 01/15/26
Created By: Candace Fox
File: PM20880-1
Page: 1

Roux

TCL Volatiles - EPA 8260D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial Large Septa unpreserved (4oz)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Methylene chloride	75-09-2	5	2.29	ug/kg	70-130	30	70-130	30	30			
1,1-Dichloroethane	75-34-3	1	0.145	ug/kg	70-130	30	70-130	30	30			
Chloroform	67-66-3	1.5	0.14	ug/kg	70-130	30	70-130	30	30			
Carbon tetrachloride	56-23-5	1	0.23	ug/kg	70-130	30	70-130	30	30			
1,2-Dichloropropane	78-87-5	1	0.125	ug/kg	70-130	30	70-130	30	30			
Dibromochloromethane	124-48-1	1	0.14	ug/kg	70-130	30	70-130	30	30			
1,1,2-Trichloroethane	79-00-5	1	0.267	ug/kg	70-130	30	70-130	30	30			
Tetrachloroethene	127-18-4	0.5	0.196	ug/kg	70-130	30	70-130	30	30			
Chlorobenzene	108-90-7	0.5	0.127	ug/kg	70-130	30	70-130	30	30			
Trichlorofluoromethane	75-69-4	4	0.695	ug/kg	70-139	30	70-139	30	30			
1,2-Dichloroethane	107-06-2	1	0.257	ug/kg	70-130	30	70-130	30	30			
1,1,1-Trichloroethane	71-55-6	0.5	0.167	ug/kg	70-130	30	70-130	30	30			
Bromodichloromethane	75-27-4	0.5	0.109	ug/kg	70-130	30	70-130	30	30			
trans-1,3-Dichloropropene	10061-02-6	1	0.273	ug/kg	70-130	30	70-130	30	30			
cis-1,3-Dichloropropene	10061-01-5	0.5	0.158	ug/kg	70-130	30	70-130	30	30			
Bromoform	75-25-2	4	0.246	ug/kg	70-130	30	70-130	30	30			
1,1,2,2-Tetrachloroethane	79-34-5	0.5	0.166	ug/kg	70-130	30	70-130	30	30			
Benzene	71-43-2	0.5	0.166	ug/kg	70-130	30	70-130	30	30			
Toluene	108-88-3	1	0.543	ug/kg	70-130	30	70-130	30	30			
Ethylbenzene	100-41-4	1	0.141	ug/kg	70-130	30	70-130	30	30			
Chloromethane	74-87-3	4	0.932	ug/kg	52-130	30	52-130	30	30			
Bromomethane	74-83-9	2	0.581	ug/kg	57-147	30	57-147	30	30			
Vinyl chloride	75-01-4	1	0.335	ug/kg	67-130	30	67-130	30	30			
Chloroethane	75-00-3	2	0.452	ug/kg	50-151	30	50-151	30	30			
1,1-Dichloroethene	75-35-4	1	0.238	ug/kg	65-135	30	65-135	30	30			
trans-1,2-Dichloroethene	156-60-5	1.5	0.137	ug/kg	70-130	30	70-130	30	30			
Trichloroethene	79-01-6	0.5	0.137	ug/kg	70-130	30	70-130	30	30			
1,2-Dichlorobenzene	95-50-1	2	0.144	ug/kg	70-130	30	70-130	30	30			
1,3-Dichlorobenzene	541-73-1	2	0.148	ug/kg	70-130	30	70-130	30	30			
1,4-Dichlorobenzene	106-46-7	2	0.171	ug/kg	70-130	30	70-130	30	30			
Methyl tert butyl ether	1634-04-4	2	0.201	ug/kg	66-130	30	66-130	30	30			
p/m-Xylene	179601-23-1	2	0.56	ug/kg	70-130	30	70-130	30	30			
o-Xylene	95-47-6	1	0.291	ug/kg	70-130	30	70-130	30	30			
cis-1,2-Dichloroethene	156-59-2	1	0.175	ug/kg	70-130	30	70-130	30	30			
Styrene	100-42-5	1	0.196	ug/kg	70-130	30	70-130	30	30			
Dichlorodifluoromethane	75-71-8	10	0.915	ug/kg	30-146	30	30-146	30	30			
Acetone	67-64-1	10	4.811	ug/kg	54-140	30	54-140	30	30			
Carbon disulfide	75-15-0	10	4.55	ug/kg	59-130	30	59-130	30	30			
2-Butanone	78-93-3	10	2.22	ug/kg	70-130	30	70-130	30	30			
4-Methyl-2-pentanone	108-10-1	10	1.28	ug/kg	70-130	30	70-130	30	30			
2-Hexanone	591-78-6	10	1.18	ug/kg	70-130	30	70-130	30	30			
Bromochloromethane	74-97-5	2	0.205	ug/kg	70-130	30	70-130	30	30			

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

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Roux

TCL Volatiles - EPA 8260D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial Large Septa unpreserved (4oz)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,2-Dibromoethane	106-93-4	1	0.279	ug/kg	70-130	30	70-130	30	30			
1,2-Dibromo-3-chloropropane	96-12-8	3	0.998	ug/kg	68-130	30	68-130	30	30			
Isopropylbenzene	98-82-8	1	0.109	ug/kg	70-130	30	70-130	30	30			
1,2,3-Trichlorobenzene	87-61-6	2	0.322	ug/kg	70-130	30	70-130	30	30			
1,2,4-Trichlorobenzene	120-82-1	2	0.272	ug/kg	70-130	30	70-130	30	30			
1,4-Dioxane	123-91-1	80	35.1	ug/kg	65-136	30	65-136	30	30			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
2-Chloroethoxyethane												
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

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Roux

NYTCL Semivolatiles - EPA 8270E (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Acenaphthene	83-32-9	133.6	17.3012	ug/kg	31-137	50	31-137	50	50			
Hexachlorobenzene	118-74-1	100.2	18.704	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroethyl)ether	111-44-4	150.3	22.6452	ug/kg	40-140	50	40-140	50	50			
2-Chloronaphthalene	91-58-7	167	16.5664	ug/kg	40-140	50	40-140	50	50			
3,3'-Dichlorobenzidine	91-94-1	167	44.422	ug/kg	40-140	50	40-140	50	50			
2,4-Dinitrotoluene	121-14-2	167	33.4	ug/kg	40-132	50	40-132	50	50			
2,6-Dinitrotoluene	606-20-2	167	28.6572	ug/kg	40-140	50	40-140	50	50			
Fluoranthene	206-44-0	100.2	19.1716	ug/kg	40-140	50	40-140	50	50			
4-Chlorophenyl phenyl ether	7005-72-3	167	17.869	ug/kg	40-140	50	40-140	50	50			
4-Bromophenyl phenyl ether	101-55-3	167	25.4842	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroisopropyl)ether	108-60-1	200.4	28.5236	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroethoxy)methane	111-91-1	180.36	16.7334	ug/kg	40-117	50	40-117	50	50			
Hexachlorobutadiene	87-68-3	167	24.4488	ug/kg	40-140	50	40-140	50	50			
Hexachlorocyclopentadiene	77-47-4	477.62	151.302	ug/kg	40-140	50	40-140	50	50			
Hexachloroethane	67-72-1	133.6	27.0206	ug/kg	40-140	50	40-140	50	50			
Isophorone	78-59-1	150.3	21.6766	ug/kg	40-140	50	40-140	50	50			
Naphthalene	91-20-3	167	20.3406	ug/kg	40-140	50	40-140	50	50			
Nitrobenzene	98-95-3	150.3	24.716	ug/kg	40-140	50	40-140	50	50			
NitrosoDiPhenylAmine(NDPA)/DPA	86-30-6	133.6	19.0046	ug/kg	36-157	50	36-157	50	50			
n-Nitrosodi-n-propylamine	621-64-7	167	25.7848	ug/kg	32-121	50	32-121	50	50			
Bis(2-Ethylhexyl)phthalate	117-81-7	167	57.782	ug/kg	40-140	50	40-140	50	50			
Butyl benzyl phthalate	85-68-7	167	42.084	ug/kg	40-140	50	40-140	50	50			
Di-n-butylphthalate	84-74-2	167	31.6632	ug/kg	40-140	50	40-140	50	50			
Di-n-octylphthalate	117-84-0	167	56.78	ug/kg	40-140	50	40-140	50	50			
Diethyl phthalate	84-66-2	167	15.4642	ug/kg	40-140	50	40-140	50	50			
Dimethyl phthalate	131-11-3	167	35.07	ug/kg	40-140	50	40-140	50	50			
Benzo(a)anthracene	56-55-3	100.2	18.8042	ug/kg	40-140	50	40-140	50	50			
Benzo(a)pyrene	50-32-8	133.6	40.748	ug/kg	40-140	50	40-140	50	50			
Benzo(b)fluoranthene	205-99-2	100.2	28.1228	ug/kg	40-140	50	40-140	50	50			
Benzo(k)fluoranthene	207-08-9	100.2	26.72	ug/kg	40-140	50	40-140	50	50			
Chrysene	218-01-9	100.2	17.368	ug/kg	40-140	50	40-140	50	50			
Acenaphthylene	208-96-8	133.6	25.7848	ug/kg	40-140	50	40-140	50	50			
Anthracene	120-12-7	100.2	32.565	ug/kg	40-140	50	40-140	50	50			
Benzo(ghi)perylene	191-24-2	133.6	19.6392	ug/kg	40-140	50	40-140	50	50			
Fluorene	86-73-7	167	16.2324	ug/kg	40-140	50	40-140	50	50			
Phenanthrene	85-01-8	100.2	20.3072	ug/kg	40-140	50	40-140	50	50			
Dibenzo(a,h)anthracene	53-70-3	100.2	19.3052	ug/kg	40-140	50	40-140	50	50			
Indeno(1,2,3-cd)Pyrene	193-39-5	133.6	23.2798	ug/kg	40-140	50	40-140	50	50			
Pyrene	129-00-0	100.2	16.5998	ug/kg	35-142	50	35-142	50	50			
Biphenyl	92-52-4	380.76	21.71	ug/kg	37-127	50	37-127	50	50			
4-Chloroaniline	106-47-8	167	30.394	ug/kg	40-140	50	40-140	50	50			
2-Nitroaniline	88-74-4	167	32.1976	ug/kg	47-134	50	47-134	50	50			

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. (Soil/Solids only)
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NYTCL Semivolatiles - EPA 8270E (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
3-Nitroaniline	99-09-2	167	31.4962	ug/kg	26-129	50	26-129	50	50			
4-Nitroaniline	100-01-6	167	69.138	ug/kg	41-125	50	41-125	50	50			
Dibenzofuran	132-64-9	167	15.7982	ug/kg	40-140	50	40-140	50	50			
2-Methylnaphthalene	91-57-6	200.4	20.1736	ug/kg	40-140	50	40-140	50	50			
Acetophenone	98-86-2	167	20.6746	ug/kg	14-144	50	14-144	50	50			
2,4,6-Trichlorophenol	88-06-2	100.2	31.6632	ug/kg	30-130	50	30-130	50	50			
P-Chloro-M-Cresol	59-50-7	167	24.883	ug/kg	26-103	50	26-103	50	50			
2-Chlorophenol	95-57-8	167	19.7394	ug/kg	25-102	50	25-102	50	50			
2,4-Dichlorophenol	120-83-2	150.3	26.8536	ug/kg	30-130	50	30-130	50	50			
2,4-Dimethylphenol	105-67-9	167	55.11	ug/kg	30-130	50	30-130	50	50			
2-Nitrophenol	88-75-5	360.72	62.792	ug/kg	30-130	50	30-130	50	50			
4-Nitrophenol	100-02-7	233.8	68.136	ug/kg	11-114	50	11-114	50	50			
2,4-Dinitrophenol	51-28-5	801.6	77.822	ug/kg	4-130	50	4-130	50	50			
4,6-Dinitro-o-cresol	534-52-1	434.2	80.16	ug/kg	10-130	50	10-130	50	50			
Pentachlorophenol	87-86-5	133.6	36.74	ug/kg	17-109	50	17-109	50	50			
Phenol	108-95-2	167	25.217	ug/kg	26-90	50	26-90	50	50			
2-Methylphenol	95-48-7	167	25.885	ug/kg	30-130	50	30-130	50	50			
3-Methylphenol/4-Methylphenol	106-44-5	240.48	26.1522	ug/kg	30-130	50	30-130	50	50			
2,4,5-Trichlorophenol	95-95-4	167	31.9972	ug/kg	30-130	50	30-130	50	50			
Carbazole	86-74-8	167	16.2324	ug/kg	54-128	50	54-128	50	50			
2-Fluorophenol	*367-12-4*									*25-120*		
Phenol-d6	*13127-88-3*									*10-120*		
Nitrobenzene-d5	*4165-60-0*									*23-120*		
2-Fluorobiphenyl	*321-60-8*									*30-120*		
2,4,6-Tribromophenol	*118-79-6*									*10-136*		
4-Terphenyl-d14	*1718-51-0*									*18-120*		

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QAPP Table 2 - Worksheet 3

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Roux

METALS by 6010D (SOIL)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria	Holding Time	Container
Aluminum, Total	7429-90-5	4	1.3	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Antimony, Total	7440-36-0	2	1.54	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Arsenic, Total	7440-38-2	0.4	0.1728	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Barium, Total	7440-39-3	0.4	0.0424	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Beryllium, Total	7440-41-7	0.2	0.022	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Cadmium, Total	7440-43-9	0.4	0.022	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Calcium, Total	7440-70-2	4	2.268	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Chromium, Total	7440-47-3	0.4	0.3392	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Cobalt, Total	7440-48-4	0.8	0.0992	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Copper, Total	7440-50-8	0.4	0.0908	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Iron, Total	7439-89-6	10	3.2	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Lead, Total	7439-92-1	2	0.0952	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Magnesium, Total	7439-95-4	4	0.652	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Manganese, Total	7439-96-5	0.4	0.2144	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Nickel, Total	7440-02-0	1	0.3232	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Potassium, Total	7440-09-7	100	20.28	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Selenium, Total	7782-49-2	0.8	0.1316	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Silver, Total	7440-22-4	0.2	0.1192	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Sodium, Total	7440-23-5	80	42.4	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Thallium, Total	7440-28-0	0.8	0.3608	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Vanadium, Total	7440-62-2	0.4	0.0604	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved
Zinc, Total	7440-66-6	2	0.2424	mg/kg	80-120	20	75-125	20	20		180 days	1 - Metals Only-Glass 60mL/2oz unpreserved

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TCL PCBs - EPA 8082A (SOIL)

Holding Time: 365 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Aroclor 1016	12674-11-2	50	4.44	ug/kg	40-140	50	40-140	50	50			
Aroclor 1221	11104-28-2	50	5.01	ug/kg	40-140	50	40-140	50	50			
Aroclor 1232	11141-16-5	50	10.6	ug/kg	40-140	50	40-140	50	50			
Aroclor 1242	53469-21-9	50	6.74	ug/kg	40-140	50	40-140	50	50			
Aroclor 1248	12672-29-6	50	7.5	ug/kg	40-140	50	40-140	50	50			
Aroclor 1254	11097-69-1	50	5.47	ug/kg	40-140	50	40-140	50	50			
Aroclor 1260	11096-82-5	50	9.24	ug/kg	40-140	50	40-140	50	50			
Aroclor 1262	37324-23-5	50	6.35	ug/kg	40-140	50	40-140	50	50			
Aroclor 1268	11100-14-4	50	5.18	ug/kg	40-140	50	40-140	50	50			
PCBs, Total	1336-36-3	50	4.44	ug/kg				50	50			
2,4,5,6-Tetrachloro-m-xylene	*877-09-8*									*30-150*		
Decachlorobiphenyl	*2051-24-3*									*30-150*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

TABLE 3
LABORATORY DATA QUALITY INDICATORS

QUALITY ASSURANCE PROJECT PLAN

Parameter	Analytical Method	MS/MSD Laboratory Precision	LCS Accuracy	MS/MSD Accuracy	Completeness
TCL VOCs	EPA 8260D	≤20% RPD	Worksheet 1 (%)	Worksheet 1 (%)	≤95%
TCL SVOCs	EPA 8270E	≤50% RPD	Worksheet 2 (%)	Worksheet 2 (%)	≤95%
TAL Metals	EPA 6010D	≤35% RPD	80-120 %	75-125 %	≤95%
Mercury	EPA 7471B	≤35% RPD	80-120 %	80-120 %	≤95%
Cyanide	EPA 9010C/9012B	≤35% RPD	80-120 %	75-125 %	≤95%
PCBs	EPA 8082A	≤30% RPD	40-140 %	40-140 %	≤95%
TOC	EPA 9060A(M)	≤20% RPD	75-125 %	75-125 %	≤95%

Acronyms:

RPD = Relative percent difference
N/A = Not applicable
LCS = Laboratory control sample
MS/MSD = Matrix spike/matrix spike duplicate

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Roux

TCL Volatiles - EPA 8260D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial Large Septa unpreserved (4oz)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Methylene chloride	75-09-2	5	2.29	ug/kg	70-130	30	70-130	30	30			
1,1-Dichloroethane	75-34-3	1	0.145	ug/kg	70-130	30	70-130	30	30			
Chloroform	67-66-3	1.5	0.14	ug/kg	70-130	30	70-130	30	30			
Carbon tetrachloride	56-23-5	1	0.23	ug/kg	70-130	30	70-130	30	30			
1,2-Dichloropropane	78-87-5	1	0.125	ug/kg	70-130	30	70-130	30	30			
Dibromochloromethane	124-48-1	1	0.14	ug/kg	70-130	30	70-130	30	30			
1,1,2-Trichloroethane	79-00-5	1	0.267	ug/kg	70-130	30	70-130	30	30			
Tetrachloroethene	127-18-4	0.5	0.196	ug/kg	70-130	30	70-130	30	30			
Chlorobenzene	108-90-7	0.5	0.127	ug/kg	70-130	30	70-130	30	30			
Trichlorofluoromethane	75-69-4	4	0.695	ug/kg	70-139	30	70-139	30	30			
1,2-Dichloroethane	107-06-2	1	0.257	ug/kg	70-130	30	70-130	30	30			
1,1,1-Trichloroethane	71-55-6	0.5	0.167	ug/kg	70-130	30	70-130	30	30			
Bromodichloromethane	75-27-4	0.5	0.109	ug/kg	70-130	30	70-130	30	30			
trans-1,3-Dichloropropene	10061-02-6	1	0.273	ug/kg	70-130	30	70-130	30	30			
cis-1,3-Dichloropropene	10061-01-5	0.5	0.158	ug/kg	70-130	30	70-130	30	30			
Bromoform	75-25-2	4	0.246	ug/kg	70-130	30	70-130	30	30			
1,1,2,2-Tetrachloroethane	79-34-5	0.5	0.166	ug/kg	70-130	30	70-130	30	30			
Benzene	71-43-2	0.5	0.166	ug/kg	70-130	30	70-130	30	30			
Toluene	108-88-3	1	0.543	ug/kg	70-130	30	70-130	30	30			
Ethylbenzene	100-41-4	1	0.141	ug/kg	70-130	30	70-130	30	30			
Chloromethane	74-87-3	4	0.932	ug/kg	52-130	30	52-130	30	30			
Bromomethane	74-83-9	2	0.581	ug/kg	57-147	30	57-147	30	30			
Vinyl chloride	75-01-4	1	0.335	ug/kg	67-130	30	67-130	30	30			
Chloroethane	75-00-3	2	0.452	ug/kg	50-151	30	50-151	30	30			
1,1-Dichloroethene	75-35-4	1	0.238	ug/kg	65-135	30	65-135	30	30			
trans-1,2-Dichloroethene	156-60-5	1.5	0.137	ug/kg	70-130	30	70-130	30	30			
Trichloroethene	79-01-6	0.5	0.137	ug/kg	70-130	30	70-130	30	30			
1,2-Dichlorobenzene	95-50-1	2	0.144	ug/kg	70-130	30	70-130	30	30			
1,3-Dichlorobenzene	541-73-1	2	0.148	ug/kg	70-130	30	70-130	30	30			
1,4-Dichlorobenzene	106-46-7	2	0.171	ug/kg	70-130	30	70-130	30	30			
Methyl tert butyl ether	1634-04-4	2	0.201	ug/kg	66-130	30	66-130	30	30			
p/m-Xylene	179601-23-1	2	0.56	ug/kg	70-130	30	70-130	30	30			
o-Xylene	95-47-6	1	0.291	ug/kg	70-130	30	70-130	30	30			
cis-1,2-Dichloroethene	156-59-2	1	0.175	ug/kg	70-130	30	70-130	30	30			
Styrene	100-42-5	1	0.196	ug/kg	70-130	30	70-130	30	30			
Dichlorodifluoromethane	75-71-8	10	0.915	ug/kg	30-146	30	30-146	30	30			
Acetone	67-64-1	10	4.811	ug/kg	54-140	30	54-140	30	30			
Carbon disulfide	75-15-0	10	4.55	ug/kg	59-130	30	59-130	30	30			
2-Butanone	78-93-3	10	2.22	ug/kg	70-130	30	70-130	30	30			
4-Methyl-2-pentanone	108-10-1	10	1.28	ug/kg	70-130	30	70-130	30	30			
2-Hexanone	591-78-6	10	1.18	ug/kg	70-130	30	70-130	30	30			
Bromochloromethane	74-97-5	2	0.205	ug/kg	70-130	30	70-130	30	30			

Please Note that the RL information provided in this table is calculated using a 100% Solids factor. ***(Soil/Solids only)***
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TCL Volatiles - EPA 8260D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial Large Septa unpreserved (4oz)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,2-Dibromoethane	106-93-4	1	0.279	ug/kg	70-130	30	70-130	30	30			
1,2-Dibromo-3-chloropropane	96-12-8	3	0.998	ug/kg	68-130	30	68-130	30	30			
Isopropylbenzene	98-82-8	1	0.109	ug/kg	70-130	30	70-130	30	30			
1,2,3-Trichlorobenzene	87-61-6	2	0.322	ug/kg	70-130	30	70-130	30	30			
1,2,4-Trichlorobenzene	120-82-1	2	0.272	ug/kg	70-130	30	70-130	30	30			
1,4-Dioxane	123-91-1	80	35.1	ug/kg	65-136	30	65-136	30	30			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
2-Chloroethoxyethane												
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

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Roux

NYTCL Semivolatiles - EPA 8270E (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Acenaphthene	83-32-9	133.6	17.3012	ug/kg	31-137	50	31-137	50	50			
Hexachlorobenzene	118-74-1	100.2	18.704	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroethyl)ether	111-44-4	150.3	22.6452	ug/kg	40-140	50	40-140	50	50			
2-Chloronaphthalene	91-58-7	167	16.5664	ug/kg	40-140	50	40-140	50	50			
3,3'-Dichlorobenzidine	91-94-1	167	44.422	ug/kg	40-140	50	40-140	50	50			
2,4-Dinitrotoluene	121-14-2	167	33.4	ug/kg	40-132	50	40-132	50	50			
2,6-Dinitrotoluene	606-20-2	167	28.6572	ug/kg	40-140	50	40-140	50	50			
Fluoranthene	206-44-0	100.2	19.1716	ug/kg	40-140	50	40-140	50	50			
4-Chlorophenyl phenyl ether	7005-72-3	167	17.869	ug/kg	40-140	50	40-140	50	50			
4-Bromophenyl phenyl ether	101-55-3	167	25.4842	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroisopropyl)ether	108-60-1	200.4	28.5236	ug/kg	40-140	50	40-140	50	50			
Bis(2-chloroethoxy)methane	111-91-1	180.36	16.7334	ug/kg	40-117	50	40-117	50	50			
Hexachlorobutadiene	87-68-3	167	24.4488	ug/kg	40-140	50	40-140	50	50			
Hexachlorocyclopentadiene	77-47-4	477.62	151.302	ug/kg	40-140	50	40-140	50	50			
Hexachloroethane	67-72-1	133.6	27.0206	ug/kg	40-140	50	40-140	50	50			
Isophorone	78-59-1	150.3	21.6766	ug/kg	40-140	50	40-140	50	50			
Naphthalene	91-20-3	167	20.3406	ug/kg	40-140	50	40-140	50	50			
Nitrobenzene	98-95-3	150.3	24.716	ug/kg	40-140	50	40-140	50	50			
NitrosoDiPhenylAmine(NDPA)/DPA	86-30-6	133.6	19.0046	ug/kg	36-157	50	36-157	50	50			
n-Nitrosodi-n-propylamine	621-64-7	167	25.7848	ug/kg	32-121	50	32-121	50	50			
Bis(2-Ethylhexyl)phthalate	117-81-7	167	57.782	ug/kg	40-140	50	40-140	50	50			
Butyl benzyl phthalate	85-68-7	167	42.084	ug/kg	40-140	50	40-140	50	50			
Di-n-butylphthalate	84-74-2	167	31.6632	ug/kg	40-140	50	40-140	50	50			
Di-n-octylphthalate	117-84-0	167	56.78	ug/kg	40-140	50	40-140	50	50			
Diethyl phthalate	84-66-2	167	15.4642	ug/kg	40-140	50	40-140	50	50			
Dimethyl phthalate	131-11-3	167	35.07	ug/kg	40-140	50	40-140	50	50			
Benzo(a)anthracene	56-55-3	100.2	18.8042	ug/kg	40-140	50	40-140	50	50			
Benzo(a)pyrene	50-32-8	133.6	40.748	ug/kg	40-140	50	40-140	50	50			
Benzo(b)fluoranthene	205-99-2	100.2	28.1228	ug/kg	40-140	50	40-140	50	50			
Benzo(k)fluoranthene	207-08-9	100.2	26.72	ug/kg	40-140	50	40-140	50	50			
Chrysene	218-01-9	100.2	17.368	ug/kg	40-140	50	40-140	50	50			
Acenaphthylene	208-96-8	133.6	25.7848	ug/kg	40-140	50	40-140	50	50			
Anthracene	120-12-7	100.2	32.565	ug/kg	40-140	50	40-140	50	50			
Benzo(ghi)perylene	191-24-2	133.6	19.6392	ug/kg	40-140	50	40-140	50	50			
Fluorene	86-73-7	167	16.2324	ug/kg	40-140	50	40-140	50	50			
Phenanthrene	85-01-8	100.2	20.3072	ug/kg	40-140	50	40-140	50	50			
Dibenzo(a,h)anthracene	53-70-3	100.2	19.3052	ug/kg	40-140	50	40-140	50	50			
Indeno(1,2,3-cd)Pyrene	193-39-5	133.6	23.2798	ug/kg	40-140	50	40-140	50	50			
Pyrene	129-00-0	100.2	16.5998	ug/kg	35-142	50	35-142	50	50			
Biphenyl	92-52-4	380.76	21.71	ug/kg	37-127	50	37-127	50	50			
4-Chloroaniline	106-47-8	167	30.394	ug/kg	40-140	50	40-140	50	50			
2-Nitroaniline	88-74-4	167	32.1976	ug/kg	47-134	50	47-134	50	50			

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Roux

NYTCL Semivolatiles - EPA 8270E (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
3-Nitroaniline	99-09-2	167	31.4962	ug/kg	26-129	50	26-129	50	50			
4-Nitroaniline	100-01-6	167	69.138	ug/kg	41-125	50	41-125	50	50			
Dibenzofuran	132-64-9	167	15.7982	ug/kg	40-140	50	40-140	50	50			
2-Methylnaphthalene	91-57-6	200.4	20.1736	ug/kg	40-140	50	40-140	50	50			
Acetophenone	98-86-2	167	20.6746	ug/kg	14-144	50	14-144	50	50			
2,4,6-Trichlorophenol	88-06-2	100.2	31.6632	ug/kg	30-130	50	30-130	50	50			
P-Chloro-M-Cresol	59-50-7	167	24.883	ug/kg	26-103	50	26-103	50	50			
2-Chlorophenol	95-57-8	167	19.7394	ug/kg	25-102	50	25-102	50	50			
2,4-Dichlorophenol	120-83-2	150.3	26.8536	ug/kg	30-130	50	30-130	50	50			
2,4-Dimethylphenol	105-67-9	167	55.11	ug/kg	30-130	50	30-130	50	50			
2-Nitrophenol	88-75-5	360.72	62.792	ug/kg	30-130	50	30-130	50	50			
4-Nitrophenol	100-02-7	233.8	68.136	ug/kg	11-114	50	11-114	50	50			
2,4-Dinitrophenol	51-28-5	801.6	77.822	ug/kg	4-130	50	4-130	50	50			
4,6-Dinitro-o-cresol	534-52-1	434.2	80.16	ug/kg	10-130	50	10-130	50	50			
Pentachlorophenol	87-86-5	133.6	36.74	ug/kg	17-109	50	17-109	50	50			
Phenol	108-95-2	167	25.217	ug/kg	26-90	50	26-90	50	50			
2-Methylphenol	95-48-7	167	25.885	ug/kg	30-130	50	30-130	50	50			
3-Methylphenol/4-Methylphenol	106-44-5	240.48	26.1522	ug/kg	30-130	50	30-130	50	50			
2,4,5-Trichlorophenol	95-95-4	167	31.9972	ug/kg	30-130	50	30-130	50	50			
Carbazole	86-74-8	167	16.2324	ug/kg	54-128	50	54-128	50	50			
2-Fluorophenol	*367-12-4*									*25-120*		
Phenol-d6	*13127-88-3*									*10-120*		
Nitrobenzene-d5	*4165-60-0*									*23-120*		
2-Fluorobiphenyl	*321-60-8*									*30-120*		
2,4,6-Tribromophenol	*118-79-6*									*10-136*		
4-Terphenyl-d14	*1718-51-0*									*18-120*		

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Please Note that the information provided in this table is subject to change at anytime at the discretion of Pace Analytical Services.

ROUX

TABLE 4
FIELD AND LABORATORY QUALITY CONTROL SAMPLE ANALYSIS FREQUENCY

QUALITY ASSURANCE PROJECT PLAN

Analysis Type	Equipment/ Rinsate Blank	Field Duplicates	Initial Calibration	Ongoing Calibration	Laboratory Control Sample	Laborary Duplicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes/ Labeled Compounds
TCL VOCs	1 per day	1 per 20 samples	See Table 4 Supplement	See Table 4 Supplement	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every field sample and QC samples
TCL SVOCs	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every field sample and QC samples
TAL Metals	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA
Mercury	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA
Cyanide	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA
PCBs	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA
TOC	1 per day	1 per 20 samples			1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	N/A	NA

TABLE 4 (SUPPLEMENT)
INSTRUMENT CALIBRATION

QUALITY ASSURANCE PROJECT PLAN

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for Corrective Action	SOP Reference (Pace)
VOA (GC/MS) for 8260D	4-Bromofluoro benzene (BFB) tune	Water: 5-1,000 ng Solid: 5-1,500 ng	Prior to each ICAL; At the beginning of analytical sequence; Every 12hrs	Perform in full SCAN mode; See SOP for BFB acceptance criteria	Perform instrument/injection port maintenance as necessary; Retune instrument	Analyst	224558
	Initial Calibration (ICAL)		Initial instrument setup; After non-routine instrument service; CCV/ICV criteria are not met	Minimum of 5 standards; Low standard must be ≤ RL; %RSD ≤ 20 except for 10% of compounds may be > 20% but ≤ 30% RSD; r ≥ 0.99 (linear regression); r2 ≥ 0.99 (non-linear regression)	Review integrations and calculations; Perform and document remedial action as required; Repeat calibration		
	Initial Calibration Verification (ICV)		Immediatelyafter each ICAL	%D ≤ 30; exclusions apply – see SOP; Prepared using standard source different than used for initial calibration	Re-analyze ICV if analytical error is suspected; Recalibrate as needed		
	Continuing Calibration Verification (CCV)		At the beginning of every analytical sequence; Every 12 hours	%D ≤ 20 except for 20% of compounds may be > 20 but ≤ 30%D; Area counts of internal standards must be within 50–200% of the mid-level initial calibration standard	Review integrations and calculations; Re-analyze samples as needed		
VOA (GC/MS) 624.1	4-Bromofluoro benzene (BFB) tune	1 - 200 ug/L Acrolein, Acrylonitrile, Vinyl Acetate, m,p-Xylene : 2 - 400 ug/L Acetone, 2-Butanone, 4-Methyl-2-pentanone, 2-Hexanone: 2.5 - 500 ug/L Tert-Butyl Alcohol: 5 - 1000 ug/L 1,4 Dioxane: 100-2000 ug/L	Prior to each ICAL; At the beginning of analytical sequence; Every 14hrs and/or 12hrs after the Method Blank	Perform in full SCAN mode; See SOP for BFB acceptance criteria	Perform instrument/injection port maintenance as necessary; Retune instrument	Analyst	25693
	Initial Calibration (ICAL)		Initial instrument setup; After non-routine instrument service; LCS/ICV criteria are not met	Minimum of 5 standards; Low standard must be ≤ RL; %RSD ≤ 35; linear or quadratic regression $R^2 \geq 0.920$	Review integrations and calculations; Remake standards and repeat calibration Perform maintenance		
	Initial Calibration Verification (ICV)		Immediately after each ICAL	% recovery must be within method requirements for each analyte, see Table 5 of SOP (Range for LCS); Prepared using standard source different than used for initial calibration	Re-analyze ICV if analytical error is suspected; Recalibrate as needed		
	Continuing Calibration Verification (CCV)		At the beginning of every analytical sequence; Every 12 hours	% recovery must be within method requirements for each analyte, see Table 5 of SOP (Range for LCS); Prepared using standard source different than used for initial calibration. Area counts of internal standards must be within 50–200% of the mid-level initial calibration standard.	Review integrations and calculations; Re-analyze samples as needed. Re-analyze LCS if one or more compound fail the acceptance criteria		
SVOC (GC/MS) and (GC/MS-SIM)	Decafluorotriphenyl phosphine (DFTPP) tune	Water / Soil (Full Scan): 1-200 ug/mL Water / Soil (SIM): 0.05-20 ug/mL	Prior to each ICAL; At the beginning of analytical sequence; Every 12 hours	Criteria listed in Table 3 of SW-846 8270E. Perform in full SCAN mode. DDT breakdown must be ≤20%. Pentachlorophenol and benzidine peak tailing factor must be ≤2.	Perform instrument/injection port maintenance as necessary. Retune instrument	Analyst	434081 (Full Scan) 32637 (SIM)
	Initial Calibration (ICAL)		Initial instrument setup; After non-routine instrument service; CCV/ICV criteria are not met	Minimum of 5 standards, 6 if non-linear regression is used; Low standard must be ≤ RL; %RSD ≤ 20% or r ≥ 0.995 (linear regression) or r 2 ≥ 0.99 (non-linear regression); If %RSD ≤20, linear/non-linear must be used. Minimum RF's as per Table 4 of SW-846 8270E. If linear or non-linear regression used, verify the LOQ by recalculating lowest calibration standard using curve. (50-150%R)	Recalibrate if >10% of target analytes exceed %RSD, r, or r2 criteria. If ≤10% of compounds exceed criteria, recalibration is not required as long as %RSD 0.98, or r2 >0.98. If recalculated concentrations are outside of 50-150%R, report RL as estimated value or raise the RL to next highest calibration standard.		
	Initial Calibration Verification (ICV)		Immediately after each ICAL	70-130%, 40-160%R for difficult analytes. Prepared using standard source different than used for initial calibration	Locate source of problem. Recalibrate if >10% of all analytes are outside of criteria.		
	Continuing Calibration Verification (CCV)		At the beginning of every analytical sequence; Every 12 hours	%D ≤ 20 except difficult compounds may exhibit %D < 60%; Minimum RF per Table 4 in SW-846 8270E. Area counts of internal standards must be within 50-200% of the mid-level initial calibration standard	Recalibrate if >20% of all target analytes or >15% of analytes from a particular class (base-neutral or acid) exceed %D criteria. If IS is outside of criteria, locate the source of problem and re-analyze the CCV. If ≤20% of compounds exceed criteria, recalibration is not required if %D<40 (or <60 for difficult analytes)		

TABLE 4 (SUPPLEMENT)
INSTRUMENT CALIBRATION

QUALITY ASSURANCE PROJECT PLAN

Instrument	Calibration Procedure	Calibration Range	Frequency	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for Corrective Action	SOP Reference (Pace)
PCB, Pesticides, Herbicides (GC/ECD)	Initial Calibration (ICAL)	Method specific PCBs: 0.1-10 ug/mL Pesticides: 0.0005-0.2 ug/mL Herbicides: 0.05–2.0 ug/mL	Initial instrument setup; After non-routine instrument service; CCV/ICV criteria are not met	Minimum of 5 standards; Low standard must be ≤ RL; %RSD ≤ 20 or r ≥ 0.99 (linear regression), If linear regression is used, recalculated concentration of the lowest and mid calibration point is within 30% of the true value	Review integrations and calculations; Perform and document remedial action as required; Repeat calibration	Analyst	224528 (Pest 8081) 224531 (Pest 608) 224529 (PCB 8082) 224530 (PCB 608) 224526 (Herb)
	Initial Calibration Verification (ICV)		Immediately after each ICAL	PCBs, Pesticides and Herbicides %D ≤ 20; Prepared using standard source different than used for initial calibration	Re-analyze ICV if analytical error is suspected; Recalibrate as needed		
	Continuing Calibration Verification (CCV)		At the beginning and end of every analytical sequence; Every 12 hours	PCBs and Pesticides %D ≤ 20; Herbicides %D ≤ 15; Area counts of internal standards must be within 50–150% of the mid-level initial calibration standard. The retention times of the internal standards must be within +0.05 RRT of the previous daily standard.	Review integrations and calculations; Evaluate samples bracketed by failing CCV for obvious matrix interference; Re-analyze samples as needed		
Petro (GC/FID)	Initial Calibration (ICAL)	Individual Alkanes: 3-500 ug/mL Range: 42-7000 ug/mL	Initial instrument setup; After non-routine instrument service; CCV/ICV criteria are not met	Minimum of 5 standards; Low standard must be ≤ RL; %RSD ≤ 20% or r ≥ 0.99 (linear regression)	Review integrations and calculations; Perform and document remedial action as required; Repeat calibration	Analyst	224535
	Initial Calibration Verification (ICV)		Immediately after each ICAL	%D ≤ 30%; Prepared using standard source different than used for initial calibration	Re-analyze ICV if analytical error is suspected; Recalibrate as needed		
	Continuing Calibration Verification (CCV)		At the beginning and end of every analytical sequence; Every 12 hours	%D ≤ 20%	Review integrations and calculations; Evaluate samples bracketed by failing CCV for obvious matrix interference; Re-analyze samples as needed		
ICP-MS	Daily performance check, initial and continuing calibration per SOP	Linear Dynamic Range: Per analyte and confirmed with linear check standard	Performance check daily, ICAL daily , CCV every 10 samples	Per SOP	Inspect system, correct problem, rerun calibration and affected samples	Analyst	ENV-SOP-MANS-0041 V04
CVAF/CVAA (Mercury)	Initial and continuing calibration per SOP	Per SOP	ICAL daily; CCV every 10 samples	Per SOP	Inspect system, correct problem, rerun calibration and affected samples		ENV-SOP-MANS-0033 V04/ENV-SOP-MANS-0033 V04/ENV-SOP-MANS-0044 V10/ENV-SOP-MANS-0045 V09
Hydride (As and Se)	Initial and continuing calibration per SOP	Per SOP	ICAL daily ; CCV every 10 samples	Per SOP	Inspect system, correct problem, rerun calibration and affected samples		ENV-SOP-MANS-0040 V06
CVAF (Low-Level Mercury)	Initial and continuing calibration per SOP	Per SOP	ICAL daily ; CCV every 10 samples	Per SOP	Inspect system, correct problem, return calibration and affected samples		ENV-SOP-MANS-0042 V06

Definitions:
ng = nanogram
ug/kg = microgram per kilogram
ug/mL = microgram per milliliter
%RSD = percent relative standard deviation
GC/MS = Gas Chromatography/Mass Spectrometry

TABLE 4 (SUPPLEMENT)
ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION

QUALITY ASSURANCE PROJECT PLAN

(UFP-QAPP Manual Section 3.2.3) (EPA 2106-G-05 Section 2.3.6)	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	Reference
GC/MS	Inlet Maintenance: Septa, Injection port liner, clip column	Passing Tune/CCAL; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery	See SOP	See SOP	Analyst or Section Supervisor	See specific analysis SOP
	Column	Passing Tune/ICAL/ ICV; overall chromatogram	Instrument performance and sensitivity					
	Source cleaning : Filaments, insulators	Tuning	Instrument performance and sensitivity					
	Pump	Complete MS pump down.	Air and water check	Frequency is dependent on vacuum within instrument				
GC/ECD/FID	Inlet Maintenance: Septa, Injection port liner, clip column	Passing CCAL; overall chromatogram	Instrument performance and sensitivity	Frequency is dependent on degree of contamination and standard recovery				
	Column	Passing CCAL; overall chromatogram	Instrument performance and sensitivity					

Definitions:
CCAL = continuing calibration
ICAL = initial calibration
ICV = initial calibration verification
SOP = standard operating procedure

ROUX

TABLE 5
SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS

QUALITY ASSURANCE PROJECT PLAN

Matrix	Parameter	Container Type[1]	Minimum Volume	Holding Time from Sample Date[2]	Sample Preservation Technique
Sediment	TCL VOCs	Large Septa Vial (unpreserved)	4 oz	14 days	4° ± 2°C (no headspace)
	TCL SVOCs	Glass (unpreserved)	250 mL / 8 oz	14 days	4° ± 2°C
	TAL Metals	Metals Only Glass (unpreserved)	60 mL / 2 oz	180 days	4° ± 2°C
	Mercury	Metals Only Glass (unpreserved)	60 mL / 2 oz	28 days	4° ± 2°C
	Cyanide	Glass (unpreserved)	250 mL / 8 oz	14 days	4° ± 2°C
	PCBs	Glass (unpreserved)	250 mL / 8 oz	365 days	4° ± 2°C
	TOC (sediment)	TOC Only Glass (unpreserved)	60 mL / 2 oz	28 days	4° ± 2°C

Notes:

1. Sample containers required by Pace Analytical
2. Freezing (-20°±5°C) samples extends hold time to 365 days for all parameters except VOC samples; hold time remains at 14 days.

Acronyms:

mL - milliliters

oz = ounce

FIGURES

1. Project Organizational Chart

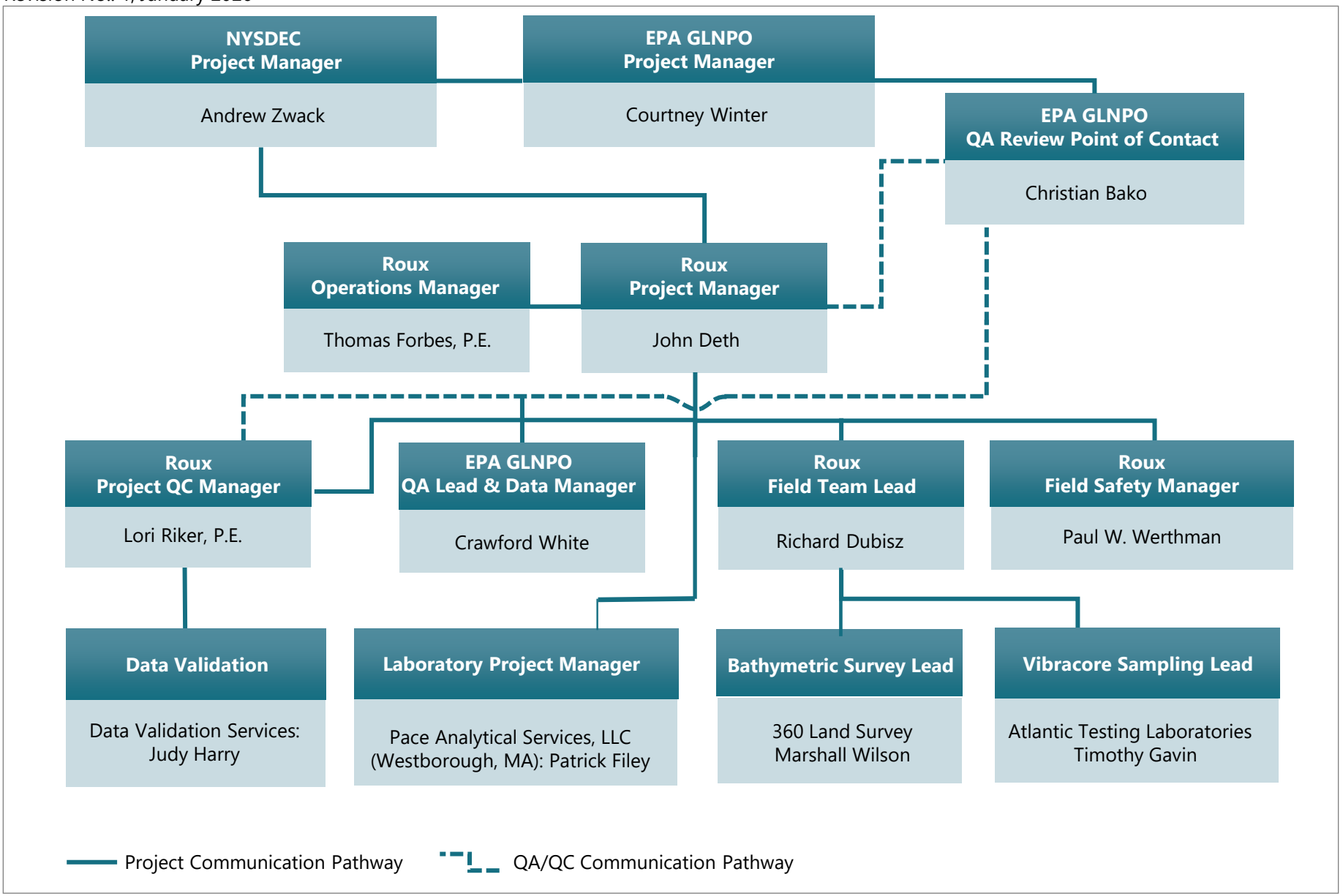


Figure 1
Project Organizational Chart
QAPP: Smokes Creek PDI Work Plan

ATTACHMENTS

A. Laboratory Standard Operating Procedures

B. Field Audit Checklist

ATTACHMENT A

Laboratory Standard Operating Procedures

ENV-SOP-WES2-0098 v01 Total and Amenable Cyanide

Reference: **Method 9010C / 9012B,** SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Revision 2 and Revision 3 2004

SM 4500CN-CEG. Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. 2021.

Method 10-204-00-1-A, Lachat Instruments, 6645 West Mill Road, Milwaukee, WI 53218, 1994.

Method 9014 (Modified). SW-846, Test Methods for Evaluating Solid Waste: Physical / Chemical Methods, EPA SW-846, Update III, 1997

1. Scope and Application

Matrices: This method is applicable to water, liquids, solids, soils and sludges

Definitions: Refer to Alpha Analytical Quality Manual.

The following SOP is a reflux-distillation procedure used to extract soluble cyanide salts and many insoluble cyanide complexes from wastes and leachates. It is based on the decomposition of nearly all cyanides by a reflux distillation procedure using a strong acid and a magnesium catalyst. Cyanide, in the form of hydrocyanic acid (HCN) is purged from the sample and captured into an alkaline scrubber solution. The concentration of cyanide in the scrubber solution is then determined by flow injection analysis on a Lachat Analyzer.

This method was designed to address the problem of “trace” analyses (<1000ppm). The method may also be used for “minor” (1000ppm – 10,000ppm) and “major” (>10,000ppm) analyses by adapting the appropriate sample dilution. However, the amount of sodium hydroxide in the standards and the sample analyzed must be the same.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Area Supervisor, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the Lachat and in the interpretation of Lachat data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

Cyanide, as hydrocyanic acid (HCN), is released from samples containing cyanide by means of a reflux-distillation operation under acidic conditions and absorbed in a scrubber containing sodium hydroxide solution. The cyanide concentration in the absorbing solution is then determined colorimetrically by Lachat flow injection analysis.

2.1 Method Modifications from Reference

The sample size used is 50mL. The Midi distillation unit has demonstrated the ability to achieve the same RDL using 50mL instead of 500mL sample volume. Refer to EPA Method 335.4.

Modification for Method 9014: An automated determination of cyanide using the Lachat instrument is used instead of manual spectrophotometric determination.

Modification for amenable cyanide: Analysis is not prepped under amber light.

3. Reporting Limits

The Reported Limit for aqueous samples is 0.005mg/L; soil and solid samples is 1mg/Kg

4. Interferences

4.1 Interferences are eliminated or reduced by using the distillation procedure. However, chlorine and sulfide are interferences. Refer to Section 10.1.1.

4.2 High results may be obtained for samples that contain nitrate and/or nitrite. During the distillation, nitrate and nitrite will form nitrous acid, which will react with some organic compounds to form oximes. These compounds once formed will decompose under test conditions to generate HCN. The possibility of interference of nitrate and nitrite is eliminated by pretreatment with sulfamic acid just before distillation. Nitrate and nitrite are interferences when present at levels higher than 10mg/L and in conjunction with certain organic compounds.

4.3 Thiocyanate is reported to be an interference when present at very high levels. Levels of 10mg/L were not found to interfere.

4.4 Fatty acids, detergents, surfactants, and other compounds may cause foaming during the distillation when they are present in high concentrations. Add anti-foaming agent to the sample during the distillation procedure (Section 10.3.1).

4.5 Carbonates and aldehydes are possible interferences.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Additional references for laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

The following chemicals have the potential to be highly toxic or hazardous. For detailed explanations consult the MSDS:

- Cyanide
- Sulfuric acid
- Pyridine
- Chloramine-T

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

Samples are collected in plastic or glass containers. All containers must be thoroughly cleaned and rinsed.

Oxidizing agents such as chlorine decompose most cyanides. Testing for chlorine must be done in the field prior to sample preservation.

6.2 Sample Preservation

Prior to preservation, samples must be tested for chlorine (Section 6.1).

Aqueous samples are preserved with 50% sodium hydroxide in the field to a pH $\geq$ 12 at the time of collection.

Samples and distillates are stored in the refrigerator at 4 ±2 °C.

6.3 Sample Shipping

No specific requirements.

6.4 Sample Handling

When properly preserved, cyanide samples are stored for up to 14 days prior to sample preparation steps.

Distillates must be analyzed within 14 days of distillation. Samples must be analyzed within 14 days of receipt.

Note: for MCP-TCN samples must be analyzed within 24h after distillation

7. Equipment and Supplies

7.1 Cyanide Midi Distillation Unit: Lab Crest, BGL or comparable midi distillation unit. With reaction vessels, collection vessels, cold fingers and impingers.

7.2 pH paper: Range 1-14

7.3 Lead Acetate Paper

7.4 Vacuum source

7.5 50mL centrifuge tubes: New, plastic, with caps.

7.6 KI starch paper: Residual Chlorine sensitivity

7.7 Class A volumetric flasks: 25, 50, 100, 500 and 1000mL

7.8 Graduated cylinders: 50mL glass or plastic

7.9 Eppendorf pipettor or pipets: 0.5, 1, 2, and 5mL

7.10 Lachat 8500 Flow Analyzer: Including Quick Chem software, autosampler, pump and accessories.

7.11 Balance: Capable of weighing to 0.0001gram

7.12 Beakers: 100mL

7.13 Chiller

7.14 Stir plate

7.15 Stir bars

7.16 Dilution vials

8. Reagents and Standards

Reagent grade chemicals are used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficient high purity to permit its use without lessening the accuracy of the determination.

8.1 Standards and Reagents for Distillation

8.1.1 **Reagent Water:** All references to water in this method refer to Deionized Water (DI) from Alpha's water treatment system.

8.1.2 **Ascorbic Acid, $C_6H_8O_6$:** Powder. Store at room temperature. Expires upon manufacturer's specified date.

8.1.3 **Sodium hydroxide solution (1N), NaOH:** In a 1L volumetric flask, dissolve 40g of NaOH. Bring to volume with DI water. Store at room temperature. Expires one month from the date of preparation.

8.1.4 **Sulfamic acid (0.4N), H_2NSO_3H:** In a 1L volumetric flask, dissolve 40g H_2NSO_3H. Bring to volume with DI water. Store at room temperature. Expires 6 months from the date of preparation.

8.1.5 **Sulfuric acid (1:1), H_2SO_4:** To a 1L volumetric flask, add 500mL DI water. Slowly and carefully add 500mL of concentrated H_2SO_4. Store at room temperature. Expires one month from the date of preparation.

8.1.6 **Magnesium chloride solution (2.5M), $MgCl_2 \cdot 6H_2O$:** In a 1L volumetric flask, dissolve 510g of $MgCl_2 \cdot 6H_2O$. Bring to volume with DI water. Store at room temperature. Expires 6 months from the date of preparation.

8.1.7 **LCS, 1000ppm cyanide stock solution:** Commercially available standard with a certificate of analysis and from a different source than the Lachat calibration standards. Purchased from Ricca, Catalog # 2543-32. Store refrigerated at 4 ± 2 °C. Expires upon manufacturer's specified date. **Standardize weekly** as per Section 8.1.7.2.

8.1.7.1 **Rhodanine Indicator:** Dissolve 40mg (0.040g) of paradimethylaminobenzalrhodanine (ACS grade) in 200mLs acetone (ACS grade). Store in a glass bottle. Can also be purchased commercially prepared.

8.1.7.2 Weekly Standardization Verification:

- Measure 10mls of Cyanide Stock solution (8.1.7) into an Erlenmeyer flask. Add 0.25mL of Rhodanine Indicator Solution (8.1.7.1) titrate with 0.0192 N AgNO3 (8.1.21) until the color changes from a canary yellow (which turns cloudy) and to a salmon hue.
- Titrate a Blank consisting of 0.10mL of 10 N NaOH (8.1.15) in 10mL of deionized water to which has been added 0.25mL of Rhodanine Indicator Solution (8.1.7.1).
- Calculate concentration:

$$\text{mg/L CN} = \frac{(\text{mLs AgNO3 titrated-blank})\,(\text{N of AgNO3})\,(5.204)\,(10{,}000)}{(10\text{mLs})}$$

- Based on the calculated concentration, determine the volume of CN stock solution needed to make 100mls working standard at 10 mg/L concentration.

8.1.8 LCS 10ppm cyanide working solution: Pipet an appropriate amount of standardized 1000ppm cyanide stock solution (Section 8.1.7) to) into a 100mL volumetric flask. Add 10mL of 1N NaOH (Section 8.1.3). Bring to volume with DI water. Prepare each day of use.

8.1.8.1 This can also be made by taking 5mL of 10ppm (Section 8.1.8) up to 500mL with 0.1N NaOH. This would be distilled as a whole volume (50mL). Prepare daily.

8.1.9 1000ppm Stock Spiking Solution: 1000ppm cyanide standard available commercially with a certificate of analysis. This is from a different source than the LCS (8.1.7). Purchased from LabChem Inc., Catalog # LC13545. Store refrigerated at 4 ± 2 °C. Expires upon manufacturer's specified date. **Standardize weekly** as per Section 8.1.7.2.

8.1.10 10ppm Working Cyanide Spiking Solution: Pipet 1mL of the 1000ppm Stock Spiking Solution (Section 8.1.9) into a 100mL volumetric flask. Add 10mL 1N NaOH (Section 8.1.3). Bring to volume with DI water. Prepare fresh each day of use. **pH 4 Acetate Buffer solution:** In a 500mL volumetric flask, dissolve 410g of sodium acetate trihydrate. Bring to volume with DI water. Adjust to pH of 4.5 with acetic acid (Section 8.1.13). Store at room temperature. Expires 6 months from the date of preparation.

8.1.11 Lead Carbonate Powder, [Pb (CO3)]

8.1.12 LCS 0.5 ppm Cyanide Working Solution: Pipet 5mL of the 10ppm Working Cyanide Spiking Solution (Section 8.1.10) into a 100mL volumetric flask . Add 1mL of 10N NaOH (Section 8.1.15). Bring to volume with DI water. Prepare each day of use.

8.1.13 Concentrated Acetic Acid: Store at room temperature. Expires upon manufacturer's specified date.

8.1.14 Ottawa Sand or Boiling chips

8.1.15 Sodium hydroxide solution (10N), NaOH: In a 1L volumetric flask, dissolve 400g of NaOH. Bring to volume with DI water. Store at room temperature. Expires 6 months from the date of preparation.

8.1.16 Sodium hydroxide solution (0.1N), NaOH: In a 10L carboy mix 100mL of 10N NaOH. Bring to volume with DI water. Store at room temperature. Expires daily.

8.1.17 Total Cyanide SRM: ERA catalog # 541. Store in room temperature. Expires upon manufacturer's specified date.

8.1.18 Calcium Hypochlorite Solution: Dissolve 5g Ca(OCl)2 in 100mL Deionized water. Store in an amber colored bottle in the dark. Expires monthly.

8.1.19 Standard sodium chloride, 0.0141M (0.0141N): Dissolve 824.0 mg NaCl (dried at 140°C) in distilled water and dilute to 1000 mL; 1.00 mL = 500 g Cl^- .

8.1.20 Potassium chromate indicator solution: Dissolve 50 g K2CrO4 in a little distilled water. Add AgNO3 solution (8.1.21) until a definite red precipitate is formed. Let stand 12 h, filter, and dilute to 1 L with distilled water. Can also be purchased commercially prepared.

8.1.21 Silver Nitrate Solution: Prepare by crushing approximately 5g AgNO3 (ACS grade) crystals and drying to constant weight at 40℃. Then weigh 3.27 grams of dried AgNO3, dissolve in distilled water in a 1liter volumetric flask, and dilute to volume. Standardize as per 8.1.21.1. Can also be purchased commercially prepared.

8.1.21.1 Standardize the Silver Nitrate Solution: If Silver Nitrate Solution is prepared in the laboratory, standardize as indicated below:

- Fill a 25mL burette with a AgNO3 solution (8.1.21).
- Measure 10mL of the 0.0141N NaCl solution (8.1.19) to a 125mL Erlenmeyer flask. Add a few drops of Potassium Chromate Indicator solution (8.1.20).
- Titrate with AgNO3 to pinkish salmon color end point (sample becomes a cloudy salmon instead of bright salmon).

$$\text{N of AgNO3} = \frac{\text{(mLs of sample) (N of NaCl solution)}}{\text{(mLs of AgNO3 titrated)}}$$

Where:

mLs of sample = 10mL

N of NaCl = 0.0141

8.1.22 Project Specific LCS, 1000ppm Complex Cyanide stock solution: Commercially available standard with a certificate of analysis, containing potassium ferrocyanide 3-hydrate. Purchased from Environmental Resource Associates, Catalog # 049. Store refrigerated at 4 ± 2 °C. Expires upon manufacturer's specified date. **Standardize weekly** per section 8.1.22.1.

8.1.22.1 Weekly Standardization Verification:

- Measure 10mls of Complex Cyanide Stock solution (8.1.22) into an Erlenmeyer flask. Add 0.25mL of Rhodanine Indicator Solution (8.1.7.1) titrate with 0.0192 N AgNO3 (8.1.21) until the color changes from a canary yellow (which turns cloudy) and to a salmon hue.

- Titrate a Blank consisting of 0.10mL of 10 N NaOH (8.1.15) in 10mL of deionized water to which has been added 0.25mL of Rhodanine Indicator Solution (8.1.7.1).
- Calculate concentration:

$$\text{mg/L CN} = \frac{(\text{mLs AgNO3 titrated-blank})\,(\text{N of AgNO3})\,(5.204)\,(10{,}000)}{(10\text{mLs})}$$

- Based on the calculated concentration, determine the volume of CN stock solution needed to make 100mls working standard at 10 mg/L concentration.

8.1.23 **Project Specific LCS 10ppm Complex Cyanide working solution:** Pipet an appropriate amount of standardized 1000ppm Complex Cyanide stock solution (Section 8.1.22) to) into a 100mL volumetric flask. Add 10mL of 1N NaOH (Section 8.1.3). Bring to volume with DI water. Prepare each day of use.

8.1.23.1 This can also be made by taking 5mL of 10ppm (Section 8.1.23) up to 500mL with 0.1N NaOH. This would be distilled as a whole volume (50mL). Prepare daily.

8.1.24 **Project Specific 1000ppm Stock Complex Cyanide Spiking Solution:** 1000ppm Complex Cyanide standard available commercially with a certificate of analysis. This is from a different Lot than the LCS (8.1.22). Purchased from Environmental Resource Associates, Catalog # 049. Store refrigerated at 4 ± 2 °C. Expires upon manufacturer's specified date. **Standardize weekly** as per Section 8.1.22.1.

8.1.24.1 **Project Specific 10ppm Working Complex Cyanide Spiking Solution:** Pipet 1mL of the 1000ppm Stock Complex Cyanide Spiking Solution (Section 8.1.24) into a 100mL volumetric flask. Add 10mL 1N NaOH (Section 8.1.3). Bring to volume with DI water. Prepare fresh each day of use. **pH 4 Acetate Buffer solution:** In a 500mL volumetric flask, dissolve 410g of sodium acetate trihydrate. Bring to volume with DI water. Adjust to pH of 4.5 with acetic acid (Section 8.1.13). Store at room temperature. Expires 6 months from the date of preparation.

8.1.25 **Project Specific LCS 0.5 ppm Complex Cyanide Working Solution: Pipet** 5mL of the 10ppm Working Complex Cyanide Spiking Solution (Section 8.1.24.1) into a 100mL volumetric flask . Add 1mL of 10N NaOH (Section 8.1.15). Bring to volume with DI water. Prepare each day of use.

8.2 Standards and Reagents for Lachat Analysis

8.2.1 **Helium gas:** To prevent bubble formation, degas all solutions except the standards with helium. Use He at 140kPa (20 lb/in^2) through a helium degassing tube (Lachat part number 50100). Bubble He vigorously through the solution for one minute.

8.2.2 **Reagent 1. Carrier, 0.1N Sodium Hydroxide:** In a 1L plastic container add 10mL of 10N NaOH (Section 8.1.16). Bring to 1L volume with DI. Store at room temperature. Prepare fresh bi-weekly.

8.2.3 **Reagent 2. Acetate Buffer, 2.68M:** In a 1L volumetric flask, dissolve 163g spdium acetate trihydrate (acetic acid, sodium salt trihydrate, $CH_3CO_2NA{\bullet}H_2O$) in approximately 800mL of water. Add 40mL of acetic acid to the solution. Dilute to the mark and invert it to mix. Store at room temperature. Prepare fresh monthly.

8.2.4 Reagent 3. Chloramine-T: Dissolve 2.0g chloramine-T hydrate in 500mL DI. Prepare fresh daily.

8.2.5 Reagent 4. Pyridine-Barbituric Acid Reagent: Under a fume hood, place 15g barbituric acid in a 1L beaker and add 100mL water, rinsing down the sides of the beaker to wet the barbituric acid. Add 75mL pyridine (C_5H_5N) while stirring and mix until the barbituric acid dissolves. Add the 15mL concentrated hydrochloric acid (12M HCl) and mix. Store at room temperature. Prepare fresh weekly.

8.2.6 0.5ppm Calibration standard: Pipet 5mL of the 10ppm working cyanide spiking solution (Section 8.1.10) into a 100mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

8.2.7 0.2ppm Calibration standard: Pipet 2mL of the 10ppm working cyanide spiking solution (Section 8.1.10) into a 100mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

8.2.8 0.1ppm Calibration standard: Pipet 1mL of the 10ppm working cyanide spiking solution (Section 8.1.10) into a 100mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use. This calibration standard is also used as the Continuing Calibration Verification sample.

8.2.9 0.04ppm Calibration standard: Pipet 5mL of the 0.2ppm calibration standard (Section 8.2.7) into a 25mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

8.2.10 0.02ppm Calibration standard: Pipet 1mL of the 0.5ppm calibration standard (Section 8.2.6) into a 25mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

8.2.11 0.01ppm Calibration standard: Pipet 10mL of the 0.02ppm calibration standard (Section 8.2.10) and 10mL of 0.1N NaOH into a container and mix. Prepare each day of use.

8.2.12 0.004ppm Calibration standard: Pipet 5mL of 0.04ppm calibration standard (Section 8.2.9) into a 50mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

8.2.13 0.1ppm ICV standard: Pipet 1mL of the 10ppm LCS cyanide working solution (8.1.8) into a 100mL volumetric flask. Bring to volume with 0.1N NaOH. Prepare each day of use.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 Blank

A minimum of one method blank is distilled and analyzed per batch of 20 or less samples. The Method Blank is utilized to determine if contamination or any memory effects are occurring. (Section 10.3.1.1)

Evaluate Method Blanks for contamination that may be introduced into the analytical or preparation process.

Positive sample results are suspect if the analytes in the reagent blank are > ½ MRL (or reporting limit). Samples analyzed with a contaminated Method Blank must be reprepared and

re-analyzed unless concentrations are ≥10 times the concentration found in the method blank or the samples are nondetect (ND).

Samples must be qualified with a "B" flag if the Method Blank is > ½ MRL.

All samples analyzed since the last acceptable blank analysis must be reanalyzed.

9.2 Laboratory Control Sample (LCS)

Distill and analyze two LCSs per batch of 20 samples. A Low LCS is analyzed at 0.1mg/L and a high LCS is analyzed at 0.2mg/L. (Section 10.3.1.2)

LCS measurements for Method SM 4500 CN-CE must be within ±10%. For Method 9010C/9012B, the LCS measurements must be within ± 15% for liquids and +/- 20% for soils.

Samples for Method 9010C/9012B: LCSDs are distilled and analyzed along with the LCSs, as described above. The RPD between LCS and LCSD must be ≤ 20% for liquids and <35% for soils.

For soil samples: LCS and LCSD recovery must be within vendor specified acceptance criteria (it will be different for different lots of SRM)

If any LCS fails acceptance criteria for either % Recovery or RPD, analysis is terminated, and samples are redigested and analyzed

9.3 Initial Calibration Verification (ICV)

The Initial Calibration Verification Standard (ICV) (Section 8.2.13) is analyzed immediately following the calibration to verify the curve. If the measurements exceed ±10% of 0.1ppm, the analysis is terminated and recalibration must occur. An acceptable result for the ICV must be obtained prior to any sample analysis.

9.4 Continuing Calibration Verification (CCV)

The Continuing Calibration Verification Standard (CCV) (Section 8.2.8) is analyzed after every 10 injections. The CCV measurements cannot exceed ±10% of the 0.1ppm. If the CCV is not within acceptance criteria, the standard is injected again. If failure continues, sample analysis is terminated, and the source of the problem is found and corrected. All samples analyzed since the last acceptable calibration verification must be reanalyzed.

9.5 Matrix Spike

Distill and analyze one spike per batch of 20 samples. For Method 9010C/9012B distill and analyze one spike per batch of 10 samples.

For Method 9010C/9012B, the % Recovery must be within ±20% for liquids and ±35% for solids. For SM 4500CN-CE, the % Recovery must be within ±10%. (Section 10.3.1.4).

Samples for Method 9010C/9012B: A Matrix Spike Duplicate (MSD) is distilled and analyzed along with the MS, as described above. The RPD between MS and MCSD must be ≤ 20% for liquids and <35% for soils

9.6 Laboratory Duplicate

Analyze one duplicate sample for every 20 samples. A duplicate sample is a sample brought through the entire sample preparation and analytical process. (Section 10.3.1.5)

The RPD must be 20% or less for liquids and 35% or less for soil and solids. See Section 12 for Corrective Action if these criteria are not met.

9.7 Method-specific Quality Control Samples

9.7.1 Minimum *Reporting Limit (MRL) Check*

With each analytical batch, analyze a reagent-water sample spiked at the MRL. Analyze the MRL check after the Initial Calibration Verification and Initial Calibration Blank. The MRL check must recover between 50-150% of the expected value. If the MRL is outside of criteria, reanalyze once. If the MRL is outside of criteria a second time, recalibrate and re-analyze all associated samples. If the MRL is biased high, nondetect (ND) samples can be reported.

9.8 Method Sequence

The analytical sequence is:

- Screening samples for chlorine and sulfide
- Prep of amenable cyanide, if needed
- Distillation:
  - Samples
  - LCS Low
  - LCS High
  - Blank
  - Matrix Spike
  - Duplicate
- Analysis:
  - Calibration and Standardization of Lachat Instrument
  - CCV
  - CCB
  - ICV
  - ICB
  - 10 samples
  - CCV
  - CCB
  - 10 samples
  - CCV
  - CCB
  - Calculation of sample cyanide concentration

10. Procedure

10.1 Equipment Set-up

10.1.1 Screening for Chlorine and Sulfide Interference

10.1.1.1 Chlorine Interference

Oxidizing agents, such as chlorine, decompose most cyanides. Test by placing a drop of sample on a strip of potassium iodide (KI) - starch paper previously moistened with acetate buffer solution, pH 4. If positive indication is noted, then

treat an aliquot of sample with Ascorbic Acid (Section 8.1.2). Repeat this test until the KI paper is negative. Immediately inform the Department Supervisor of this interference.

Manganese dioxide, nitrosyl chloride, etc., if present also may cause discoloration of the test paper

10.1.1.2 Sulfide Interference

Oxidized products of sulfide convert CN- to SCN- rapidly, especially at high ph. Test for S^{-2} by placing a drop of sample on lead acetate test paper previously moistened with acetic acid buffer solution, pH 4 (Section 8.1.11). Darkening of the paper indicates the presence of S^{-2}. Add powdered lead carbonate [Pb (CO3)] in 1g increments to the whole sample volume. Re-test with acetate paper. Repeat test until a drop of treated sample no longer darkens the acidified lead acetate test paper. Record in the sample prep logbook the amount of lead carbonate added to the sample

10.1.2 Amenable Cyanide Prep

10.1.2.1 Add 25mL, or 1g and 25mL of DI (8.1.1), to a 100mL beaker with a stir bar.

10.1.2.2 Add 1mL of 10ppm LCS cyanide working solution (8.1.8) to the beaker.

10.1.2.3 Prep one sample in duplicate.

10.1.2.4 Add 1-2mL of calcium hypochlorite solution (8.1.18) to all samples and QC under the hood.

10.1.2.5 Check for the presence of chlorine by placing a drop of the sample on a KI-starch paper (7.6). It should turn blue if there is sufficient chlorine.

10.1.2.6 Check samples every 15 minutes for one hour for the presence of chlorine and add more calcium hypochlorite if needed.

10.1.2.7 After one hour of digesting, add ascorbic acid (8.1.2) until KI strip no longer turns blue.

10.1.2.8 Bring sample volume up to 50mL and distill following steps 10.3.1.6 through 10.3.1.15.

10.2 Initial Calibration

10.2.1 Allow 15 minutes for heating unit to warm up to 60 °C.

10.2.2 Prepare a series of 7 calibration standards (Sections 8.2.6 – 8.2.12) and a 0.1N NaOH blank. Alternatively, calibration standards may be prepared by auto-diluting a 0.5ppm calibration standard (Section 8.2.6). Perform this function per the Lachat manufacturer's instructions for the Quick Chem 8500.

10.2.3 Set up manifold as shown in Table 1.

10.2.4 Input data system parameters as shown in Table 2.

10.2.5 Place standards and blank in the autosampler, according to the manufacturer's instructions. Input the information required by the data system, such as concentration, replicates and QC scheme.

10.2.6 Inject the standards, according to the manufacturer's instructions.

10.2.7 Prepare a standard curve by plotting instrument response against standard concentration values. A calibration curve is fitted to the calibration solution concentration/response

data using the computer. The calibration coefficient of the curve must be greater than or equal to 0.995 before sample analysis can begin.

Calibration coefficient will be calculated using Lachat software. All calibration points are back calculated by Lachat software and should be within 10% of true concentration, except for the 2 lowest points of calibration curve. %recoveries for low range will be wider but shouldn't exceed 50% at concentrations up to twice the method reporting limit, between 20% between 3 and 5 times the method reporting limit and within 10% at concentrations greater than 5 times the method reporting limit and correlation coefficient will not be worse than 0.995.

10.3 Equipment Operation and Sample Processing

10.3.1 Distillation

10.3.1.1 Add 50mL of shaken liquid sample, or 1gram of a well-homogenized solid sample and 50mL of DI, to the 50mL reaction vessel.

10.3.1.2 For the Liquid High LCS, fill one 50mL reaction vessel with 50mL DI. For the soil High LCS, add 1g Ottawa Sand (Section 8.1.15) and 50mL of DI. After the system has been charged with air, add 1mL of 10ppm LCS cyanide working solution (8.1.8) or 1mL 10ppm LCS Complex Cyanide Working Solution (8.1.23), as appropriate, to the closed system. (Final concentration equals 0.2mg/L.)

For the Liquid Low LCS, fill one 50mL reaction vessel with 50mL of DI. For a soil Low LCS, add 0.2-0.3 g (depending on actual SRM stock concentration) of SRM (sec 8.1.17) and 50mL of DI. Record exact SRM weight. For liquid samples: After the system has been charged with air, add 0.5mL of 10ppm LCS cyanide working solution (Section 8.1.8), or 1mL 10ppm LCS Complex Cyanide Working Solution (8.1.23), as appropriate, to the closed system. (Final concentration equals 0.1mg/L.) **Don't add liquid Cyanide Standard for soil samples!** Final LCS soil concentration will change based on SRM lot
Samples for Method 9010C/9012B: Prepare an LCS Duplicate along with the LCSs described above.

10.3.1.3 For the method blank for liquid samples, fill one 50mL reaction vessel with 50mL of DI. For the method blank for soil samples, fill a 50mL reaction vessel with 1g of Ottawa Sand (Section 8.1.15) and 50mL DI.

10.3.1.4 For the matrix spike, fill a 50mL reaction vessel with 50mL of sample that has been chosen to be spiked. For soil samples, use 1g of soil and add 50mL of DI water. After the system has been charged with air, add 1mL of 10ppm working cyanide spiking solution (8.1.10) or 10ppm working Complex Cyanide spiking solution (8.1.23) to the closed system.

Samples for Method 9010C/9012B: Prepare a Matrix Spike Duplicate (MSD) in the same manner as the MS, as described above.

10.3.1.5 For the duplicate, fill a 50mL reaction vessel with a duplicate aliquot of 50mL, or 1g soil and 50mL DI water of a sample that has been chosen to be duplicated.

10.3.1.6 Into the receiver or scrubber tube add 5mL of a 1N NaOH solution and add 40mL of DI water.

10.3.1.7 Arrange tubes in the distillation unit noting in the logbook which sample is in which glassware. The glassware is numbered and consistently placed in the same position in the distillation unit.

10.3.1.8 Assemble the unit completely. Turn on the pump. There must be gas bubbling in each tube. Check to make sure all connections are tight, and bubbles are flowing at an equal rate in each sample tube. If not, adjust the flow rate with the knobs in front of each receiver tube and/or check lines to ensure they are not obstructed.

10.3.1.9 Add 5mL of 0.4N sulfamic acid (8.1.4) to each sample tube and rinse the closed 50mL reaction vessel with a squirt of DI. No residue is to be left of the vessel wall.

10.3.1.10 Add 5mL of 1:1 H_2SO_4 (8.1.5) to each sample tube and rinse the closed 50mL reaction vessel with a squirt of DI. No residue is to be left on the vessel wall. Turn on the heat. Samples are to come to a boil on all the midi-still units.

10.3.1.11 After 2 minutes of heating, add 2mL of 2.5M $MgCl_2$ Solution (8.1.6) to each sample tube, followed by a rinse with DI. If foaming occurs, an additional 2mL of $MgCl_2$ Solution may be added. If foaming continues, stop the distillation for that sample and reduce the sample size by 2 – 5x (as determined by the severity of the foaming). Contact the Inorganics Supervisor for guidance.

10.3.1.12 Turn on the chiller.

10.3.1.13 Set the timer-dial on the distillation unit to “110”.

10.3.1.14 After 110 minutes the unit will shut off; leave the chiller running for an additional 30 minutes while the tubes cool down.

10.3.1.15 Pour contents of the scrubber tube into a new, labeled, centrifuge tube (Section 7.5). Carefully rinse the scrubber tube with DI water and add rinseate to the centrifuge tube to bring to 50mL volume. Cap and refrigerate for later analysis by the Lachat Instrument.

10.3.2 Lachat Analysis

10.3.2.1 Following initial calibration and standardization, (Section 10.2 and 10.4), place the samples in the autosampler, according to the manufacturer’s instructions. Input the information required by the data system, such as concentration, replicates and QC scheme.

10.3.2.2 Inject the samples, according to the manufacturer’s instructions.

10.3.2.3 The data system calculates sample concentration using the regression equation. Results are mg/L for Aqueous samples and mg/Kg for soil and solid samples.

10.3.2.4 If sample concentrations are greater than the highest calibration standard, the distilled sample is diluted with 0.1N sodium hydroxide (NaOH) diluent (Section 8.2.2), and reanalyzed. When the automated diluter is used, 0.1N NaOH is also used. **Do not dilute distilled samples or standards with DI water.**

10.4 Continuing Calibration

10.4.1 After the calibration has been established, it must be verified by the analysis of an Initial Calibration Verification Standard (ICV) (Section 8.2.13). The ICV of 0.1ppm must be made from a different source than the calibration standards. If the measurements exceed ±10% of 0.1ppm, the analysis is terminated. See Section 9.3 for Corrective Actions.

10.4.2 A Blank and a Continuing Calibration Verification (CCV) sample (Section 8.2.8) are analyzed after every 10 injections. The CCV measurements cannot exceed ±10% of the CCV value of 0.1ppm and the blank result must be less than the reporting limit of 0.005

mg/L. See Section 9.4 for CCV Corrective Actions and Section 9.1 for Blank corrective actions.

10.5 Preventive Maintenance

Preventative maintenance is recorded in the instrument maintenance logbook and is performed on the Lachat instrument as follows:

Daily:

1) Clean the autosampler
2) Clean the surfaces on the auto-dilutor
3) Prime the dilutor with fresh DI water
4) Clean the pump surfaces
5) Clean the detector with DI and dry with Kim-Wipes
6) Clean the instrument surfaces with DI, wipe clean with a paper towel

Bi-weekly:

1) Clean the injection ports with DI. Take apart the injection valve and inspect it for corrosion. Make sure that the valve connectors are tight, and the O-rings are not worn. If the O-rings look worn replace with new ones.

Monthly:

1) Using DI water, clean the unions and the tees that are associated with the manifold.
2) Delete Temporary files on the computer

Every 6 months:

1) Replace the O-rings in the injection valve.
2) Replace the O-rings in the manifold
3) Back up the files on the computer

11. Data Evaluation, Calculations and Reporting

11.1 The Lachat data system calculates sample concentration using the regression equation.

11.2 Report only those values that fall between the lowest and the highest calibration standards.

11.3 Report results in mg CN/L for liquids and in mg CN/kg for soils.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

Holding time exceedance and improper preservation are noted on the nonconformance report form. The analyst narrates the nonconformance when the project is turned in for review. The narration must state what the nonconformance was and any corrective action taken.

Perform routine preventative maintenance according to Section 10.5. Record all maintenance in the instrument logbook. Notify the Department Manager if the instrument problems are not routine in nature. The Department Manager determines whether the problem can be corrected with in-house technical staff or if the instrument vendor should be contacted to schedule service. All service calls are documented in the Instrument logbook, and a copy of the service report is given to the Department Manager.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. If any part of batch quality control does not meet acceptance criteria, the

Department Manager is notified. If enough sample remains and holding time has not expired, then the batch is redistilled and reanalyzed. If there is not sufficient sample remaining to allow redistillation, then that analysis is repeated, and both sets of data are reported with the nonconformance narrated on the final report.

If either the ICV, ICB, Method Blank, LCS, LCSD, CCV, or CCB recovery falls outside the designated acceptance range, the laboratory performance is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form.

Immediate corrective action for a failing CCV/CCB includes reanalyzing the failing standard. If the standard passes the second time, then the analysis may be continued. The raw data is noted. If the standard fails again, the problem must be found and corrected. The CCV/CCB standard is remade and reanalyzed. If the standard passes, all samples analyzed since the previous passing standard are reanalyzed. The raw data is noted and all data associated with the failing standard must have one line drawn through the data, indicating it's unable.

If the standard fails after instrument maintenance, the instrument is recalibrated. A new ICV/ICB is performed, and all samples analyzed since the previous passing CCV/CCB are reanalyzed.

If following reanalysis of the LCS, it is found to still be outside acceptance criteria, the entire sample batch must be redistilled and reanalyzed. If the %RPD between the LCS/LCSD fails after reinjection, then the entire sample batch must be redistilled and reanalyzed.

If the Method Blank fails it is re-poured and reinjected. If failure continues, the associated sample data is evaluated as follows: Sample results below the detection limit may be reported with a narrative included. If samples have positive results, and the results are greater than 10x the concentration found in the method blank, the data may be reported with a narrative included. Any positive samples with results less than 10x the concentration found in the method blank must be redistilled and reanalyzed.

If the Matrix Spike recovery does not meet acceptance criteria, and the LCS recovery is acceptable, matrix interference may be assumed. The associated data may be reported with a narrative included.

If sample Duplicates are outside of the acceptance criteria, the analyst examines the sample for homogeneity. If the sample is not homogenous, this is narrated on the final report. Clean, homogenous samples are redistilled and reanalyzed within holding time.

Sample nonconformance regarding a Matrix Spike recovery or a duplicate %RSD is narrated on the final report along with the corrective action(s) taken.

13. Method Performance

13.1 Detection Limit Study (DL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the DL, LOD, and/or LOQ as outlined in Alpha SOP ID 1732. These studies performed by the laboratory are maintained on file for review.

The quarterly method reporting limit (MRL) verification requirement is satisfied by the quarterly LOQ analysis, as per SOP/1732.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP ID 1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Hazardous Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

2121 Chemical Hygiene Plan

1732 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ) SOP

1739 Demonstration of Capability (DOC) Generation SOP

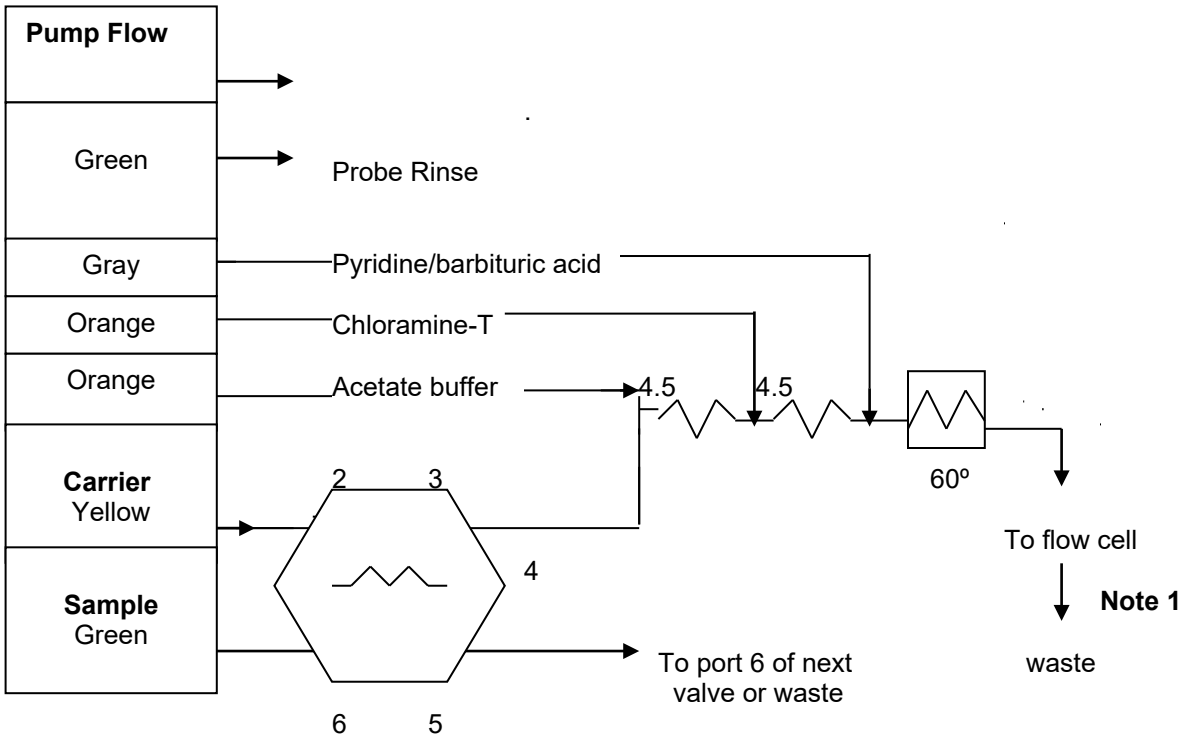
1728 Hazardous Waste Management and Disposal SOP

16. Attachments

TABLE 1: Cyanide Manifold Diagram

TABLE 2: Data System Parameters for QC 8500

TABLE 1
Cyanide Manifold Diagram



Sample Loop = 150cm x 0.8mm i.d. Interference Filter = 570nm
QC8000 Sample loop = 150cm x 0.8mm i.d.

CARRIER is a 0.1 N sodium hydroxide solution.

All manifold tubing is 0.8mm (0.030 in) i.d. This is 5.2µL/cm.

4.5 is 70.0cm of tubing on a 4.5cm coil support

APPARATUS: An injection valve, flow cell, a 10mm path length flow cell, and a colorimetric detector module are required.

The box shows 650cm of tubing wrapped around the heater block at the specified temperature.

Note 1: 2 meter back pressure loop, 0.52mm i.d.

TABLE 2
Data system Parameters for QC 8500

The timing values listed below are approximate and will need to be optimized using graphical events programming.

Sample Throughput: 65 samples/hour, 55 s/sample
Pump Speed: 35
Cycle Period: 55

Analyte Data:

Concentration Units: mg CN^-/L
Peak Base Width: 60.5 s
% Width Tolerance: 100
Threshold: none
Inject to Peak Start: 55 s
Chemistry: Direct

Calibration Data:

Levels	1	2	3	4	5	6	7	8
Concentration ug/50mL	25	10	5	2	1	0.5	0.2	0

Calibration Fit Type: 1st Order Polynomial
Calibration Rep. Handling: Replace
Weighting Method: 1/X
Concentration Scaling: None
Force Through Zero: No

Sampler Timing:

Min. Probe in Wash Period: 14 s
Probe in Sample Period: 13 s

Valve Timing:

Load Time: 0.0 s
Load Period: 9 s
Inject Period: 20 s

Pace ANALYTICAL SERVICES	**ENV-SOP-MANS-0033 V05 Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique) EPA 7471**
	Effective Date: 01/08/2026

Management Approval:
Cindy McQueen Approved on 1/8/2026 1:45:26 PM
Nathan Sorelle Approved on 1/8/2026 2:47:46 PM
Jason Hebert Approved on 1/8/2026 2:56:48 PM

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1.0 SCOPE & APPLICATION

This Standard Operating Procedure (SOP) describes the laboratory procedure used by PAS-Mansfield for the determination of Mercury by Manual Cold-Vapor technique, following SW-846 7471, February 2007. This SOP is applicable to Soils, Sediments, bottom deposits, and sludge-type materials.

1.1 Target Analyte List, Limits of Detection, & Quantitation (LOD & LOQ)

The target analyte(s) that can be determined by this SOP and the associated LOD, LOQ, and RL are provided in the table below:

Standard Analyte List - Soils

Analyte	CAS #	LOD[1] Mg/kg	LOQ[1] mg/kg	RL[1] mg/kg
Mercury	7439-97-6	0.0522	0.0833	0.08

[1] *LOD, LOQ, and RL are always adjusted to account for actual amounts used and for dilution. Values as of effective date of this SOP. LOD, LOQ, and RL are subject to change. Contact quality personnel for current information.*

LOQ are established in accordance with PAS policies and procedures for method validation, determination of detection limits (LOD), and quantitation limits (LOQ). Refer to laboratory SOP ENV-SOP-WES2-0112, method Detection Limit & Limit of Quantitation, or however named, for additional information.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detect in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detects and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

1.2 Reference Methods & Documents

This SOP is based on reference method SW-846 7471B, 2007. If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modification is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.3 Quantitation Range

This procedure has a quantitation range of 0.083 to 3.33 mg/kg.

1.4 State/Program Specific Requirements

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Massachusetts MCP and Connecticut RCP specific requirements, if they vary from the procedure in the SOP, are specified in Appendix B. These requirements supersede SW-846 7471 when samples are analyzed from that state or under the specified project program.

2.0 SUMMARY OF METHOD

Prior to analysis, the solid or semi-solid samples must be prepared according to the procedures discussed in this method.

Method 7471, a cold-vapor atomic absorption method, is based on the absorption of radiation at the 253.7-nm wavelength by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

3.0 INTERFERENCES

Potassium permanganate is added to eliminate possible interference from sulfide. Concentrations as high as 20 mg/kg of sulfide, as sodium sulfide, do not interfere with the recovery of added inorganic mercury in reagent water.

Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/kg had no effect on recovery of mercury from spiked samples.

Samples high in chlorides require additional permanganate (as much as 25 mL) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs radiation of 253 nm. Care must therefore be taken to ensure that free chlorine is absent before the mercury is reduced and swept into the cell. This may be accomplished by using an excess of hydroxylamine sulfate reagent (25 mL).

Certain volatile organic materials that absorb at this wavelength may also cause interference. A preliminary run without reagents should determine if this type of interference is present.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.

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- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME, & STORAGE

PAS does not offer sample collection services for this test method. PAS advises customers to collect samples in accordance with a sampling plan and collection procedures appropriate to meet regulatory requirements and data quality objectives for the project. The minimum sample amounts required for the test are provided in this section.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and holding time. Refer to laboratory SOP ENV-SOP-WES2-0005, Bottle Order Preparation, or however named, for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
3, 4, 5	Glass or Plastic containers, 50 mL	0.3g	Thermal: 4°C ±2°C Chemical: NA	Preparation to Analysis: 28 Days

[1] *Default container type provided in sample kit.*

[2] *Amount of sample required for each discrete test.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-WES2-0003, Sample Login & Receipt, or however named. Chemical preservation is checked and recorded at the time of receipt or prior to sample preparation unless specifically stated in the reference method.

After receipt, samples are stored at 4°C until sample preparation. Prepared samples (extracts, digestates, distillates, etc.) are stored at ambient temperatures until sample analysis.

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After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method(s).

7.1 Instrumentation

- Nippon Instrument model #RS-4300A analyzer with integrated 80 position autosampler

7.2 Support Equipment

- Hot Block Digestor: Environmental Express, 54 position, capable of maintaining a temperature of 95°C +/-3°C.

7.3 Supplies

- Graduated cylinder: Rinse once with 50% nitric acid, then rinse with reagent water prior to use.
- Volumetric flasks, class A, various volumes: Rinse once with 50% nitric acid then rinse with reagent water prior to use.
- Polypropylene digestion vessels: 50 mL volume, with plastic screw caps
- Pump tubing: Environmental Express, three stop and two stop tubing with various IDs
- PTFE membranes: Pall TF 1000 disks
- Dilution vials: 20 mL capacity, used when making analytical dilutions
- Laboratory wipes
- Compressed air
- Whatman 41 or equivalent filter paper
- Eppendorf pipettes: Accurate means to make trace standards
- PTFE Boiling Stones for matrix matching the method blank and LCS

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP ENV-SOP-MANS-0076, Reagent & Solvent Control, or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared, when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

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Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method(s).

- Reagent water: Reagent water is DI water shown to be interference free. All references to water in this method refer to reagent water unless otherwise specified.
- Concentrated nitric acid, (HNO_3): Trace grade. Store at room temperature in the appropriately marked acid cabinet
- Concentrated hydrochloric acid (HCl): Trace grade. Store at room temperature in the appropriately marked acid cabinet

8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available.

8.2.1 Primary Mercury Standard

Mercury Standard, 100 ppm: This solution is purchased commercially prepared with a certificate of analysis. Store at room temperature. Expires according to manufacturer's specifications

8.2.2 Secondary Mercury Standard

Mercury Standard, 100 ppm: This solution is purchased commercially prepared with a certificate of analysis and is from a different vendor than that used for the Primary Mercury Standard. Store at room temperature. Expires according to manufacturer's specifications

8.3 Formulations

8.3.1 Analytical Reagents

- Reductant, stannous chloride in 3% HCl: This is the ***Reductant*** for the instrument. In a 1 L volumetric flask, add 30mL concentrated trace grade HCl and 11 g $SnCl_2$-$2H_20$. Mix to dissolve the solid and bring to volume with reagent water. Store at room temperature, prepare as needed.
- Carrier, hydrochloric acid, 3%: This is the ***Carrier*** for the instrument. In a 1 L volumetric flask, add 30 mL concentrated trace grade HCl. Bring to volume with reagent water. Store at room temperature, prepare as needed.

8.3.2 Preparation Reagents

- Aqua regia: Prepare immediately before use by carefully adding three volumes of concentrated Cl to one volume of concentrated HNO_3.
- Potassium permanganate, mercury free, 5% solution (w/v): Dissolve 5 g of potassium permanganate in 100m L of reagent water. Store at room temperature.
- Sodium chloride-hydroxylamine hydrochloride solution: Dissolve 12 g of sodium chloride and 12 g of hydroxylamine hydrochloride in reagent water and dilute to 100 mL. Store at room temperature.

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8.3.3 Working Standards

- 0.1 ppm Mercury Working Stock: To a 500 mL volumetric flask, add 25 mL of concentrated HNO_3 and 0.5 mL of 100 ppm primary mercury standard. Bring to volume with reagent water. Store at room temperature. Expires one month from date of preparation
- 0.3 ppm Mercury ICV Working Stock: To a 50 mL volumetric flask, add 2.5 mL of concentrated HNO_3 and 0.15 mL of 100 ppm secondary mercury standard. Bring to volume with reagent water. Store at room temperature. Expires one month from date of preparation
- SRM: Purchased from ERA in 300-500 g lots.

8.3.4 QC Standards

- ICV Standard, 3.0 ppb: This standard is used for Calibration Verification. Add 10.0 mL of reagent water to a digestion vessel. Using a volumetric pipette, add 0.5 mL of 0.3 ppm Mercury ICV Working Stock to the digestion vessel. Digest the ICV Standard as described in Section 9.3.2.
- Method Blank: This standard is prepared and analyzed with each prep batch. Add 5.0 mL of reagent water to a digestion vessel. Add 0.3 g of PTFE boiling stones to the vessel. Digest the method blank as described in Section 9.3.2.
- LCS Standard, 1.0 ppb: This standard is prepared and analyzed with each prep batch. Add 5.0 mL of reagent water to a digestion vessel. Add either 0.15 g of SRM or 5 mL of 0.1 ppm Mercury Working Stock. If using a liquid spike add 0.3 g of PTFE boiling stones to the digestion vessel. Digest the LCS Standard as described in Section 9.3.2.
- Matrix Spike, 0.001 mg/L: Weigh an additional aliquot of the sample designated to be the batch matrix spike. Add 10.0 mL of reagent water to the digestion vessel containing the weighed sample aliquot. Add a 5 mL aliquot of 0.1 ppm Mercury Working Stock. Digest the MS as described in Section 9.3.2.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Instrument Setup

- Turn the instrument on. The autosampler will initialize itself. Choose the instrument software from the desktop menu. The autosampler will initialize again.
- Enter the appropriate fields for sample identification and data storage. Fill the carrier and reductant bottles
  - The carrier is 3% HCL
  - The reductant is 1.1% $SnCl_2$ in 3% HCl
- Allow the instrument to warm up while clearing samples. Samples that are cloudy or with particulate present after clearing must be filtered through Whatman 41 filter paper before analysis.
- Place carrier uptake line and reductant uptake line. Load carrier and reductant lines into pump magazines. Load the two waste lines into the pump magazines below the roller. Lock the magazines into place.

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9.1.2 Support Equipment

Refer to laboratory SOP ENV-SOP-WES2-0036, Balance Calibration Verification, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

Instruments are calibrated on a daily basis

9.2.2 Calibration Levels

Calibration standards are stored under ambient conditions.

- 0 ppb/ICB/CCB: Add 10 mL of reagent water to a polypropylene digestion vessel.
- 0.5 ppb: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 0.25 mL of 0.1 ppm Mercury Working Stock (Section 8.3.3) to the digestion vessel.
- 1.0 ppb: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 0.5 mL of 0.1 ppm Mercury Working Stock to the digestion vessel.
- 2.0 ppb: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 1.0 mL of 0.1 ppm Mercury Working Stock to the digestion vessel.
- 5.0 ppb/CCV: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 2.5 mL of 0.1 ppm Mercury Working Stock to the digestion vessel.
- 10 ppb: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 5.0 mL of 0.1 ppm Mercury Working Stock to the digestion vessel.
- 20 ppb: Add 10 mL of reagent water to a polypropylene digestion vessel. Using a volumetric pipette, add 10.0 mL of 0.1 ppm Mercury Working Stock to the digestion vessel.

These standards are then digested as described in 9.3.2

9.2.3 Calibration and Sample Analysis

- The instrument will now run the calibration standards; verify a R value of 0.995 or better before proceeding with the ICV and ICB (evaluation of these standards is described in 9.2.4.3 and 9.2.5.1). Ten analytical samples, a CCV and CCB, ten

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analytical samples, CCV, CCB, etc. The CCBs and CCVs must be recovered within the proper ranges (described in 9.2.4.4 and 9.2.5.1.) for analysis to continue.

- If the sample result is beyond the concentration of the highest point on the calibration curve, dilute the sample extract with a portion of one of the prepared blanks (ICB, CCB or PBS) to produce an analytical result that is within the range.

9.2.3.1 Curve Fit

A linear curve fit is used for this method. 6 curve points of increasing concentration are used along with a blank. The curve must compute an R value of 0.995 or higher to be considered valid.

9.2.3.2 Relative Error (%RE)

Multi-Point Calibration (Linear Regression Models):

Calculate relative error for the low calibration standard and the mid-point calibration standard using the equation in Section 10.2.1, or by using the values provided by the software. Before performing this calculation, quantify the measured concentration of both of these standards against the new calibration curve and use these values as the measured concentration of standard (x'i).

The %RE for the low and mid-calibration standards must be within ±50% and ±30%, respectively. Record the results of the calculation by saving the calibration tab of the software where the %RE is displayed for each calibration point.

If the criterion is not met, the calibration is not acceptable for use. Investigate and troubleshoot to correct the problem and perform a new calibration. Do not proceed to analyze samples; sample analysis may not proceed if this quality control measure is not within criteria.

Refer to POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for additional information and calculations.

9.2.3.3 Initial Calibration Verification (ICV)

The ICV is analyzed after the calibration curve. It is prepared in the manner specified in Section 8.3.4. The ICV must be recovered within ±10% of the true value. See Section Appendix A for corrective action.

9.2.3.4 Continuing Calibration Verification (CCV)

The CCV is analyzed after every ten analytical samples. It is prepared in the same manner as the 5.0 ppb calibration standard (Section 9.2.2). The CCV must be recovered within 20% of the true value. See Appendix A for corrective action.

9.2.4 Calibration Blanks

9.2.4.1 Initial Calibration Blank (ICB)

The ICB is analyzed after the ICV and is prepared in the same manner as the 0ppb standard (Section 9.2.2). The ICB must recover below 0.5 ppb.

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9.2.4.2 Continuing Calibration Blank (CCB)

The CCB is analyzed after the CCV. It is prepared in the same manner as the 0ppb standard (Section 9.2.2). The CCB must recover below 0.5 ppb.

9.3 Sample Preparation

9.3.1 Homogenization & Subsampling

Refer to laboratory SOP ENV-SOP-WES2-0002, Sample Custody & Tracking, or however named, for information regarding the handling, homogenization, and splitting of samples to ensure that a representative aliquot is used for preparation.

9.3.2 Preparation of Mercury Soil samples

Weigh a 0.3-0.4 g portion of untreated and homogenized sample and place in the bottom of a polypropylene digestion vessel. Record the weight in the electronic laboratory notebook (ELN). NOTE: When preparing the batch, include one sample duplicate aliquot to be prepared in the same manner and a matrix spiked sample as described in 8.3.4.

Add 2.5 mL of reagent water and 2.5 mL of aqua regia. Heat 2 min on a hot block at 95°C +/-3°C. Cool; then add 15 mL reagent water, and 7.5 mL potassium permanganate solution to the digestion vessel. Wait 15 minutes to be sure the potassium permanganate is not exhausted (purple color disappears), if it does add additional potassium permanganate to all samples and QC until stable. Mix thoroughly and place in the hot block for 30 min at 95°C +/-3°C. Cool and add 3 mL of sodium chloride-hydroxylamine hydrochloride to reduce the excess permanganate. Bring up to final volume of 50 mL with reagent water.

CAUTION: Perform this addition under a hood, as Cl_2 could be evolved.

Note: Alternate volumes of standards may be made based on need as long as they are made with the same proportions as described above.

9.4 Sample Analysis

9.4.1 Routine Analytical Sequence

- Analysis of calibration standards
- Generation of calibration curve and curve analysis
- ICV
- ICB
- A maximum of 10 analytical samples
- CCV
- CCB
- A maximum of 10 analytical samples
- CCV
- CCB
- Etc.

Instrument Shut Down

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- When analysis is complete place reagent uptake lines in a beaker of DI water.
- Continue to run the pumps for several minutes to flush reagents out of the lines.
- Continue to run the pumps for several more minutes to flush the lines thoroughly with DI water.
- Pull the reagent uptake lines out of the DI water beaker and allow the pump to draw air completely through the lines
- Unlock the top and bottom pump magazines and remove tubing from the magazines.
- Exit from the software application

  Note: This procedure must be followed every time the instrument is shut down to prevent water or reagents from being drawn back into the instrument which can cause severe damage.

- Dump the samples and standard in the Metals lab-pack drum. Dump liquid wastes in the metals prep liquid waste drum located in the prep room.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

Calibrations and initial quality control standards (ICV and ICB) are evaluated as described in 9.2.3 and 9.2.4. Analytical samples are then run as described in 9.4.1 with quality control standards evaluated as described in 9.2.3 and 9.2.4.

10.2 Calculations

Refer to laboratory SOP ENV-SOP-WES2-0124, Common Lab Calculations, or however named, for equations used to perform common calculations.

10.2.1 Relative Error (%RE)

$$\%\ Relative\ Error = \left(\frac{x'i - xi}{xi}\right) x\ 100$$

Where:

xi = True value of the calibration standard

x'i = Measured concentration of the calibration standard

10.2.2 Mercury Concentration in Soils

Calculate Mercury Concentration from the Daily Calibration Curve: The curve is generated utilizing a straight-line equation defined as:

$$A = K_1 + K_2 C$$

Where:

A= Average peak height of the sample/standard integrations

C= Sample/Standard concentration, µg/L

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K_1= y-intercept

K_2= Slope

The instrument will plot peak height against concentration (µg/L). The result is generated in µg/L. This value is divided by 1000 to convert the units to mg/L. The mg/L units are converted to mg/kg by multiplying by L/kg. A dilution factor (DF) is applied if necessary. The Result is then divided by the % Total Solids prior to release to the client.

Result, mg/kg= (Concentration, µg/L) x (1mg/1000µg) x (DF) x (L/kg)

Where: L/kg= Final Volume of digestate, in L

Weight of original sample, in kg

Calculate Percent Recovery for the Matrix Spike corrected for concentrations measured in the unfortified sample. Percent recovery is calculated using the following equation:

$$\%\ Recovery = (Cm - C)X\ 1000$$

Where:

Cm= Measured mercury in the fortified sample

C= Measured native mercury sample concentration

S=Concentration equivalent of spike added to sample

Calculate the Relative Percent Difference (RPD) for each Duplicate of the initial quantitated concentration (IC) and the duplicate quantitated concentration (Dc) using the following formula:

$$RPD = \frac{|(IC - Dc)|}{\{(IC + Dc)/2} X100$$

10.3 Reporting

Results reported as Mercury, Total in mg/kg.

11.0 Quality Control & Method Performance

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix A for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.

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LCS Duplicate	LCSD	1 per batch of 20 or fewer samples, when the method dictates
Matrix Spike	MS	1 per batch of 20 or fewer samples
Matrix Spike Duplicate	MSD	1 per batch of 20 or fewer samples, when requested
Sample Duplicate	DUP	1 per batch of 20 or fewer samples, unless MSD performed

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	1 per analytical run
Initial Calibration Blank	ICB	1 per analytical run
Continuing Calibration Verification	CCV	1 per 10 analytical samples run
Continuing Calibration Blank	CCB	1 per 10 analytical samples run

11.2.1 Linear Dynamic Range (LDR)

The Linear Dynamic Range is established by the highest point of the calibration range.

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

Establish Limit of Detection (LOD) and limits of quantitation (LOQ) at initial method set up and verify the LOD and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for LOD and LOQ requirements and procedures.

11.3.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-WES2-0005, Demonstration of Capability, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

12.0 Data Review & Corrective Action

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective

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actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-WES2-0126, Data Review, or specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 Pollution Prevention & Waste Management

Refer to laboratory SOP ENV-SOP-MANS-0077, Waste Management, or however named, for waste handling and management practices pertaining to the waste streams created at this facility.

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Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have been modified from the reference test method as follows:

Alpha analyzes only one 0.3g aliquot of sample. The original method does not address the automated instrument procedure. A reduced volume of sample is digested in disposable digestion tubes on a hot block digestor.

When applicable, comparability and/or equivalency studies necessary to validate the modification as required per corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, are retained by local quality personnel for historical reference.

15.0 RESPONSIBILITIES

- PAS employees that perform any part this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

16.0 ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table
- Appendix B: State/Program Specific Requirements (if applicable)
- Appendix C: State/Program Specific Requirements (if applicable)

17.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.

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- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- ENV-MAN-WES2-0001, *Quality Manual*, current version.
- TNI Standard, "Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis", current version.
- MA DEP MCP 310 CMR 42.00
- SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical methods, EPA SW-846, Update III, February 2007

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
Entire Document	Document Flip to Pace Template

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
25924	4	Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique	7/7/2022

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Appendix A: QC Summary & Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Demonstration of Capability (DOC)	Annual	±20% true value, 20% RPD	DOC must be redone if failure occurs	
Initial Calibration (ICAL)	Once every 24 Hours	The curve correlation coefficient (cc) must be greater than or equal to 0.995 in order for the curve to be linear	If the correlation coefficient is less than 0.995, find and correct the problem, recalibrate	
Initial Calibration Verification (ICV)	1 per calibration	Within 10% of true value	If the ICV % recovery is outside of acceptance criteria, the ICV is reinjected. If the % recovery is outside the acceptance criteria, the analysis is terminated until the problem is found and corrected, then recalibrate	
Initial Calibration Blank (ICB)	1 per calibration	<RL	If the ICB recovery is at or above the RL it is reinjected. If the recovery is again above compliance, then the analysis is terminated until the problem is found and corrected, then recalibration.	
Continuing Calibration Verification (CCV)	Once after every 10 analytical samples run	Within 20% of true value	If the CCV % recovery is outside of acceptance criteria, the CCV is reinjected. If the % recovery is still outside the acceptance criteria, all samples analyzed since the last acceptable CCV must be reanalyzed following correction of the problem, and after the instrument is recalibrated.	Samples with non-detect results can be approved with a high bias CCV.
Continuing Calibration Blank (CCB)	Once after every 10 analytical samples	<RL	If the CCB recovery is outside of acceptance criteria, the CCB is reinjected. If the recovery is still outside the acceptance criteria, all samples analyzed since the last acceptable CCB must be reanalyzed following correction of the problem, and after the instrument is recalibrated.	Samples with non-detect results or results 10x the result in the CCB can be approved.
Method Blank (MB)/ Preparation Blank	1 per batch of 20 or fewer samples	< RL or <10% of the sample concentrations	For method blanks that have concentrations greater than the RL, the data is rejected and the associated samples sent back for redigestion unless the associated sample concentrations are greater than 10x the blank concentration or is	

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			non-detect. In this case the blank is narrated, and the results are reported without qualification.	
Laboratory Control Sample (LCS)	1 per batch of 20 or fewer samples	+20% of true value	If outside criteria, LCS is reinjected. either recalibrate and rerun or the associated batch and another LCS must be redigested if failure occurs again	Samples with non-detect results can be approved with a high bias LCS.
Matrix Spike/Spike Duplicate (MS/MSD)	1 per batch of 20 or fewer samples	75-125%	A post-digestion spike is performed. If the post digestion spike is still outside criteria, qualify the results with a narrative.	
Sample Duplicate (DUP)	1 per batch of 20 or fewer samples	RPD between sample and its duplicate must be 20% or less	Visually evaluate the sample matrix. If the matrix appears problematic, the sample digestate may be diluted and reanalyzed, or a narrative included with the data to explain the matrix problem or a narrative indicating the concentration of mercury less than 5x the RL	
Linear Dynamic Range (LDR)	Daily, per calibration	Established by the highest point of the calibration range.	Recalibrate	

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Appendix B: State/Program Specific Requirements

This appendix provides state specific requirements that supersede or supplement the main body of the SOP. When analyzing samples from these states, these requirements are applicable.

State	SOP Section	Requirement
MA/CT	Appendix A, LCS/LCSD	Aliquots of a solid reference material (SRM, purchased from an outside vendor) are used as LCS and LCSD for soil analysis. These are digested and analyzed in the same manner as soil samples.
MA/CT	Appendix A, LCS/LCSD	A LCS/LCSD pair is analyzed once per each analytical batch of twenty samples or less. The standards are prepared in the same manner as in Section 8. The LCS and the LCSD both must be recovered within the vendor's 95% confidence limits. The RPD between the LCS/LCSD must be < 30%.
MA/CT	Appendix A, MS	Analyze one matrix spike per twenty or less analytical samples for a project specific job. The recovery of the matrix spike must be between 75 – 125%. Calculate percent recovery using Section 9.6.2. This is tracked and requested by the client and is not a requirement for all MCP batches.
MA/CT	Appendix A, Duplicates	Analyze one sample in duplicate per twenty or less project specific samples. The RPD between the sample and its duplicate must be < 35%, otherwise narrate. This is tracked and requested by the client and is not a requirement for all MCP batches.
MA/CT	Appendix A, LCS/LCSD Failure	If the LCS or LCSD is not recovered within acceptance criteria, reanalyze the failing LCS. If the recovery is acceptable, no further action is required. If one LCS is acceptable and the other is not, no corrective action is required,

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		but the LCS exceedance must be narrated. It both LCS and LCSD recoveries are unacceptable, reprep and reanalyze the LCS/LCSD and all associated field samples unless the project specific MS recovery is within acceptance criteria. If this is the case, narrate. If the LCS/LCSD RPD is outside the acceptance limit, narrate.
MA/CT	Appendix A, Matrix Spike Failure	If the recovery of the matrix spike is outside of the acceptance criteria of 75 – 125%, no corrective action is required. A narrative must be submitted with the data for inclusion on the final report.
MA/CT	Appendix A, Duplicate Failure	If the RPD between the sample and its duplicate is greater than 35%, no corrective action is required. A narrative must be submitted with the data for inclusion on the final report.

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Pace ANALYTICAL SERVICES	**ENV-SOP-MANS-0048 V07 Metals by ICP EPA 6010D**
	Effective Date: 11/17/2025

Management Approval:
Cindy McQueen Approved on 11/11/2025 9:50:43 AM
Nathan Sorelle Approved on 11/17/2025 9:52:53 AM
Jason Hebert Approved on 11/17/2025 9:55:50 AM

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1.0 SCOPE & APPLICATION

This Standard Operating Procedure (SOP) describes the laboratory procedure used by PAS-Mansfield for the determination of trace elements, including metals, in solution by inductively coupled plasma-atomic emission spectrometry, following Method 6010D, SW-846 2014. This SOP is applicable to groundwater, aqueous, TCLP, industrial and organic wastes, soils, sludges, and sediments.

1.1 Target Analyte List, Limits of Detection & Quantitation (LOD & LOQ)

The target analyte(s) that can be determined by this SOP and the associated LOD, LOQ, and RL are provided in Appendix A**.**

LOQ are established in accordance with PAS policies and procedures for method validation, determination of detection limits (LOD), and quantitation limits (LOQ). Refer to laboratory SOP ENV-WES2-0112, or however named, for additional information.

The reporting limit (RL) is the value to which analytes are reported as detected or non-detect in the final report. When the RL is less than the lower limit of quantitation (LLOQ), all detects and non-detects at the RL are qualitative. The LLOQ is the lowest point of the calibration curve used for each target analyte.

1.2 Reference Methods & Documents

This SOP is based on reference method 6010D, SW-846, 2014. If the laboratory procedure is modified from the reference method, a list of modifications and rationale for the modification is provided in Section 14.0. Modifications are permitted when allowed by the regulatory program for which test results will be used and when the modification has been validated comparable and equivalent to the reference method.

1.3 Quantitation Range

The upper limit of quantitation for each target analyte in this procedure is defined in Appendix D. The quantitation range for each target analyte in this procedure is defined in Section 9.2.2 Calibration Levels.

1.4 State/Program Specific Requirements

Massachusetts Contingency Plan (MCP) specific requirements, if they vary from the procedure in the SOP, are specified in Appendix C. These requirements supersede Method 6010D, SW-846 when samples are analyzed from that state or under the specified project program.

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2.0 SUMMARY OF METHOD

Prior to analysis, samples must be solubilized or digested using appropriate Sample Preparation Methods. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered, and acid preserved prior to analysis.

This method describes multi-elemental determinations by ICP-AES using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by a radiofrequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis the position used must be as free as possible from spectral interference and must reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would degrade the analytical result. The possibility of additional interferences named in Section 4.0 must also be recognized and appropriate corrections made; tests for their presence are described in Section 9.7. Alternatively, users may choose multivariate calibration methods. In this case, point selections for background correction are superfluous since whole spectral regions are processed.

This SOP includes the manual calculations for Total Hardness and Calcium Hardness, according to SM 2340B.

3.0 INTERFERENCES

3.1 Spectral

Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

- Background emission and stray light can usually be compensated for by subtracting the background emission determined by measurements adjacent to the analyte wavelength peak. Spectral scans of samples or single element solutions in the analyte regions may indicate when alternate wavelengths are desirable because of severe spectral interference. These scans will also show whether the most appropriate estimate of the background emission is provided by an interpolation from measurements on both sides of the wavelength peak or by measured emission on only one side. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference (interelement or molecular) or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak. For multivariate methods using whole spectral regions, background scans must be included in the correction algorithm. Off-line spectral interferences are handled by including spectra on interfering species in the algorithm.

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- To determine the appropriate location for off-line background correction, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations. If a wavelength other than the recommended wavelength is used, the analyst must determine and document both the overlapping and nearby spectral interference effects from all method analytes and common elements and provide for their automatic correction on all analyses. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Normally, 100 mg/L single element solutions are sufficient; however, for analytes such as iron that may be found at high concentration, a more appropriate test would be to use a concentration near the upper analytical range limit

- Spectral overlaps may be avoided by using an alternate wavelength or can be compensated by equations that are correct for interelement contributions. Instruments that use equations for interelement correction require the interfering elements to be analyzed at the same time as the element of interest. When operative and uncorrected, interferences will produce false positive determinations and be reported as analyte concentrations. More extensive information on interferant effects on various wavelengths and resolutions is available in reference wavelength tables and books. Users may apply interelement correction equations determined on their instruments with tested concentration ranges to compensate (off-line or on-line) for the effects of interfering elements. For multivariate methods using whole spectral regions, spectral interferences are handled by including spectra of the interfering elements in the algorithm. The interferences listed are only those that occur between method analytes. Only interferences of a direct overlap nature are listed. These overlaps were observed with a single instrument having a working resolution of 0.035 nm.

- When using inter-element correction equations, the interference may be expressed as analyte concentration equivalents (i.e. false analyte concentrations) arising from 100 mg/L of the interference element. For example, assume that As is to be determined (at 193.696 nm) in a sample containing approximately 10 mg/L of Al. 100 mg/L of Al would yield a false signal for As equivalent to approximately 1.3 mg/L. Therefore, the presence of 10 mg/L of Al would result in a false signal for As equivalent to approximately 0.13 mg/L. The user is cautioned that each instrument may exhibit somewhat different levels of interference. The interference effects must be evaluated for each individual instrument since the intensities will vary.

- Major known interferences are Fe, Al, Ca, Mg, V, Ni, Cu, and Cr. To minimize any of these interferences, every analyte is analyzed on each instrument at or near its linear range and corrected for these interferences. This is done on an annual basis, and data is kept on file.

- Inter-element corrections will vary for the same emission line among instruments because of differences in resolution, as determined by the grating, the entrance and exit slit widths, and by the order of dispersion. Inter-element corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear must be avoided when practical. Inter-element corrections that

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constitute a major portion of an emission signal may not yield accurate data. Users must not forget that some samples may contain uncommon elements that could contribute spectral interferences.

- The interference effects must be evaluated for each individual instrument whether configured as a sequential or simultaneous instrument. For each instrument, intensities will vary not only with optical resolution but also with operating conditions (such as power, viewing height and argon flow rate). When using the recommended wavelengths, the analyst is required to determine and document for each wavelength the effect from referenced interferences as well as any other suspected interferences that may be specific to the instrument or matrix. The analyst is encouraged to utilize a computer routine for automatic correction on all analyses.

- The primary wavelength for each analyte is based upon the instrument manufacturer's recommendations. An alternate wavelength is chosen if there is an indication of elevated background or overlap of another spectral wavelength. The wavelength for each analyte must be as free from interferences as possible.

- If the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution must fall within a specific concentration range around the calibration blank. The concentration range is calculated by multiplying the concentration of the interfering element by the value of the correction factor being tested and divided by 10. If after the subtraction of the calibration blank the apparent analyte concentration falls outside of this range in either a positive or negative direction, a change in the correction factor of more than 10% should be suspected. The cause of the change must be determined and corrected and the correction factor updated. The interference check solutions must be analyzed more than once to confirm a change has occurred. Adequate rinse time between solutions and before analysis of the calibration blank will assist in the confirmation.

- When inter-element corrections are applied, their accuracy must be verified, daily, by analyzing the spectral interference check solution. The correction factor or multivariate correction matrices tested daily. All inter-element spectral correction factors or multivariate correction matrices are verified and updated when an instrumentation changes, such as in the torch, nebulizer, injector, or plasma conditions occur. The standard solution must be inspected to ensure that there is no contamination that may be perceived as a spectral interference.

- When inter-element corrections are not used, verification of absence of interferences is required.

    - One method is to use a computer software routine for comparing the determinative data to limits, files for notifying the analyst when an interfering element is detected in the sample at a concentration that will produce either an apparent false positive concentration, (i.e., greater than) the analyte instrument detection limit, or false negative analyte concentration, (i.e., less than the lower control limit of the calibration blank defined for a 99% confidence interval).
    - Another method is to analyze an Interference Check Solution(s) which contains similar concentrations of the major components of the samples (>10 mg/L) on a continuing basis to verify the absence of effects at the wavelengths selected. This data must be kept on file with the sample analysis data. If the check solution confirms an operative interference that is >20% of the analyte concentration, the analyte must be determined

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using (1) analytical and background correction wavelengths (or spectral regions) free of the interference, (2) by an alternative wavelength, or (3) by another documented test procedure.

3.2 Physical

- Physical interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample, using a peristaltic pump, use of an internal standard or by using a high solids nebulizer. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, affecting aerosol flow rate and causing instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a tip washer, using a high solids nebulizer or diluting the sample. Also, it has been reported that better control of the argon flow rate, especially to the nebulizer, improves instrument performance: this may be accomplished with the use of mass flow controllers. The test described in Section 10.3.4.1 will help determine if physical interference is present.

3.3 Chemical

- Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique, but if observed, can be minimized by careful selection of operating conditions (incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. Additionally, if filtered samples are found to have an organic or sulfur like odor they are processed by heating after the addition of the acids to matrix match. Chemical interferences are highly dependent on matrix type and the specific analyte element.

3.4 Memory

- Memory interferences result when analytes in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the uptake tubing to the nebulizer and from the build-up of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples. The possibility of memory interferences must be recognized within an analytical run and suitable rinse times must be used to reduce them. The rinse times necessary for a particular element must be estimated prior to analysis. This may be achieved by aspirating a standard containing elements at a concentration ten times the usual amount or at the top of the linear dynamic range. The aspiration time for this sample must be the same as a normal sample analysis period, followed by analysis of the rinse blank at designated intervals. The length of time required to reduce analyte signals to within a factor of two of the method detection limits must be noted. Until the required rinse time is established, this method suggests a rinse period of at least 60 seconds between samples and standards. If memory interference is suspected, the sample must be reanalyzed after a rinse period of sufficient length. Alternate rinse times may be established by the analyst based upon their DQOs.

3.5 Other Interferences

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- Users are advised that high salt concentrations can cause analyte signal suppressions and confuse interference tests. If the instrument does not display negative values, fortify the interference check solution with the elements of interest at 0.5 to 1 mg/L and measure the added standard concentration accordingly. Concentrations must be within 20% of the true spiked concentration or dilution of the samples will be necessary. In the absence of measurable analyte, overcorrection could go undetected if a negative value is reported as zero.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- **PAS:** Acronym for Pace® Analytical Services, LLC

5.0 HEALTH & SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001).
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

PAS offers sample collection services for this test method. Unless otherwise specified by client or program specific sampling protocols, refer to SOP ENV-SOP-WES2-0003, Sample Login & Receipt,, or however named, for the procedure used when sample collection is performed by the location

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referenced in the scope and application of this SOP. If sample collection is performed by a different PAS facility, contact a PAS Project Manager (PM) to obtain the SOP used by that location.

PAS provides containers for the collection of samples upon client request. The routine container type and size is provided in the following table along with requirements for sample size, preservation and holding time. Refer to laboratory SOP ENV-SOP-WES2-0122, Bottle Orders, or however named, for procedures related to preparation of bottle kits.

Container Type, Minimum Sample Amount, Preservation, and Holding Time

Matrix	Container Size & Type[1]	Minimum Sample Amount[2]	Preservation	Holding Time
Liquid	250 mL Plastic A-25	250 mL	Chemical: Nitric Acid	Collection to Analysis: 6 months
Solid	4 oz. Glass A-120	4 oz	Refrigerated	Collection to Analysis: 6 months

[1] *Default container type provided in sample kit.*

[2] *Amount of sample required for each discrete test.*

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

Use of equivalent instrumentation, support equipment, and supplies from alternative vendors is acceptable so long as they meet the specifications as stated in the reference method(s).

7.1 Instrumentation

- Inductively Coupled argon plasma optical emission spectrometer
  - Thermo Scientific ICAP Duo 6500, ICAP Duo 7000 or ICAP PRO XP Duo Computer-controlled emission spectrometer with background correction
  - Radio-frequency generator compliant with FCC regulations
  - Optional mass flow controller for argon nebulizer gas supply
  - Optional peristaltic pump
  - Optional autosampler
  - Each instrument has an associated auto-sampler and recirculating chiller

7.2 Support Equipment

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- Analytical Balance – Capable of weighing to 0.01g; Ohaus AX523, or equivalent.

7.3 Supplies

- Argon Gas supply – High purity
- Auto-Sampler Tubes – 13 x 10 mm metals free auto-sampler tubes; Moldpro, or equivalent
- Filters – Filtermate filters, 2 um PTFE; Environmental Express, Catalog # SC0408.
- Whatman #41 ashless 90mm filter paper

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP ENV-SOP-MANS-0076, Reagent and Solvent Control, or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared when available. Expiration and storage requirements are defined per manufacturer.

8.1 Reagents

Use of equivalent reagents from alternative vendors is acceptable so long as the substitution meets the performance specifications required by the reference method(s).

- **Hydrochloric acid (conc), HCl**. Stored at room temperature in acid resistant cabinet. Expiration date is defined by vendor.
- **Hydrochloric acid (1**:1), HCl. Add 500 mL concentrated HCl to 400 mL DI water and dilute to 1 Liter in an appropriately sized beaker. Stored at room temperature in polypropylene bottle, expiration date is defined by vendor.
- **Nitric acid (conc), $HN0_3$** – Stored at room temperature in acid resistant cabinet. Expiration date is defined by vendor
- **Nitric Acid (1:1), HNO_3** – Add 500 mL concentrated HNO_3 to 400 mL DI water and dilute to 1 liter in a appropriately sized beaker. Stored at room temperature in polypropylene bottle, expiration date is defined by vendor
- **Reagent Water**: All references to water in the method refer to reagent water unless otherwise specified. Reagent water will be interference free. Refer to Chapter One for a definition of reagent water.

8.2 Standards

Use of equivalent standards from alternative vendors is acceptable so long as they are traceable to a national standard, when commercially available.

- **Standard stock solutions** may be purchased or prepared from ultra-high purity grade chemicals or metals (99.99% pure or greater). All stock standards are ordered through ISO and American Association for Lab Accreditation vendor. All standards are in aqueous solutions and are generally at concentrations of 1,000ppm and 10,000ppm.

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8.2.1 Calibration Standards

- Calibration Stock Standards – Custom Blend of Elements. Inorganic Ventures, Absolute Standard or equivalent. See Appendix E for the standard information.
- Internal Calibration Verification (ICV) stock Standard Solutions – Custom Blend. Must separate stock from the calibration standards. Agilent Technologies or Equivalent. See Appendix E for the standard information.
- Wavelength Optimization Standards – Prepared as needed in house from 1,000 or 10,000ppm stock standards.

8.2.2 Internal Standard -

- Yttrium 1000ppm Absolute Standards or equivalent
- Scandium 1000ppm Absolute Standards or equivalent

8.3 Formulations

8.3.1 Working Solutions

Working solutions are stored In glass containers under ambient conditions.

2% (v/v) Nitric Acid/3% (v/v) Hydrochloric Acid Solution

Add 200 mL HNO3 (see section 8.1) and 300 mL HCl (see section 8.1) to 10 L with ASTM Type I water (18 megaohm).

Used for all blanks and rinsing and preparation of standards.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Instrument Setup

9.1.1.1 Routine Instrument Operating Conditions

Set up the instrument with proper operating parameters established as detailed below. The instrument must be allowed to become thermally stable before beginning (usually requiring at least 30 minutes of operation prior to calibration).

Startup Procedures

- Turn on power on the chiller
- Click on the ThermoSpec Icon; enter analyst initials in login screen
- Click on Plasma icon to start instrument

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- Allow to warm up for 30 minutes
- Enter analytical workgroup number (obtained from LIMS) globally under the Instrument menu by selecting Tools, then Options, then Analyst
- Click on the Sequence tab and enter the sequence by selecting New Autosampler Table, Add Sequence, Add # of spaces
- Enter the sample locations and IDs
- Press Run Auto-session Button (►) in menu bar

Specific wavelengths are listed in Table 1. Other wavelengths may be substituted if they can provide the needed sensitivity and are corrected for spectral interference. The instrument and operating conditions utilized for determination must be capable of providing data of acceptable quality to the program and data user.

Operating conditions for axial plasma will vary from 1100-1500 watts forward power, 15-19 Liters/min argon coolant flow, 0.5-0.7 L/min argon nebulizer flow, 140-200 rpm pump rate and a default 1 minute pre-flush time and 10 second measurement time is recommended for all simultaneous instruments.

The plasma operating conditions need to be optimized prior to use of the instrument. This routine is not required daily, but only when first setting up a new instrument or following a change in operating conditions. The following procedure is recommended or follows manufacturer's recommendations. The purpose of plasma optimization is to provide a maximum signal to background ratio for some of the least sensitive elements in the analytical array. The use of a mass flow controller to regulate the nebulizer gas flow or source optimization software greatly facilitates the procedure.

The Thermo ICP’s typically use a Meinhard Nebulizer. The nebulizer flow for each instrument is 1.0 +/- 0.2 mL/min.

The 6500 Duo instruments automatically perform a wavelength check at start up without user interaction.

The instrument operating condition finally selected as being optimum must provide the lowest reliable instrument detection limits and method detection limits.

If either the instrument operating conditions, such as incident power or nebulizer gas flow rate are changed, or a new torch injector tube with a different orifice internal diameter is installed, the plasma and argon pressures must be reoptimized.

After completing the initial optimization of operating conditions, but before analyzing samples, the laboratory must establish and initially verify an

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interelement spectral interference correction routine to be used during sample analysis. A general description concerning spectral interference and the analytical requirements for background correction are discussed in the section on interferences. Criteria for determining an interelement spectral interference is an apparent positive or negative concentration for the analyte that falls within ± ½ LLOQ. The upper control limit is the analyte instrument detection limit. Once established, the entire routine is periodically verified every six months. In between that time, IEC's are done on a need be basis per analyte. Only a portion of the correction routine must be verified more frequently or daily. Initial and periodic verification of the routine must be kept on file. Special cases where continual verification is required are described elsewhere.

Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each individual analyte line on each particular instrument. All measurements must be within the instrument linear range where the correction equations are valid.

Method detection limits must be established for all wavelengths utilized for each type of matrix commonly analyzed. The matrix used for the MDL calculation must contain analytes of known concentrations within 3-5 times the anticipated detection limit.

Determination of limits using reagent water MDLs represent a best-case situation and do not represent possible matrix effects of real-world samples.

If additional confirmation is desired, reanalyze the seven replicate aliquots on two more non-consecutive days and again calculate the method detection limit values for each day. An average of the three values for each analyte may provide for a more appropriate estimate.

The upper limit of the linear dynamic range must be established for each wavelength utilized by determining the signal responses with 10% of the true value of each element from a concentration standard at the upper limit of the range run on the same calibration as required by the sample responses above the calibration range. The range which may be used for the analysis of samples must be no more than 90% of the resulting data. Determined analyte concentrations that are above the upper range limit must be diluted and reanalyzed. The analyst must also be aware that if an inter-element correction from an analyte above the linear range exists, a second analyte where the inter-element correction has been applied may be inaccurately reported.

> **NOTE:** Many of the alkali and alkaline earth metals have non-linear response curves due to ionization and self-absorption effects. These curves may be used if the instrument allows; however the effective range must be checked, and the second order curve fit must have a correlation coefficient of 0.995 or better. Third order fits are not acceptable. These curves are much more sensitive to changes in operating conditions than the linear lines and must be checked whenever there have been moderate equipment changes.

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The analyst must (1) verify that the instrument configuration and operating conditions satisfy the analytical requirements and (2) maintain quality control data confirming instrument performance and analytical results.

9.1.2 Support Equipment

Refer to laboratory SOP ENV-SOP-WES2-0036, Balance Calibration, or however named, for additional information on calibration requirements for support equipment that may be used in this procedure.

9.2 Calibration

Refer to corporate POL ENV-POL-CORQ-0005, *Acceptable Calibration Practices for Instrument Testing*, for general laboratory calibration policies and procedures.

9.2.1 Calibration Frequency

Daily.

9.2.2 Calibration Levels

Calibration standards are stored in various sized plastic containers under ambient conditions. A calibration curve consists of a single point standard and a calibration blank.

See Appendix E for calibration standard concentrations.

9.2.3 Calibration Sequence

- Cal Blank
- ICAL
- ICV
- ICB
- LLOQ
- ICSA
- SIC Multi
- LDR Check
- CCV
- CCB

9.2.4 Calibration Evaluation

9.2.4.1 Curve Fit

Curve is a single point linear curve forced through the blank.

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9.2.4.2 Relative Error (% RE)

Test Method - Single Point Calibration:

To verify adequate sensitivity a standard shall be analyzed at or below the lowest concentration for which quantitative data are to be reported without qualification. The low standard must be recovered within 80%-120% of the true value.

If the criteria are not met, the calibration is not acceptable for use. Investigate and troubleshoot to correct the problem and perform a new calibration. Do not proceed to analyze samples; sample analysis may not proceed if this quality control measure is not within criteria.

Test Method - Multi-Point Calibration (Linear Regression Models):

Calculate relative error for the low calibration standard and the mid-point calibration standard using the equation in Section 10.2.1. Before performing this calculation, quantify the measured concentration of both of these standards against the new calibration curve and use these values as the measured concentration of standard (x'i).

The %RE for the low and mid-calibration standards must be within ±20% and ±10%, respectively.

If the criterion is not met, the calibration is not acceptable for use. Investigate and troubleshoot to correct the problem and perform a new calibration. Do not proceed to analyze samples; sample analysis may not proceed if this quality control measure is not within criteria.

9.2.4.3 Initial Calibration Verification (ICV)

9.2.4.4 Calibrate the instrument according to the instrument manufacturer's recommended procedures, using the typical mixed calibration standard solutions described in Section 8.7. Flush the system with the calibration blank (Section 8.8.1) between each standard or as the manufacturer recommends. (Use the average intensity of multiple exposures for both standardization and sample analysis to reduce random error.) The calibration curve consists of a calibration blank, RL standard and a high-level standard. Calibration curve verification is accomplished through the analysis of the ICV, ICB and SIC standards.

9.2.4.5 Continuing Calibration Verification (CCV)

Check calibration with an CV following the initial calibration (Section 8.9). Verify calibration with the Continuing Calibration Verification (CCV) Standard (Section 8.9) at the end of the initial calibration sequence (ICV, ICB), after every ten samples, and at the end of an analytical run. Use a calibration blank (Section 8.8.1) immediately following daily calibration, after every 10 samples and at the end of the analytical run.

- The results of the ICV are to agree within 10% of the expected value, and CCVs are to agree within 10% of the expected value;

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if not, terminate the analysis, correct the problem, and recalibrate the instrument. Each may be rerun once to confirm or cure the initial failure.

- The results of the calibration blank should be below ½ of LLOQ or RL (whichever is lower). If not, repeat the analysis and if the failure is repeated terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples. If the blank is less than 1/10 the concentration of the action level of interest, and no sample is within ten percent of the action limit, analyses need not be rerun, and recalibration need not be performed before continuation of the run.
- Verify the inter-element and background correction factors at the beginning of each analytical run. Do this by analyzing the SIC (Section 8.10). Results must be less than +/- LLOQ for all non-spiked elements.
- When low-level sensitivity is required, a check standard at the requested limit of quantitation is analyzed to confirm the reported detection limit (RDL). This is performed on a project-by-project basis.

9.2.4.6 Low-Level of Quantification (LLOQ)

The LLOQ is initially verified by the analysis of at least 7 replicate samples, spiked at the LLOQ and processed through all preparation and analysis steps of the method at or below the lowest calibration point. The mean recovery and relative standard deviation of these samples provide an initial statement of precision and accuracy at the LLOQ. In most cases the mean recovery should be +/- 35% of the true value and RSD should be < 20%. In-house limits may be calculated when sufficient data points exist. Monitoring recovery of LLOQ over time is useful for assessing precision and bias.

Ongoing LLOQ verification, at a minimum, is on a quarterly basis to validate quantitation capability at low analyte concentration levels. This verification may be accomplished either with clean control material (e.g., reagent water, method blanks. Optimally, the LLOQ should be less than the desired regulatory action levels based on the stated project-specific requirements.

9.2.4.7 Ongoing Low Level of Quantification, (LLOQ)

Ongoing LLOQ verification, at a minimum, is on a quarterly basis to validate quantitation capability at low analyte concentration levels. This verification may be accomplished either with clean control material (e.g., reagent water, method blanks. Optimally, the LLOQ should be less than the desired regulatory action levels based on the stated project-specific requirements.

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9.2.4.8 Internal Standard

The Internal standard consists of a multi-element solution; each internal standard covers a range of the spectrum (low, middle, or high wavelengths) and the elements within that range.

5.0ug/mL Scandium

3.0ug/mL Yttrium

Note: The standard is used to monitor instrument fluctuations including but not limited to nebulization efficiency, plasma variations, environmental temperature changes, peristaltic pump pulsations, etc. Therefore, the solution used to start an analysis calibration cannot be added to or changed out during analysis without requiring subsequent full recalibration.

9.2.5 Calibration Blanks

9.2.5.1 Initial Calibration Blank (ICB)

The calibration blank is prepared by acidifying reagent water to the same concentrations of the acids found in the standards. Prepare enough to flush the system between standards and samples. The calibration blank will also be used for all initial (ICB) and continuing calibration blank (CCB) determinations (see Sections 10.2 and 10.4). Refer to Section 10.4.1.2 for acceptance criteria and/or corrective actions.

The Method blank

The Method Blank must contain all of the reagents in the same volumes as used in the processing of the samples. The method blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis. Refer to Section 9.1 for acceptance criteria and/or corrective actions.

The Rinse Blank

The Rinse Blank consists of HNO3 (1% or 2%) (v/v) in reagent water. Prepare enough to flush the system between standards and samples.

9.3 Sample Preparation

9.3.1 Homogenization & Subsampling

Refer to laboratory SOP ENV-SOP-WES2-0003, Sample Login & Receipt, or however named, for information regarding the handling, homogenization, and splitting of samples to ensure that a representative aliquot is used for preparation.

9.4 Sample Analysis

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9.4.1 Sequence Preparation

1) For all analytes and determinations, the laboratory must analyze an ICV (Section 8.9), and a calibration blank (ICB, Section 8.8.1), immediately following daily calibration.

   A calibration blank (CCB, Section 8.8.1) and a calibration verification standard (CCV, Section 8.9) must be analyzed after every tenth sample and at the end of the sample run. Analysis of the calibration verification (CCV) must verify that the instrument is within 10% of the calibration with the relative standard deviation < 5% from replicate (minimum of three) integrations. If the calibration cannot be verified within the specified limits, the sample analysis must be discontinued, the cause determined and the instrument recalibrated. All samples following the last acceptable ICV/ICB, or CCV/CCB must be reanalyzed. The analysis data for the calibration blank, check standard, and ICV or CCV must be kept on file with the sample analysis data.

2) Rinse the system with the rinse blank solution (Section 8.8.3) before the analysis of each sample. The suggested default rinse time is one minute. Each ICP instrument may establish a reduction in this rinse time through a suitable demonstration.

3) Dilute and reanalyze samples that exceed the linear range or use a calibrated alternate, less sensitive line for which quality control data is already established.

4) If less than acceptable accuracy and precision data are generated a series of tests are performed prior to reporting concentration data for analyte elements. At a minimum, these tests should be performed with each batch of samples prepared/analyzed with corresponding unacceptable data quality results. These tests, as outlined in Sections 10.3.5 and 10.3.6, will ensure that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values.

5) **Post Digestion Spike Addition**: If the sample concentrations are insufficient to perform a dilution test, a post digestion spike added to a portion of a prepared sample, or its dilution for the elements failing the matrix spike recoveries must be run, recovery limits equal to 75% to 125% of the known spike value. If the spike is not recovered within the specified limits If the post-digestion recovery fails to meet the acceptance criteria, the sample results must be reported as estimated values

6) **Dilution Test**: If the analyte concentration is sufficiently high (minimally, a factor of 25 above the lower limit of quantitation after dilution), an analysis of a 1:5 dilution must agree within ± 20% of the original determination. Elements that fail the dilution test are reported as estimated values.

7) **CAUTION**: If spectral overlap is suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended.

9.4.2 Routine Analytical Sequence

- Calibration of Instrument
- Initial calibration Verification Standard
- Initial Calibration Blank

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- Low Limit of Quantitation Check
- Interference Check Standard A
- Mixed SIC Solution
- Linear Dynamic Range Check
- Continuing Calibration Verification Standard
- Continuing Calibration Blank
- 10 Samples
- Continuing Calibration Verification Standard
- Continuing Calibration Blank
- 10 Samples
- Continuing Calibration Verification Standard
- Continuing Calibration Blank

10.0 DATA ANALYSIS & CALCULATIONS

and required procedures.

10.1 Calculations

Refer to laboratory SOP ENV-SOP-WES2-0124, Common Lab calculations, or however named, for equations used to perform common calculations.

10.1.1 Relative Error (%RE)

$$\%\ Relative\ Error = \left(\frac{x'i - xi}{xi}\right) x\ 100$$

Where:

xi = True value of the calibration standard

x'i = Measured concentration of the calibration standard

10.1.2 Metals Concentration in Soil samples

Soil samples are calculated as follows:

$$A = \frac{Sanoke\ weight\ (grams)}{Final\ Volume\ (mL)}$$

$$B = \left(Concentration\ in\ \frac{mg}{kg}\right) = \frac{Concentration\ of\ analyte\ (\frac{mg}{L})}{A}$$

Dry Weight correction

The LIMS calculates the dry weight correction; however it is calculated as follows:

$$Final\ concentration\ in\ \frac{mg}{kg}\ dry\ weight = \frac{B}{\%\ Solids}$$

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10.1.3 Metals Concentration in Liquid samples

Liquid samples are calculated as follows:

$$Dilution\ Factor = \frac{Final\ Volume\ (mL)}{Sampe\ Volume\ (mL)}$$

$$Final\ concentration\ in\ \frac{mg}{L} = Concentration\ of\ analyte\ \left(\frac{mg}{L}\right) X\ Dilution\ factor$$

10.1.4 Calculations for Hardness

The method for determining hardness is to compute it from the results of separate determinations of Calcium and Magnesium on aqueous samples

Total Hardness

$$Total\ Hardness, mg\ equivalent\ \frac{CaCO_3}{L} = \left[2.497\ \left(Ca, \frac{mg}{L}\right)\right] + [4.118\left(Mg, \frac{Mg}{L}\right)]$$

Calcium Hardness

$$Calcium\ Hardness, mg\ equivalent\ \frac{CaCO_3}{L} = [2.497\ \left(Ca, \frac{mg}{L}\right)]$$

10.2 Reporting

For Reporting information refer to Appendix A: Routine Analyte List, LOD, LOQ, and RL.

11.0 Quality Control & Method Performance

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix B for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples.
Matrix Spike	MS	1 per batch
MS Duplicate	MSD	As requested
Sample Duplicate	DUP	1 per batch

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11.1.1 Spectra Interference Check Standard

A mixed check solution is analyzed once daily (section 8.11). One solution (SIC) has only elevated concentrations of Fe, Al, Ca, Mg to ensure no interferences occur. The concentrations of the analytes of interest must have an absolute value for the LLOQ. This solution is analyzed at the beginning of the first analytical run of the day.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix B for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	Per calibration
Initial Calibration Blank	ICB	Per Calibration
Continuing Calibration Verification	CCV	After every 10 exposures
Continuing Calibration Blank	CCB	After every 10 exposures
Linnear Dynamic Range	LDR	Daily check or don't report above calibration
Instrument Detection Limit	LLOQ	Per calibration

11.2.1 Linear Dynamic Range (LDR)

LDR Check Solution: A multiple element or single element solution analyzed at a point above the highest calibration standard under the same calibration used to quantify the associated sample data. The LDR check must be within +/-10% of the true value of each element of interest to be considered valid.

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, for general requirements and procedures for method validation.

Establish limits of quantitation (LOQ) at initial method set up and verify the LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for and LOQ requirements and procedures.

11.3.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-WES2-0122, Demonstration of Capability, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

12.0 Data Review & Corrective Action

12.1 Data Review

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The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-WES2-0126, Data Review, for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix B for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 Pollution Prevention & Waste Management

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Refer to laboratory SOP (234835, Hazardous Waste Management and Sample Disposal), or however named, for waste handling and management practices pertaining to the waste streams created at this facility.

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

15.0 RESPONSIBILITIES

- PAS employees that perform any part of this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- PAS supervisors and managers, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP in the work area(s) they oversee.
- PAS employees are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local QM and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015, *Document Management* and ENV-SOP-CORQ-0016, *SOP for Creation of SOP and SWI.*

16.0 ATTACHMENTS

- Appendix A: Routine Analyte List, LOD, LOQ, and RL
- Appendix B: QC Summary & Corrective Action Table
- Appendix C: State/Program Specific Requirements
- Appendix D: Charts and Tables
    - Table 1: Element Wavelengths
    - Table 2: Precision and Accuracy Acceptance Criteria
    - LCS and Matrix Spike
    - MCP Reporting Limits

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17.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.
- ENV-SOP-CORQ-0006, *Manual Integration*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manua*l, current version.
- ENV-MAN-WES2-0001 V03 *Quality Manual*, current version.
- TNI Standard, "Volume 1 Management and Technical Requirements for Laboratories Performing Environmental Analysis", current version.
- MA DEP 310 CMR 42.00
- Reference Method no: Method 6010D SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA A@-846, Update V, July 2014
- SM 2340B, Hardness by Calculation, Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 21st Edition, 1997

18.0REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
General Document	Document was changed from previous template to Pace Analytical Services Template

Document Succession: This version replaces the following document(s):

Document Number	Version	Document Title	Effective Date:
26796	6	Inductively Coupled Plasma – Atomic Emission Spectrometry	6/13/2023

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Appendix A: Target Analyte Lists, LOD, LOQ, and RL

Standard Analyte List- (Aqueous)

Analyte	CAS #	DL (mg/L)	LOQ[1] (mg/L)	RL[1] (mg/L)
Aluminum	7429-90-5	0.03	0.1	0.1
Antimony	7440-36-0	0.0037	0.05	0.05
Arsenic	7440-38-2	0.0042	0.005	0.005
Barium	7440-39-3	0.0012	0.01	0.01
Beryllium	7440-41-7	0.0007	0.005	0.005
Boron	7440-42-8	0.0092	0.03	0.03
Cadmium	7440-43-9	0.0008	0.005	0.005
Calcium	7440-70-2	0.0189	0.10	0.10
Chromium	7440-47-3	0.0050	0.01	0.01
Cobalt	7440-48-4	0.0017	0.02	0.02
Copper	7440-50-8	0.004	0.01	0.01
Iron	7439-89-6	0.0104	0.05	0.05
Lead	7439-92-1	0.0036	0.01	0.01
Lithium	7439-93-2	0.0021	0.009	0.009
Magnesium	7439-95-4	0.0223	0.10	0.10
Manganese	7439-96-5	0.0040	0.1	0.1
Molybdenum	7439-98-7	0.0009	0.05	0.05
Nickel	7440-02-0	0.0048	0.025	0.025
Potassium	7440-09-7	0.122	2.5	2.5
Sulfur	7704-34-9	0.0635	0.25	0.25
Selenium	7782-49-2	0.0039	0.01	0.01
Silica	7631-86-9	0.109	0.007	0.007
Sodium	7440-23-5	0.266	2.0	2.0
Strontium	7440-24-6	0.0009	0.01	0.01
Thallium	7440-28-0	0.0058	0.02	0.02
Tin	7440-31-5	0.0027	0.05	0.05
Titanium	7440-32-6	0.0022	0.01	0.01
Vanadium	7440-62-2	0.0010	0.01	0.01

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Zinc	7440-66-6	0.0036	0.05	0.05

[1] *LOD, LOQ, and RL are always adjusted to account for actual amounts used and for dilution. Values as of effective date of this SOP. LOD, LOQ, and RL are subject to change. Contact quality personnel for current information.*

Standard Analyte List- (Soils)

Analyte	CAS #	DL (mg/kg)	LOQ[1] (mg/Kg)	RL[1] (mg/Kg)
Aluminum	7429-90-5	0.806	4.0	4.0
Antimony	7440-36-0	0.148	2.0	2.0
Arsenic	7440-38-2	0.0974	0.40	0.40
Barium	7440-39-3	0.0695	0.40	0.40
Beryllium	7440-41-7	0.0306	0.20	0.20
Boron	7440-42-8	0.1400	1.2	1.2
Cadmium	7440-43-9	0.0393	0.40	0.40
Calcium	7440-70-2	1.40	4.0	4.0
Chromium	7440-47-3	0.0712	0.40	0.40
Cobalt	7440-48-4	0.069	0.80	0.80
Copper	7440-50-8	0.179	0.40	0.40
Iron	7439-89-6	0.417	2.0	2.0
Lead	7439-92-1	0.107	2.0	2.0
Lithium	7439-93-2	0.048	0.36	0.36
Magnesium	7439-95-4	0.89	0.40	0.40
Manganese	7439-96-5	0.14	0.40	0.40
Molybdenum	7439-98-7	0.0542	2.0	2.0
Nickel	7440-02-0	0.19	1.0	1.0
Potassium	7440-09-7	19.8	100	100
Sulfur	7704-34-9	1.25	10	10
Selenium	7782-49-2	0.262	0.80	0.80
Silica	7631-86-9	4.34	20	20
Sodium	7440-23-5	8.03	80	80
Strontium	7440-24-6	0.0364	2.0	2.0
Thallium	7440-28-0	0.19	0.80	0.80
Tin	7440-31-5	0.276	4.0	4.0

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Titanium	7440-32-6	0.0737	0.40	0.40
Vanadium	7440-62-2	0.0811	0.40	0.40
Zinc	7440-66-6	0.37		2.0

[1] *LOD, LOQ, and RL are always adjusted to account for actual amounts used and for dilution. Values as of effective date of this SOP. LOD, LOQ, and RL are subject to change. Contact quality personnel for current information.*

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Appendix B: QC Summary & Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
Demonstration of Capability (DOC)	Annual	±20% RSD, 80-120% Recovery	IDOC must be re-analyzed	None
Initial Calibration (ICAL)	Daily (Every 24 hours)	LLOQ recovery 80%-120%	Recalibrate and rerun	None
Initial Calibration Verification (ICV)	Immediately following daily calibration	Must be within 10% of the expected value	re-analyze once, if still failing terminate the analysis, correct the problem, and recalibrate the instrument or exclude failing analyte from analysis	None
Initial Calibration Blank (ICB)	Immediately following daily calibration	<1/2 RL	re-analyze once, if still failing terminate the analysis, correct the problem, and recalibrate the instrument or exclude failing analyte from analysis	None
Low limit of Quantitation (LLOQ)	Following calibration	80%-120%	To verify adequate sensitivity a standard shall be analyzed at or below the lowest concentration for which quantitative data are to be reported without qualification. The low standard must be recovered within 80%-120% of the true value. If the criteria are not met, the calibration is not acceptable for use. Investigate and troubleshoot to correct the problem and perform a new calibration. Do not proceed to analyze samples; sample analysis may not proceed if this quality control measure is not within criteria.	None
Continuing Calibration Verification (CCV)	After every 10th sample and at the end of the sample run	Must verify instrument is within 10% of the calibration with the relative standard deviation <5% from replicate (minimum of two) integrations	Immediate corrective action for a failing CCV/CCB includes reanalyzing the failing standard. If the standard passes the second time then the analysis may be continued. The batch sheet is noted. If the standard fails again, instrument maintenance must be performed and the CCV/CCB standard is reanalyzed. If the standard passes, then all samples run after the last passing CCV/CCB	Analysis may proceed if it can be demonstrated that the CCV exceedance has no impact on analytical measurements. For example, the CCV %R is high, and the analyte is not detected in sample(s).

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Continuing Calibration Blank (CCB)	After every 10th sample and at the end of the sample run	< RL	pair must be re-analyzed. If the standard fails after instrument maintenance, the instrument is recalibrated. A new ICV/ICB is performed, and all previous data after the last passing CCV/CCB is reanalyzed.	Analysis may proceed if it can be demonstrated that the CCB detection has no impact on analytical measurements. For example, the samples are non-detect or 10x higher than the CCB.
Mixed element interference check	The mixed element SIC solution is analyzed at least once per day,	The concentration measured for any target analytes must be less than ±LLOQ	If the SIC fails take corrective action which may include re-evaluation of the inter-element correction values (IECs) after running single element SIC. The instrument calibration routine must then be performed and confirmed by the ICV/ICB pair and the SIC re-analyzed before proceeding with analysis	None
Linear Dynamic Range	Daily	90%-110% of true value	Dilute samples within the calibration range or re-establish / verify the LDR	Flagging is not appropriate
Method Blank (MB)	Per Batch	< RL	If the results of the method blank exceed the RDL for any analyte, perform re-analysis of a new aliquot of the method blank. If all of the samples for the analyte are non-detected or 10x the concentration detected in the method blank, and the method blank is at or above the RDL, no action is required. If one or more associated samples for that analyte have positive results at or above the RDL but less than 10x the concentration, those samples must be considered to be out of control, and are re-digested and reanalyzed.	Analysis may proceed if it can be demonstrated that the MB detection has no impact on analytical measurements. For example, the samples are non-detect or 10x higher than the MB.
Laboratory Control Sample (LCS)	Per Batch	±20% RSD, See table 2 for criteria	LCS can be rerun once due to failure. If upon reanalysis the LCS is still out of control, the failed analytes are re-prepped and re-analyzed.	Analysis may proceed if it can be demonstrated that the LCS detection has no impact on analytical measurements. For example, the samples are non-detect and

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				the LCS %R is above 120%.
Matrix Spike/Spike Duplicate (MS/MSD)	MS Per Batch/MSD per request	See table 2 for criteria	f the Matrix Spike falls outside of the limits as stated in Table 2, or outside any historical documentation for analytes of interest a post analytical spike is performed for the failed analytes. The same sample from which the MS/MSD aliquots were prepared should be spiked with a post digestion spike at a minimum level of 10 times and a maximum of 100 times the lower limit of quantitation. The acceptable % Recovery of the post analytical spike is 75-125%. A nonconformance is noted in the LIMS and approved in secondary peer review and/or by the Metals Manager.	Qualified in LIMS and narrated
Sample Duplicate (DUP)	Per Batch	See Table 2 for criteria	If the Duplicate falls outside of the limits as stated in Table 2, or outside any historical documentation and the concentrations of the failing analytes are less than 5x the RL or a matrix interference is found a nonconformance is noted in the LIMS and approved in secondary peer review and/or by the Metals Manager	Qualified in LIMS and narrated

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Appendix C: State/Program Specific Requirements

This appendix provides state specific requirements that supersede or supplement the main body of the SOP. When analyzing samples from these states, these requirements are applicable. For MCP Reporting Limits, please see Table 4 in Appendix D

State	SOP Section	Requirement
NJ	Section 11, Method Blank	Target analytes must be < RL/LLOQ. If concentration of contamination in MB is >RL/LLOQ, reanalyze the MB. If reanalysis is acceptable, no further action is required. If reanalysis is not acceptable, all associated samples must be redigested and reanalyzed unless sample results are either not detected or >10x concentration in MB. If 10x concentration of the MB the samples will be qualified with a B.
MA MCP	Section 11, Method Blank	Target analytes must be < RL/LLOQ. If concentration of contamination in MB is >RL/LLOQ, reanalyze the MB. If reanalysis is acceptable, no further action is required. If reanalysis is not acceptable, all associated samples must be redigested and reanalyzed unless sample results are either not detected or >10x concentration in MB
MA MCP	Section 11, LCS/LCSD	Analyze one LCS/LCSD pair per sample batch. The LCS/LCSD samples are a spiked volume of reagent water for aqueous digestions or an aliquot of a standard reference material (SRM) for soil/solid digestions, that is brought through the entire preparation and analytical process. The LCS samples must have a % Recovery of 80-120% of the true value for aqueous samples and a % Recovery within the vendor acceptance limits (the 95% confidence level) for soils of the actual value. The LCS/LCSD must have a calculated RPD (relative percent difference) of ≤ 20% (aqueous) and ≤ 30% (soil).

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		If the LCS or LCSD is not recovered within acceptance criteria for an analyte, reanalyze the failed LCS. If the recovery is acceptable, no further action is required. If one LCS is acceptable and the other is not, no corrective action is required. The LCS exceedance must be narrated. If both the LCS/LCSD are outside of criteria, redigest and reanalyze the LCS/LCSD and all associated samples. If the LCS/LCSD RPD is outside of the acceptance criteria, narrate.
MA MCP	Section 11, CCV	If the CCV fails, reanalyze the CCV. If the re-analysis is acceptable, no further action is required. If reanalysis is still outside of criteria, recalibrate and reanalyze all associated samples since the last compliant CCV. If the recovery is high (>110%) and all associated sample results are not detected, no corrective action is required.
MA MCP	Section 11, MS	A Matrix Spike is performed on one field sample per matrix designated by data user on chain-of-custody or at project setup. The MS must recover within 75 – 125%. If the MS recovery is ≥ 30% and ≤ 125%, and the LCS recovery is valid, no further action is required. If the MS recovery is < 30% and associated with non-detected results, redigest (homogenize sample well) and reanalyze sample/MS pair. Report results and narrate. Perform Dilution test and/or post-digestion spike. Narrate exceedances in report narrative.
MA MCP	Section 11, Post-Digestion Spike	A PDS is performed on the same sample the MS was performed on. Only required for analytes that did not meet the acceptance criteria in the MS and only if spike concentration added

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		in MS was > concentration in unspiked sample. Percent Recovery must be 75-125%. Narrate exceedances in report narrative.
MA MCP	Section 11, MSD	One per digestion batch of ≤ 20 field samples designated by data user on the chain-of-custody or at project set-up. Digest and analyze an additional aliquot of the same field sample used for the MS. The RPD for each target analyte must be ≤ 20% for aqueous and ≤ 35% for solids. Narrate exceedances in report narrative
MA MCP	Section 11, Initial Calibration Blank, Continuing Calibration Blank	The results of the ICB/CCB must be < RL/LLOQ. If the results are greater than the RL/LLOQ, re-analyze the ICB/CCB; if acceptable, no further action is required. If reanalysis is still outside of criteria and all associated sample concentrations are either not detected or > 10x blank level, no further action is required. Otherwise, recalibrate and reanalyze ICV and ICB. If ICBs consistently have target metals > RL/LLOQ, re-evaluate the RL/LLOQ.
MA MCP	Section 11, Low-Level Calibration Verification	Daily prior to sample analysis, an LLCV standard is analyzed at the RL/LLOQ for each target analyte. The percent recovery must be within 70 – 130%. If the criteria is not met, re-analyze the LLCV. If reanalysis is acceptable, no further action is required. If reanalysis is still outside of criteria and associated analytes are ≤10x RL/LLOQ in associated field samples, recalibrate and reanalyze the LLCV and associated field samples. If associated field samples are >10x RL/LLOQ, narrate.
MA MCP	Section 11, Dilution Test (Serial Dilution)	Performed once per batch of ≤ 20 field samples. A 1:5 dilution is performed on the same sample that was used for the MS. The percent difference (%D) of the sample and dilution results for target analytes at levels > 25x the

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		RL/LLOQ must be less than or equal to 20% for all matrices. Narrate exceedances in report narrative.

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MCP Analytical Sequence:

- Instrument Calibration
- Initial Calibration Verification (ICV)
- Initial Calibration Blank (ICB)
- Low-Level Calibration Verification (LLCV)
- Blank (to check for carry-over)
- Spectra Interference Check Standard
- Linear Dynamic Range Check
- Continuing Calibration Verification Standard
- Continuing Calibration Blank
- 10 Samples
- Continuing Calibration Verification Standard
- Continuing Calibration Blank

Appendix D: Charts and Tables

Table 1: Element Wavelengths

Element	6500 Duo wavelength (nm)
Pb	220.3
Se	196
Sb	206.8
As	189
Ba	455.4
Be	313
Cd	214.4
Co	228.6
Cu	324.7
Cr	267.7
Fe	259.9
Mn	257.6
Mo	202.0
Ni	231.6
Ag	328.0
Ti	190.8
V	292.4
Zn	206.2

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Al	396.1
Ca	315.8
Mg	279.0
B	208.9
Si	212.9
Sn	189.9
Sr	421.5
Ti	334.9
Bi	223.0
Na	589.5
K	766.4
S	180.7
Li	

Table 2: precision and accuracy acceptance criteria

	% Recovery LCS		Aqueous % Recovery MS		Soil % Recovery SRM *		Duplicate	
Element	**Lower Control Limit**	**Upper Control Limit**	**Lower Control Limit**	**Upper Control Limit**	**Lower Control Limit**	**Upper Control Limit**	**Aqueous % RPD**	**Soil % RPD**
Aluminum	80	120	75	125	29	171	20	20
Antimony	80	120	75	125	4	196	20	20
Arsenic	80	120	75	125	81	119	20	20
Barium	80	120	75	125	83	118	20	20
Beryllium	80	120	75	125	83	117	20	20
Boron	80	120	75	125	70	129	20	20
Cadmium	80	120	75	125	82	117	20	20
Calcium	80	120	75	125	83	117	20	20
Chromium	80	120	75	125	80	119	20	20
Cobalt	80	120	75	125	83	117	20	20
Copper	80	120	75	125	83	117	20	20
Iron	80	120	75	125	51	150	20	20
Lead	80	120	75	125	80	120	20	20
Lithium	80	120	75	125	80	120	20	20
Magnesium	80	120	75	125	74	126	20	20
Manganese	80	120	75	125	83	117	20	20
Molybdenum	80	120	75	125	81	119	20	20

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Nickel	80	120	75	125	82	117	20	20
Potassium	80	120	75	125	74	126	20	20
Sulfur	80	120	75	125	NA	NA	20	20
Selenium	80	120	75	125	80	120	20	20
Silica (SiO2)	80	120	75	125	NA	NA	20	20
Silver	80	120	75	125	66	134	20	20
Sodium	80	120	75	125	74	127	20	20
Strontium	80	120	75	125	80	120	20	20
Thallium	80	120	75	125	79	120	20	20
Tin	80	120	75	125	69	131	20	20
Titanium	80	120	75	125	82	118	20	20
Vanadium	80	120	75	125	79	121	20	20
Zinc	80	120	75	125	82	119	20	20

Table 3: LCS and Matrix Spike

Analyte	Liquid Concentration (mg/L)	Soil Concentration * (MS Spike only) {mg/Kg}
Antimony	0.50	160
Arsenic	0.12	160
Barium	2.00	160
Beryllium	0.05	80
Cadmium	0.051	80
Chromium	0.20	160
Copper	0.25	160
Lead	0.51	160
Nickel	0.50	160
Selenium	0.12	160
Silver	0.05	40
Thallium	0.12	160
Zinc	0.50	160
Iron	1.00	800
Manganese	0.5	160
Calcium	10.0	800
Magnesium	10.0	800
Potassium	10.0	800

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Sodium	10.0	800
Silica	1.00	800
Aluminum	2.00	800
Cobalt	0.50	160
Vanadium	0.50	160
Boron	1.00	NA
Molybdenum	1.00	NA
Lithium	1.00	800
Titanium	1.00	NA

Table 4: MCP Reporting Limits

Element	Aqueous (mg/L)	Soil (mg/Kg)
Aluminum	0.10	4.0
Antimony	0.05	2.0
Arsenic	0.005	0.40
Barium	0.01	0.40
Beryllium	0.005	0.20
Boron	0.03	1.2
Cadmium	0.004	0.40
Calcium	0.10	4.0
Chromium	0.01	0.40
Cobalt	0.02	0.80
Copper	0.01	0.40
Iron	0.05	2.0
Lead	0.01	2.0
Magnesium	0.10	4.0
Manganese	0.01	0.40
Molybdenum	0.05	2.0
Nickel	0.025	1.0
Potassium	2.5	100
Selenium	0.005	0.80
Silicon	0.50	20
Silver	0.007	0.40
Sodium	2.0	80
Strontium	0.01	2.0
Thallium	0.02	0.40
Tin	0.05	4.0
Titanium	0.01	0.40
Vanadium	0.01	0.40
Zinc	0.05	2.0

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Appendix D: Linear Range Reference Table

Wavelength	LDR (PPM)	Standard	Type
Ag 328	1	Cal 1	**LDR**
Al 396	500	ICSA	**SIC/LDR**
As 189	5	LDR Check	**LDR**
B 209	5	LDR Check	**LDR**
Ba 455	10	LDR Check	**LDR**
Be 313	1	Cal 1	**LDR**
Ca 315	500	ICSA	**SIC/LDR**
Cd 214	1	Cal 1	**LDR**
Co 228	1	Cal 1	**LDR**
Cr 267	20	SIC Multi	**SIC/LDR**
Cu 324	20	LDR Check	**LDR**
Fe 259	200	ICSA	**SIC/LDR**
K 766	300	LDR Check	**LDR**
Li 670	5	LDR Check	**LDR**
Mg 279	500	ICSA	**SIC/LDR**
Mn 257	20	SIC Multi	**SIC/LDR**
Mo 202	5	LDR Check	**LDR**
Na 589	500	LDR Check	**LDR**
Ni 231	10	LDR Check	**LDR**
Pb 220	50	LDR Check	**LDR**
S 180	100	LDR S	**LDR**
Sb 206	1	Cal 1	**LDR**
Se 196	1	Cal 1	**LDR**
Si 212	20	LDR Check	**LDR**
Sn 189	1	Cal 1	**LDR**
Sr 421	1	Cal 1	**LDR**
Ti 334	20	SIC Multi	**SIC/LDR**
Tl 190	1	Cal 1	**LDR**
V 292	10	SIC Multi	**SIC/LDR**
Zn 206	20	LDR Check	**LDR**

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Appendix E: Standards Reference Table

Cal	Element	ICP Working Calibration Standard				ICP Calibration Verification Standard			
		Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Cal STD Final Concentration (mg/L)	Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Final Concentration(mg/L)
ICAL	Ag	100	10	1000	1.0	100	10	2000	0.500
	Al	100|1000	10|24		25.0	100	10		0.500
	As	100	10		1.0	100	10		0.500
	B	100	10		1.0	100	10		0.500
	Ba	100	10		1.0	100	10		0.500
	Be	100	10		1.0	100	10		0.500
	Ca	100|1000	10|9		10.0	100	10		0.500
	Cd	100	10		1.0	100	10		0.500
	Co	100	10		1.0	100	10		0.500
	Cr	100	10		1.0	100	10		0.500
	Cu	100	10		1.0	100	10		0.500
	Fe	100|1000	10|24		25.0	100	10		0.500
	K	1000|1000	10|24		35.0	100	10		5.000
	Li	1000	1		1.0	1000	1		0.500
	Mg	100|1000	10|9		10.0	100	10		0.500
	Mn	100	10		1.0	100	10		0.500
	Mo	100	10		1.0	100	10		0.500
	Na	100|1000	10|24		25.0	100|10,000	10|1.9		10.00
	Ni	100	10		1.0	100	10		0.500
	Pb	100	10		1.0	100	10		0.500
	Sb	100	10		1.0	100	10		0.500
	Se	100	10		1.0	100	10		0.500
	Si	50|10,000	10|0.9		10.0	50|10,000	10|1		5.250
	Sn	1000	1		1.0	1000	1		0.500
	Sr	1000	1		1.0	1000	1		0.500
	Ti	100	10		1.0	100	10		0.500
	Tl	100	10		1.0	100	10		0.500
	V	100	10		1.0	100	10		0.500
	Zn	100	10		1.0	100	10		0.500
SCal	S	1000	1	500	2.0	1000	.250	500	0.500

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Appendix F: Daily Standards Reference Tables

Table 1: ICSA

Element	Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Final Concentration (mg/L)
Al	10,000	50	1000	**500**
Ca	10,000	50		**500**
Fe	10,000	20		**200**
Mg	10,000	50		**500**

Table 2: LLOQ Intermediate Stocks (used at 100X)

Element	Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Final Concentration (mg/L)
Ag	1000	0.25	500	**0.5**
As	1000	0.25		**0.5**
B	1000	1.5		**3.0**
Ba	1000	0.5		**1.0**
Be	1000	0.25		**0.5**
Cd	1000	0.2		**0.4**
Co	1000	1.0		**2.0**
Cr	1000	0.5		**1.0**
Cu	1000	0.5		**1.0**
Li	1000	0.5		**1.0**
Mn	1000	0.5		**1.0**
Mo	1000	2.5		**5.0**
Ni	1000	1.0		**2.0**
Li	1000	0.5		**1.0**
Pb	1000	0.5		**1.0**
Sb	1000	2.5		**5.0**
Se	1000	0.5		**1.0**
Si	10,000	25		**50.0**
Sn	1000	2.5		**5.0**

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Sr	1000	0.5		**1.0**
Ti	1000	2.5		**5.0**
Tl	1000	1.0		**2.0**
V	1000	0.5		**1.0**
Zn	1000	0.25		**0.50**
LLOQ Intermediate Mineral Stock (used at 100X)				
Al	1000	5	500	**10.0**
Ca	1000	5		**10.0**
Fe	1000	2.5		**5.0**
K	1000	12.5		**25.0**
Mg	10,000	5.0		**10.0**
Na	10,000	10.0		**20.0**

Table 3: SIC Multi

Element	Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Final Concentration (mg/L)
Cr	1000	20.0	00	**20.0**
Mn	1000	20.0		**20.0**
Ti	1000	20.0		**20.0**
V	1000	10.0		**10.0**

Table 4: LDR Check

Element	Stock Concentration (mg/L)	Aliquot (mL)	Final Volume (mL)	Final Concentration (mg/L)
As	1000	5.0	**1000**	5.0
B	1000	5.0		5.0
Ba	1000	10.0		10.0
Cu	1000	20.0		20.0
K	10,000	30.0		300.0
Li	1000	5.0		5.0
Mo	1000	5.0		5.0
Na	10,000	50.0		500.0
Ni	1000	10.0		10.0

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Pb	1000	50.0		**50.0**
Si	1000	20.0		**20.0**
Zn	1000	20.0		**20.0**

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PCBs

By Capillary Column Gas Chromatography

Reference Methods: Method 8082A SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update IV, 2007.

Quality Control Requirements and Performance Standards for Analysis of Polychlorinated Biphenyls (PCBs) by Gas Chromatography (GC) in Support of Response Action under the Massachusetts Contingency Plan (MCP), Revision No.2, February 15, 2024.

State of Connecticut, Department of Environmental Protection, RRCP, Version 3.0, May 2024.

1. Scope and Application

Method 8082A is used to determine the concentrations of Polychlorinated Biphenyls (PCBs) as Aroclors in extracts from solid, oil and liquid matrices. This SOP details the analysis for PCBs using fused-silica, open-tubular, capillary columns with electron capture detectors (ECD).

Matrices: Extracts from solid, oil and liquid matrices.

Definitions: See Alpha Laboratories Quality Manual Appendix A

Regulatory Parameter List: The standard compounds listed below are determined by this method.

Parameter	CAS#
Aroclor 1016	12674-11-2
Aroclor 1221	11104-28-2
Aroclor 1232	11141-16-5
Aroclor 1242	53469-21-9
Aroclor 1248	12672-29-6
Aroclor 1254	11097-69-1
Aroclor 1260	11096-82-5
* Aroclor 1262	37324-23-5
*Aroclor 1268	11100-14-4

*Note – not certified by NJ for the oil matrix

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Director, or Quality Assurance Officer.
This method is restricted to use by or under the supervision of analysts experienced in the operation of the gas chromatograph (GC) and in the interpretation of gas chromatograms. Each analyst must demonstrate

the ability to generate acceptable results with this method by performing an initial demonstration of capability (see section 13.2).

2. Summary of Method

A measured volume or weight of sample (100mL for liquids, 1g for oil and up to 15g for solids) is extracted using the appropriate matrix-specific sample extraction technique.

Liquid samples are extracted at neutral pH with methylene chloride using Method 3510C (separatory funnel), or other appropriate technique. See extraction SOP for details.

Solid samples are extracted with methylene chloride: acetone (1:1) using Method 3540C (Soxhlet), or other appropriate technique. Solid samples may also be extracted with hexane: acetone (1:1) using Method 3546 (microwave). See extraction SOP for details.

Wipe samples are extracted with methylene chloride: acetone (1:1) using Method 3540C (Soxhlet) or other appropriate technique. See extraction SOP for details.

Oil samples are diluted with hexane following the procedure outlined in the extraction SOP.

Sulfuric acid cleanup (Method 3665A), Copper cleanup (Method 3660B) and Silica Gel cleanup (Method 3630) are utilized for PCB extracts. See extraction SOP for details.

After cleanup, the extract is analyzed by injecting 1µL into a gas chromatograph equipped with narrow- or wide-bore fused silica capillary columns and electron capture (GC/ECD) detectors.

2.1 Method Modifications from Reference

Not applicable.

3. Reporting Limits

The reporting limits for this method as outlined is as follows:

- **Aqueous samples**: 0.04 ug/L / Aroclor based on a 100mL extraction
- **Soil Samples**:
  - 33.3 ug/kg / Aroclor based on 15g extraction
  - 50.0 ug/kg / Aroclor based on 10g extraction
  - 100.0 ug/kg / Aroclor based on 5g extraction
  - 250.0 ug/kg / Aroclor based on 2g extraction
- **Oil Samples**: 5 mg/kg based on 1g extraction
- **Solid of Difficult Matrices** (i.e Caulking, Concrete, etc. are logged using the Alpha Low Level 8082 products): based on a 15g extraction
  - Aroclors 1016, 1221, 1232, 1242, 1254: 20 ug/kg
  - Aroclors 1248, 1260: 13.3 ug/kg
  - Aroclors 1262, 1268: 6.67 ug/kg

4. Interferences

4.1 Instrumental

4.1.1 Only high purity gases are used in the GC system to eliminate this source of possible contamination. Both the Hydrogen (carrier gas) and Nitrogen (detector make-up gas) are certified by the gas supplier.

4.1.2 Preventive instrument maintenance is performed routinely, and whenever highly contaminated extracts are analyzed that could result in chromatographic interferences or result in degradation of system performance. Section 10.6 describes the maintenance steps.

4.1.3 Glassware must be scrupulously cleaned. This procedure is detailed in the Organic Extraction Cleaning and Handling SOP/1953. Store dry glassware in a clean environment.

4.2 Parameters

4.2.1 All solvents used are pesticide grade or equivalent, and reagents are purchased as certified contaminant free. All these materials are routinely determined to be free of interferences by analysis of extraction blanks with every extraction batch performed.

4.2.2 Certain compounds (i.e. phthalates) can be extracted from the sample matrix and be detected by the ECD that could possibly result in false positive results or complicate the data interpretation. The use of the cleanup procedures detailed in the extraction SOP minimizes these possible interferences. Analyst experience is also crucial in making compound determinations.

4.2.3 Interferences co-extracted from the samples will vary considerably from waste to waste. While a general cleanup technique is referenced or provided as part of the method, unique samples may require additional cleanup approaches to achieve desired degrees of discrimination and quantitation.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. PCBs have been tentatively classified as known or suspected human or mammalian carcinogens. Additional references to laboratory safety are available in the Chemical Hygiene Plan.
All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

5.1 Lab coats, safety glasses, and gloves must be worn when handling samples, extracts, standards or solvents.

5.2 All solvent and extract transfers must be handled in the vented bench area in the GC laboratory.

5.3 All stock standards, working standards, and vialed sample extracts must be placed into the waste bucket in the lab, for future disposal by the Hazardous Waste Manager. The container must be labeled properly with hazard warning labels indicating the container contents.

5.4 Bottles containing flammable solvents must be stored in the flammable cabinet.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

Aqueous samples are collected in two 100mL amber glass jars with Teflon-lined lids. Solid samples are collected in one 250mL wide-mouth glass jar with a Teflon-lined lid. Oil samples are collected in a glass jar with Teflon-lined lids. All containers are purchased pre-cleaned and certified from commercial vendors.

6.2 Sample Preservation

Both aqueous and solid samples are then preserved by packing in coolers with ice or ice packs, to maintain a temperature of 4 ± 2° C. Upon receipt at the laboratory, the samples are transferred into sample storage refrigerators to maintain at a temperature of 4 ± 2° C. Preservation is not required for oil samples.

6.3 Sample Handling

- TCLP/SPLP tumbled extracts, NJ DKQP aqueous samples must be extracted within 7 days of sample collection.
- NJ DKQP soil/solid and oil samples within 14 days of collection (NJ DKQP allows 365 days for solids if frozen).
- All other samples, both aqueous and solids, have a 365-day hold time.
- Once extracted, the samples must be analyzed within 40 days of the extraction date.

7. Equipment and Supplies

7.1 Gas Chromatograph, Agilent 6890, 7890: An analytical system completed with gas chromatograph configured for split-splitless injection and all required accessories including syringes, analytical columns, gases, electron capture detectors (ECD), and data system.

7.2 GC Columns: Alpha utilizes dual-column analyses. The dual-column approach involves a single injection that is split between two columns that are mounted in a single gas chromatograph. Typical column pair used is listed below. Other columns may be used as long as method performance criteria can be met.

Column pair:

RTX-CLP: Cat. #11141 from Restek or equivalent; 30m, 0.32mm, 0.32µm

RTX-CLPII Cat. #11324 from Restek or equivalent; 30m, 0.32mm, 0.25µm

7.3 Guard Column: Cat. #10027 from Restek or equivalent; 5m, 0.32mm

7.4 Class "A" Volumetric Flasks: 10mL and 25mL (and other volumes), for standards preparation

7.5 Microsyringes: 10 µL – 1000 µL

7.6 Gooseneck splitless injecton liner, Cat #20799-214.5 from Restek or equivalent

7.7 Universal "Y" Press-tight tee split: Cat. #20406 from Restek or equivalent / **Siltek MXT Connector:** Cat. #21388 from Restek or equivalent

8. Reagents and Standards

Reagent grade or pesticide grade chemicals are used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficient high purity to permit its use without lessening the accuracy of the determination.
NOTE: Store the standard solutions (stock, composite, calibration, internal, and surrogate) at 4 ± 2° C in Teflon(R)-sealed containers in the dark. When a Lot of standards is prepared, aliquots of that Lot are stored in individual small vials. All stock standard solutions must be replaced after one year or sooner if routine QC tests indicate a problem. All other standard solutions must be replaced after six months or sooner if routine QC indicates a problem.

8.1 n-Hexane: Pesticide quality or equivalent.

8.2 Acetone: Pesticide quality or equivalent.

8.3 Organic-free Reagent Water: All references to water in this method refer to organic-free reagent water from Alpha's RO water treatment system.

8.4 Stock Standard Solutions: All stock standard solutions are purchased from commercial vendors as ampullated certified solutions. When an ampullated stock solution is opened, it is transferred to a labeled amber screw-cap vial. The expiration date of the stock solution is either the vendor specified expiration date, or 1 year from the date the ampule was opened, whichever is sooner.

8.5 Calibration Standards: Calibration standards are prepared volumetrically by diluting the appropriate stock standard(s) with hexane. Calibration standards expire 6 months from the date of preparation, or on the earliest expiration date of any of the stock solutions used to prepare the calibration standard. Calibrations are performed at the 6 concentration levels listed in Table 1. The list of ampullated calibration standards is obtain from **Agilent**:

- Aroclor 1016, Cat. #PP-282, at 100ug/mL
- Aroclor 1260, Cat. #PP-361, at 100ug/mL
- Aroclor 1262, Cat. #PP-371, at 100ug/mL
- Aroclor 1268, Cat. #PP-382, at 100ug/mL
- Aroclor 1221, Cat. #PP-292, at 100ug/mL
- Aroclor 1232, Cat. #PP-302, at 100ug/mL

- Aroclor 1242, Cat. #PP-312, at 100ug/mL
- Aroclor 1248, Cat. #PP-342, at 100ug/mL
- Aroclor 1254, Cat. #PP-351, at 100ug/mL

8.5.1 Preparation of Initial Calibration Standards:

8.5.1.1 SOIL ICAL:

- **1660 L7**: (mix of Aroclors 1016 and 1260) is prepared by diluting
  - 5mL 1016 Standard (Agilent, Cat. #PP-282)
  - 5mL 1260 Standard (Agilent, Cat. #PP-361)
  - 6.4mL of PCB ICAL Surrogate Stock

  to 25ml of Hexane to achieve concentration of
  - 1016 and 1260 at 20ug/mL
  - TCMX at 1.28ug/mL and DCB at 2.56ug/mL.

- **2154 L7:** (mix of Aroclors 1221 and 1254) is prepared by diluting
  - 5mL 1221 Standard (Agilent, Cat. #PP-292)
  - 5mL 1254 Standard (Agilent, Cat. #PP-351)

  to 25ml of Hexane to achieve concentration of
  - 1221 and 1254 at 20ug/mL
- **4268 L7** (mix of Aroclors 1242 and 1268), **3262 L7** (mix of Aroclors 1232 and 1262) and **1248 L7;** all are prepared from their respective Stock Standards according to the formula used for L7 of 2154.
- Levels 1-6 are prepared by serial dilutions and a formula with volumes needed can be found in Table 2.

8.5.1.2 RVT ICAL:

- Prepare 2 Intermediate ICAL Standards by diluting 1016/1260 L7 of Soil ICAL:
  - **Stock#1** (10ug/mL): 500uL of 1660 L7 + 500uL of Hexane
  - **Stock#2** (0.5ug/mL): 25uL of 1660 L7 + 975uL of Hexane
- Use the VYPER programs: **pcb_rvt_L1-L6** and **pcb_rvt_L7-L10** to vial 1660 ICAL according to the formula and to achieve the concentrations provided in Table 3.
- Prepare one-point cal standards for all other Aroclors by diluting respective L7 stock solutions by using the VYPER program:

  12.5uL of L7 + 987.5uL of Hexane
  pcb_rvt_1point_set

8.6 Second Source Standards: (ICV) Initial Calibration Verification standards are prepared volumetrically by diluting the appropriate stock standard(s) with hexane. Initial Calibration Verification standards expire 6 months from the date of preparation, or on the

earliest expiration date of any of the stock solutions used to prepare the standard. The list of ampullated standards is obtain from **Accustandard**:

- Aroclor 1016, Cat. #C-216S-H-10X, at 1000ug/ml
- Aroclor 1260, Cat. #C-260S-H-10X, at 1000ug/ml
- Aroclor 1262, Cat. #C-262S-H-10X, at 1000ug/ml
- Aroclor 1268, Cat. #C-268S-H-10X, at 1000ug/ml
- Aroclor 1221, Cat. #C-221S-H-10X, at 1000ug/ml
- Aroclor 1232, Cat. #C-232S-H-10X, at 1000ug/ml
- Aroclor 1242, Cat. #C-242S-H-10X, at 1000ug/ml
- Aroclor 1248, Cat. #C-248S-H-10X, at 1000ug/ml
- Aroclor 1254, Cat. #C-254S-H-10X, at 1000ug/ml

8.6.1 Preparation of ICV Standards:

- **1660 ICV:** is prepared by diluting
  - 50uL 1016 Standard (AccuStandard, Cat. #C-216S-H-10X)
  - 50uL 1260 Standard (AccuStandard, Cat. #C-260S-H-10X)
  - 320uL of PCB CCAL Surrogate Stock

  to 20ml of Hexane to achieve concentration of
  - 1016 and 1260 at 2.5ug/mL
  - TCMX at 0.16ug/mL and DCB at 0.32ug/mL

- **2154, 4268, 3262 and 1248 ICVs** are prepared from their respective Stock Standards according to the formula used for 1660 ICV.

- Prepare **RVT ICVs** for all Aroclor standard solutions by diluting respective ICV stocks by using VYPER's pcb_rvt_icv program:
  - 100uL of ICV to 900uL of Hexane, achieving a concentration of
  - 1016 and 1260 at 0.25ug/mL
  - TCMX at 0.016ug/mL and DCB at 0.032ug/mL

8.7 Internal Standard Solution: 1-Bromo-2-nitrobenzene (Ultra, Cat. #PPS-351) is used as the internal standard and is added to all single-component calibration standards and sample extracts to achieve a concentration of 0.25µg/mL. For RVT, this solution is diluted 10X more, achieving a concentration of 0.025µg/mL.

8.8 Surrogate Standards: Tetrachloro-m-xylene (TCMX) and Decachlorobiphenyl (DCB) are used as surrogates for Aroclor analysis. They are added to the calibration standards at the concentrations listed in Table 1, Continuing Calibration Standards and are spiked into all samples and QC samples prior to extraction.

- **ICAL Surrogates Stock:** is prepared by diluting 500uL of Pesticides Surrogates Standard Spiking Solution (Ultra, Cat. #ISM-320-1) and 500uL of Decachlorobiphenyl (Accustandard, Cat. #CLP-032-R-01) to 20mL of Hexane to achieve concentration of TCMX at 5ug/mL and DCB at 10ug/mL.

- **CCAL Surrogates Stock:** is prepared by diluting 1mL of TCMX&DCB (Accustandard, Cat. #CLP-032-R) and 1mL of Decachlorobiphenyl (Accustandard, Cat. #CLP-032-R-01) to 20mL of Hexane to achieve concentration of TCMX at 10ug/mL and DCB at 20ug/mL.
- **Extraction Surrogates Stock:** is prepared by diluting 10mL of TCMX&DCB (Accustandard, Cat. #CLP-032-R) to 1000mL of Acetone to achieve concentration of TCMX and DCB at 2ug/mL.
- **RVT Extraction Surrogates Stock**: is prepared by diluting 1.25mL of TCMX&DCB (Accustandard, Cat. #CLP-032-R) to 500mL of Acetone to achieve concentration of TCMX and DCB at 0.5ug/mL.
- **PCB Caulking Surrogates Stock:** is prepared by diluting 10mL of TCMX&DCB (Accustandard, Cat. #CLP-032-R) to 100mL of Acetone to achieve concentration of TCMX and DCB at 20ug/mL.
- **PCB Oil Surrogate Stock:** is prepared by diluting 5mL of TCMX&DCB (Accustandard, Cat. #CLP-032-R) to 500mL of Hexane to achieve concentration of TCMX and DCB at 2.0ug/mL.

8.9 LCS/MS Spiking Solutions:

- **PCB Matrix Spike:** The LCS/MS spiking solution is prepared by diluting 6.25mL of Arochlor 1016/1260 (Restek, Cat. #32039) to 500mL of Acetone to achieve concentration of Arochlor 1016/1260 at 12.5ug/ml. For **RVT**, 1.25mL of the stock solution is diluted to 500mL of Acetone to achieve a concentration of Aroclor 1016/1260 at 2.5 ug/mL.

- **PCB Caulking Matrix Spike:** The LCS/MS spiking solution is prepared by diluting 6.25mL of Arochlor 1016/1260 (Restek, Cat. #32039) to 50mL of Acetone to achieve concentration of Arochlor 1016/1260 at 125ug/mL.

- **PCB Oil Matrix Spike:** The LCS/MS spiking solution is prepared by diluting 2.5mL of Arochlor 1016/1260 (Restek, Cat. #32039) to 200mL of Hexane to achieve concentration of Arochlor 1016/1260 at 12.5ug/mL.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 Blank(s)

A Method Blank is an aliquot of a clean reference matrix (reagent water for water samples, Ottawa sand for soil/sediment samples, or PCB free transformer oil for oil samples) that is carried through the entire analytical procedure. Extraction blanks are performed with each extraction batch of 20 or less samples, according to the extraction SOPs. The extraction blank must not contain any of the reportable analytes above the reporting limit. If any reportable analytes are detected in the blank, the entire extraction batch is suspect and re-extraction of all associated samples is required, unless the associated samples are non-detect or concentration of the analyte in the samples is 10 times greater than the concentration of this analyte in the blank. The surrogate recoveries must also be within the acceptance criteria listed in Table 4. If surrogate acceptance criteria are exceeded, the extraction batch must be evaluated to determine if re-extraction or re-analysis is necessary. Actions associated with Method Blank failures are listed in Table 6.

9.2 Laboratory Control Sample (LCS)

A Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD) pair is extracted with each analytical batch. The LCS/LCSD consist of an aliquot of a clean (control) matrix similar to the sample matrix and of the same weight or volume. For Aroclor analysis, the LCS/LCSD are spiked with a mixture of Aroclor 1016 and 1260 (1660) at the levels listed in Table 5. The recovery acceptance criteria are listed in Table 4. If any recovery criteria are not met, the extract may be re-analyzed. If the criteria are still not met, the **entire batch is re-extracted**, unless the recoveries are high, and the associated samples are non-detect. If this is not possible, due to insufficient sample or holding time exceedances, the analyst must narrate the failure in the LIMS for inclusion in the client report. Actions associated with LCS/LCSD failures are listed in Table 6.

9.3 Initial Calibration Verification (ICV)

Refer to Section 10.2.7.

9.4 Continuing Calibration Verification (CCV)

Refer to Section 10.4.

9.5 Matrix Spike/ Matrix Spike Duplicate (MS/MSD)

Matrix Spike and Matrix Spike Duplicate are field samples spiked with known target analyte(s) at the levels listed in Table 5. Upon client request, an MS/MSD pair is extracted and analyzed with each batch of 20 or less samples. MS samples serve as a measure of extraction accuracy, by allowing the comparison of the found amount(s) of target analyte(s) with the spiked amount(s). An MS/MSD set also allows for the calculation of the extraction precision, by comparing the results of the two samples. The recovery acceptance criteria are listed in Table 4. If the recovery criteria are not met, but are met in the LCS, the failure may be attributed to sample matrix effects. Actions associated with MS/MSD failures are listed in Table 6.

For samples with a state of origin of New Jersey, a MS must be extracted for every twenty samples within a 24hr period.

9.6 Laboratory Duplicate (DUP)

Duplicates are laboratory selected replicate samples, prepared by taking an additional sample aliquot of a sample. Upon client request, a DUP is extracted and analyzed with batch of 20 or

less samples. Duplicates serve as a measure of the extraction precision, by comparing the results of the sample and duplicate. The relative percent difference (RPD) acceptance criteria are listed in Table 4. If the RPD criteria are not met, the failure may be attributed to matrix effect. Actions associated with DUP failures are listed in Table 6.

For samples with a state of origin of New Jersey, a DUP must be extracted for every twenty samples within a 24hr period.

9.7 Surrogates

All extracted samples and associated QC are spiked with surrogates at the levels listed in Table 5. The laboratory must evaluate surrogate recovery data from individual samples and QC samples versus the surrogate control limits listed in Table 4. If the surrogate limits are not met, the extract may be reanalyzed to determine if the failure was due to an instrument problem. If the criteria are still not met, the affected samples must be re-extracted to confirm that the failure was due to sample matrix, unless the surrogate recovery is high, and the associated sample is non-detect. If matrix effect is confirmed, this must be noted on a narrative sheet for inclusion in the client report.

9.8 Method Sequence

Typical Initial calibration (each level and ICV to identified with the standard lot number)

1. Prime
2. Blank
3. Standard Level 1
4. Standard Level 2
5. Standard Level 3
6. Standard Level 4
7. Standard Level 5
8. Standard Level 6
9. Standard Level 7
10. Initial Calibration Verification Standard (ICV)

Repeat steps 3 – 9 as needed for each Aroclor necessary for calibration.

NOTE: If multiple calibration mixtures are analyzed, it is acceptable to analyze appropriate ICVs after all calibration standards have been injected.

Typical Daily Sequence

1. 1660 Continuing Calibration Standard **(identified with the standard lot number)**
2. Extraction Blank

3. Laboratory Control Sample / Laboratory Control Sample Duplicate
4. Matrix Spike / Matrix Spike Duplicate (if requested by Client)
5. Duplicate (if included with batch QC)
6. Samples - **up to 20 field samples**
7. Repeat 1 – 6 as needed.

10. Procedure

10.1 Equipment Set-up

10.1.1 GC Conditions:

The dual-column / dual-detector approach involves the use of the columns listed in section 7.2. The columns are connected to an injection tee or dual injection GC, and separate electron capture detectors. Alpha typical GC conditions are listed below but may be altered as long as method performance criteria are met.

	INSTRUMENT CONDITIONS
Injector temperature	250^{0}C
Injector mode	Split 10:1
Split Flow	60.1 mL/min
Total Flow	78.2 mL/min
Detector temperature	350^{0}C
Carrier gas	Hydrogen
Carrier flow	20mL/min
Carrier mode	Constant flow
Makeup gas	Nitrogen
Total detector flow	60mL/min
Injection Volume	1µL

	OVEN TEMP PROGRAM
Temperature 1	150 ^{0}C
Time 1	0 min
Ramp 1	45^{0}C/minute
Temperature 2	230^{0}C
Time 2	0 min
Ramp 2	30^{0}C/minute
Temperature 3	330^{0}C
Time 3	1 min

10.2 Initial Calibration

10.2.1 Prepare calibration standards using the standards listed in Section 8.5 to achieve the concentrations from Table 1.

For Analysis of Aroclors which use an **Average Response Factor model (AVG)** the minimum requirement is to perform an initial multi-point calibration for a mixture of 1016/1260 and to use a **one-point initial calibration** to determine the calibration factor and pattern recognition for the remaining Aroclors (TNI standard 1.7.1.1.m). The concentrations of the other Aroclors should generally correspond to the mid-point of the linear range of the detector, but lower concentrations may be employed.

10.2.2 Establish the GC operating conditions by loading the appropriate GC method. Typical instrument conditions are listed in section 10.1.1. The same operating conditions are used for calibrations and sample analyses. Create the analytical sequence using the Agilent Chemstation data acquisition software. Record the

calibration standard, unique lot number (PP#) and analyst's initials in the analytical sequence list.

10.2.3 A 1µL injection volume of each calibration standard is typically used. Other injection volumes may be employed, provided that the analyst can demonstrate adequate sensitivity for the compounds of interest. The same injection volume must be used for all standards and samples.

10.2.4 Column adsorption may be a problem when the GC has not been used for a day or more or after system maintenance. The GC column may be primed (or deactivated) by injecting a PCB standard mixture approximately 20 times more concentrated than the mid-concentration standard. Inject this standard mixture prior to beginning the initial calibration or calibration verification.

Alternately, the system may be primed by baking at the final analytical temperature for approximately 30 minutes.

Several analytes may be observed in the injection just following system priming. Always run an instrument blank after system priming.

10.2.5 **Calibration Factor:** Internal Standard Calibration techniques are employed in this method.

10.2.7.1 Internal Standard Procedure. In each standard, calculate the response factor (RF) for each analyte, the average RF, and the relative standard deviation (RSD) of the RFs, using the Enviroquant data processing software. The calculations are performed automatically, using the formula listed in Quality Manual.

Alternatively, standards of the other seven Aroclors are necessary for pattern recognition. When employing the traditional model of a linear calibration through the origin, these standards are also used to determine a single-point calibration factor for each Aroclor, assuming that the Aroclor 1660 mixture has been used to describe the detector response.

The standards for these seven Aroclors should be analyzed before the analysis of any samples with hits above the RL. For example, an Aroclor 1254 standard should be analyzed before a sample with a hit of Aroclor 1254.

10.2.6 Initial Calibration Criteria

- If the **RSD for an analyte is < 20%**, then the response of the instrument for this compound is considered linear over the range and the mean calibration factor can be used to quantitate sample results.
- If the **RSD for any analyte is > 20%**, then linearity through the origin cannot be assumed. The mean response factor cannot be used for quantitation. An alternative calculation may be done using **linear regression** or **quadratic regression** (minimum of six ICAL points are needed and regression must be weighted inversely proportional to concentration) if the correlation coefficient is **>0.990**. If both quantitation methods fail criteria for any compound in the initial calibration, then the system must be reevaluated, and a new calibration curve must be analyzed. If quadratic regression is used for calibration, this must be noted in the laboratory narrative.

- **A minimum of 3 peaks must be chosen** for each Aroclor and preferably 5 peaks (11.4.6.1 8082A).

- **The minimum number of calibration standards** based on the type of calibration curve is listed below:

Type of Calibration Curve	Minimum Number of Calibration Standards
Linear Fit/Avg Response	5
Quadratic Fit	6

- **Removal and replacement of the calibration standards:**
  - The Analyst may remove individual analyte from the lowest (cannot remove RL level) and or the highest calibration levels of the curve. Removal of the individual analyte of interior levels is not permitted.
  - The Analyst may remove an entire single standard calibration level from the interior of the calibration curve when the instrument response demonstrates that the standard was not properly introduced to the instrument, or an incorrect standard was analyzed. The Analyst who chooses to remove a calibration standard from the interior of the calibration shall remove that particular standard calibration level for all analytes.
  - The Analyst may replace a calibration standard provided that:
    - the replacement standard will be analyzed within twenty-four (24) hours of the original calibration standard analysis for that particular calibration level;
    - all analytes of the replacement calibration standard must be replaced if a standard within the interior of the calibration is replaced;
    - the laboratory limits the replacement of calibration standards to one calibration standard concentration.

- **Percent Relative Error (%RE)**: For linear and quadratic fit compounds, the %RE must be calculated for the standard at or near the midpoint and at the lowest level of the initial calibration. The %RE between the calculated and expected concentration of an analyte must be **≤ 30%**, otherwise recalibration is necessary.

10.2.7 Initial Calibration Verification

An initial calibration verification standard must be run immediately after each initial calibration, near the midpoint of the curve. The standard must be prepared using a second source that is different than the source used for the initial calibration. (Standards listed in Section 8.6). The **%D** has to be within **20%** when compared to the mean response factor from the initial calibration.

If recovery is **outside the 80-120% criteria**, the following steps should be taken:

- Analyze the replacement standard. The cause of the failure of the first calibration verification result should be documented.
- If the reanalysis still didn't achieve the criteria, the source of the problem must be investigated, and instrument must be recalibrated.

10.2.8 Retention Time Window

10.2.8.1 The retention time window used for the identification of target analytes is ± 0.07 minutes. These criteria have been adopted from the EPA CLP Statement of Work (OLM04.2). It has been found that these limits work well, being wide enough to eliminate false-negatives while being tight enough to eliminate false-positives. Windows that are calculated using the procedure recommended in Method 8000 tend to be very narrow, creating the risk of false negative results.

10.2.8.2 The windows listed above are used as guidance; however, the experience of the analyst weighs heavily in the interpretation of the chromatograms. For example, it has been observed that certain oil matrices can cause the retention times to shift more dramatically.

10.3 Sample Processing

The determination of PCB Aroclors is accomplished by comparing the sample chromatogram to that of the most similar Aroclor standard. The use of PCB overlays is extremely helpful, either by using hardcopies of chromatograms or by utilizing the Enviroquant software. A choice must be made as to which Aroclor is most similar and whether that standard is truly representative of the PCB in the sample. Both retention time and pattern are important when determining PCBs in a sample.

Samples that contained weathered PCB present special analytical challenges. Weathering could alter the Aroclor pattern to the extent that different peaks have to be selected for quantitation. Samples that contained more than one Aroclor present similar problems. For these samples, the Analyst may have to consider selecting the earlier eluting peaks for the lower boiling Aroclor and selecting the later eluting peaks for the higher boiling Aroclors to minimize overlapping peaks.

Minimum of 3 peaks must be chosen for each Aroclor. In these instances, the Analyst may need request the assistance of someone with more expertise in determining the presence of PCB Aroclor.

If compound identification or quantitation is precluded due to interference (e.g., broad, rounded peaks or ill-defined baselines are present) cleanup of the extract may be needed. If instrument problems are suspected, rerun the extract on another instrument to determine if the problem results from analytical hardware or the sample matrix. Refer to the extraction SOPs for the procedures to be followed in sample cleanup.

- The laboratory must report the ***HIGHER*** of the two results unless obvious interference is present on of the columns.

- The **Relative Percent Difference (RPD)** should be **≤ 40%.** If the RPD exceeds 40, this will be denoted with a P flag. If the RPD exceedance is due to interference, the lower of the dual column values can be reported with I and P flags.

If any peaks are above the calibration, a dilution must be done. The dilution reported is the least dilute level at which the peak area is within the calibration range.

10.4 Continuing Calibration

10.4.1 Verify calibration each **12-hours** shift by injecting calibration verification standards prior to conducting any sample analyses. A calibration standard must also be injected at intervals of not less than **once every twenty filed samples**.

A bracketing CCV is not required with the use of internal standard calibration (Method 8082A 11.6.8)

For Aroclor analysis, the calibration verification standard should be a mixture of Aroclor 1016 and 1260 (1660). The calibration verification process does not require analysis of the other Aroclor standards used for pattern recognition (Method 8082A 11.6.2). However, if the one-point calibration is used for the seven other Aroclor, a calibration standard must be analyzed before the sample for any hits.

10.4.2 The **Response Factor** (for internal standard compounds) for each analyte to be quantitated must not exceed a **± 20% difference** when compared to the initial calibration curve The Enviroquant data processing software automatically calculates the **%D** for all analytes.

10.5 Internal Standard

The use of internal standard calibration does not require that all sample results be bracketed with CCV standard. However, when internal standard calibration is used, the retention times of internal standards and the area response of internal standards should be checked for each analysis (10.4.3).

10.5.1 **IS in CCAL** – The measured area of the internal standard must be no more than ± 50% different from the average area calculated during initial calibration **(-50 to 150%).**

10.5.2 **IS in samples** - The measured area of the internal standard must be no more than -50% to +100% different from the area calculated from opening CCV **(-50 to 200%)**

Retention Time shift >30 seconds from the retention time of the most recent calibration standard are cause for concern and must be investigated.

10.6 Preventive Maintenance

10.6.1 **Preventive Maintenance:** Routine preventive maintenance is performed to maintain GC system performance. This includes periodic replacement of injector septa, replacement of injector liner(s), and replacement of injector seals.

10.6.2 Other Maintenance: ECD detectors may become contaminated, requiring bake out at elevated temperatures, (no greater than 375°C) or repair by the manufacturer.

11. Data Evaluation, Calculations and Reporting

11.1 Quantitation of Aroclors

Per Method 8082A, quantitation is based on the use of a minimum of 3 of the major peaks present in the analyte, although the use of 5 of the major peaks is recommended. Each of these peaks is individually calibrated with a **minimum of five calibration points** based on average response factors. The %RSD must meet the criteria of ≤20% for the ICAL. The five major peaks are calculated as described below. After individual calculation meets criteria, the average of the peaks selected for quantitation is used to determine the final concentration.

11.1.1 Aqueous samples

$$\text{Concentration } (\mu g/L) = \frac{C \times DF \times Vf \times 1000}{Vo}$$

where:
C = Extract concentration (µg/mL), **NOTE**: ng on column = ng/injection volume = ng/uL = ug/mL
DF = Dilution factor
Vf = Final extract volume (mL)
Vo = Sample volume (mL)

11.1.2 Soil/sediment samples

$$\text{Concentration } (\mu g/Kg, \text{ dry weight}) = \frac{C \times DF \times Vf \times 1000}{W\ (gm)} \div \%S$$

where:
C = Extract concentration (µg/mL), **NOTE**: ng on column = ng/injection volume = ng/uL = ug/mL
DF = Dilution factor
Vf = Final extract volume (mL)
W = Weight of the sample extracted (10g for high, 30g for low)
%S = Percent solids, as a decimal value

11.1.3 Reporting Results

11.1.3.1 After performing technical data review, validating that all QC criteria have been met and confirming all positive hits, the data report is sent electronically to the LIMS computer for generation of the client report. There are two levels of review of the data in the LIMS system prior to release of data. These reviews must be done by two separate individuals.

11.1.3.2 Reporting Results for PCBs in Caulking Samples

If in the screen sample Aroclor concentration as calculated above is **≥20000ppm**, the Client is contacted by a Customer Service Representative and these results are sent to the LIMS and reported to the Client.

If the sample concentration as calculated above for any Aroclor is **<20000ppm**, the sample is sent for re-extraction by Method 3540C (Alpha SOP/1954).

11.1.3.3 Summation Rules

"TOTAL" concentrations are calculated for **ALL samples and Quality Control Samples** (i.e. LCS, MS, DUP, BLK).

TOTAL = sum of "reportable" Aroclors

Reportable- all Aroclors reported for associated project.

For dual-column analysis, Total is reported as part of column "A" data, unless all individuals are reported from "B" column. "Total" is calculated based on the associated "Report List". See Work Instruction #14335 for details.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

Holding time exceedance and/or improper preservation are noted on the nonconformance report form.

Perform instrument maintenance as described throughout this SOP as needed when instrument calibration criteria are not met. Record all maintenance in the instrument logbook.

All batch and sample specific QC criteria outlined in Section 10 are evaluated by the analyst prior to approval of the data. When any QC criteria fail, the cause for the failure must be identified and corrected. This may include instrument recalibration followed by sample reanalysis, sample cleanup, or sample re-extraction. If it is determined that the failure is due to sample matrix effects, a project narrative report is written into the LIMS by the analyst for inclusion in the data report. If there is insufficient sample volume to perform the re-analysis for confirmation, this is also noted in the narrative and included in the client report.

13. Method Performance

13.1 Method Detection Limit Study (MDL) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the MDL, LOD, and/or LOQ as outlined in Pace SOP/1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Pace SOP/1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Pace's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

SOP/1732 MDL/LOQ Generation

SOP/1739 IDC/DOC Generation

SOP/1728 Waste Management and Disposal SOP

16. Attachments

Table 1: STANDARD SOLUTIONS

Table 2: PCB ICAL PREPARATION

Table 3: PCB RVT ICAL PREPARATION

Table 4: QC ACCEPTANCE CRITERIA

Table 5: SPIKING LEVEL

Table 6: QC FAILURE ACTION PLAN

TABLE 1

STANDARD SOLUTIONS – Suggested Concentrations

STANDARD SOLUTIONS	Stock Solution (ug/mL)	Level 1 (ug/mL)	Level 2 (ug/mL)	Level 3 (ug/mL)	Level 4 (ug/mL)	Level 5 (ug/mL)	Level 6 (ug/mL)	Level 7 (ug/mL)
AROCLORS								
1016,1221,1232,1242, 1248,1254, 1260,1262,1268	100	0.1	0.5	1	2.5	5	10	20
Aroclors 1221, 1232, 1242, 1254, 1262, 1268	100	0.1	0.5	1	2.5	5	10	20
Internal Standard								
1-Bromo-2-Nitrobenzene	5000	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Surrogates:								
Tetrachloro-m-xylene	2.0	0.0064	0.032	0.064	0.16	0.32	0.64	1.28
Decachlorobiphenyl	2.0	0.0126	0.064	0.128	0.32	0.64	1.28	2.56

TABLE 2

PCB SOIL ICAL PREPARATION:

Aroclors: 1660, 2154, 4268, 3262, 1248				
Level	**Conc [ug/L]**	**Spike**	**Spike [uL]**	**Hexane [uL]**
6	10000	L7	5000	10000
5	5000	L6	500	500
4	2500	L6	250	750
3	1000	L6	100	900
2	500	L6	50	950
1	100	L6	10	990

TABLE 3

PCB RVT ICAL PREPARATION:

Level	Aroclor Conc	TCMX/DCB Conc	Stock#	VYPER Program	Stock Vol used	FV
	ug/L	ug/L			uL	mL
L1	4	0.256/0.512	2	**pcb_rvt_L1-L6**	8	1
L2	10	0.64/1.28			20	
L3	20	1.28/2.56			40	
L4	30	1.92/3.84			60	
L5	40	2.56/5.12			80	
L6	50	3.20/6.40			100	
L7	100	6.40/12.8	1	**pcb_rvt_L7-L10**	10	
L8	250	16/32			25	
L9	500	32/64			50	
L10	1000	64/128			100	

TABLE 4

QC ACCEPTANCE CRITERIA

Aqueous, Soils, Oils		
Surrogate	Lower Control Limit	Upper Control Limit
2,4,5,6-Tetrachloro-m-xylene	30%	150%
Decachlorobiphenyl		

	Aqueous, Soils % Recovery	**RPD%**	
		Waters	**Soils**
MS/MSD LCS/LCSD	40-140%	50%	50%
		20% (NJ/CT/MCP)	30% (NJ/CT/MCP)

TABLE 5

SPIKING LEVEL

	LCS\MS\Surr Spiking Level			
	Spike Solution [ug/mL]	**Surr. Solution [ug/mL]**	**Spike Conc [ug/L]**	**Surr Conc [ug/L]**
RVT	2.5	0.5	250	50
Soil/Water	12.5	2	3125	500
Oil	12.5	2	1250	200
Caulking	125	20	3125	200

TABLE 6

QC FAILURE ACTION PLAN

Blank Failures	Failure Situation	Action(s)
Surrogate Failure	1 of 4 high or low	Report as is
	2 or more high	Report as is
	2 or more low, samples are non-detect with passing surrogates	Report as is
	2 or more low, samples have hits and/or failing surrogates	Revial/rerun Re-extract if still failing
IS Failure	IS not present (less than 10% recovery)	Add IS Rerun
	IS out high or low	Revial/rerun Re-extract if still failing
Contamination	Below RL; sample(s) non-detect, below RL, or concentration 10 times or more above the blank	Report as is
	Below RL, sample(s) concentration above RL	See team leader/manager
	Above RL, sample(s) concentration 10 times or more above the blank	Report as is
	Above RL with non-detect sample(s)	Report as is
	Above RL, sample(s) concentration less than 10 times above the blank and volume available	Revial/rerun Re-extract if contamination still present
	Above RL, sample(s) concentration less than 10 times above the blank and no volume available	Revial/rerun B-flag affected data

LCS/LCSD Failures	Failure Situation	Action(s)
Surrogate Failure	1 or more high or low	Report as is
IS Failure	IS not present (less than 10% recovery)	Add IS

		Rerun
	IS out high or low	Revial/rerun Re-extract if still failing
Spike Failure	Spike compounds out high and sample(s) are non-detect with passing surrogates	Report as is
	Spike compounds out high and sample(s) have hits	Revial/rerun Re-extract if still high
	Spike compounds out low	Revial/rerun Re-extract if still low
	RPD failure	Report as is

MS/MSD/DUP Failures	**Failure Situation**	**Action(s)**
Surrogate Failure	(MS/MSD) 1 or more high or low	Report as is
	(MS/MSD) 2 or more high or low	Report as is
	(DUP) 1 or more high, parent sample non-detect	Report as is
	(DUP) 1 or more low, parent sample matches	Report as is
	(DUP) 1 or more low, parent sample doesn't match	Revial/rerun Re-extract if still failing
IS Failure	IS not present (less than 10% recovery)	Add IS Rerun
	IS out high or low	Revial/rerun Re-extract if still failing
Spike Failure (MS/MSD only)	Compounds out high or low due to sample matrix or hits	Report as is
	Compounds out high or low due to extraction error	Revial/rerun Re-extract if still failing
	RDP failure	Report as is

Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)

Reference Method No.: **EPA 8270 E**

Reference: SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update VI (Phase II), June, 2018.

1. Scope and Application

Matrices: This method is used to determine the concentration of semivolatile organic compounds in extracts prepared from many types of solid waste matrices, soils, and wastewater samples.

This method is used to quantitate most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of being eluted, without derivatization, as sharp peaks from a gas chromatographic fused-silica capillary column coated with a slightly polar silicone.

Table 9 lists “difficult” compounds that may require special treatment when being determined by this method.

Approval of any method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of a gas chromatograph/mass spectrometer and in the interpretation of mass spectra. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability (Section 13.2).

2. Summary of Method

The samples are introduced into the GC/MS by injecting 1µL or 3µL for LVI and RVT of the sample extract into a gas chromatograph (GC) with a narrow-bore fused-silica capillary column. The GC column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) connected to the gas chromatograph.

Analytes eluted from the capillary column are introduced into the mass spectrometer via direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact spectra of standards run on the same GC/MS system. Quantitation is accomplished by comparing the response of quantitation ion relative to an internal standard using a calibration curve.

2.1 Method Modifications from Reference

None.

3. Reporting Limits

Table 6 lists our routine reporting limits.

4. Interferences

4.1 Only high purity helium is used in the GC system to eliminate this source of possible contamination. The helium (carrier gas) is certified by the gas supplier.

4.2 Preventive instrument maintenance is performed routinely. Section 10.5 details the maintenance steps.

4.3 Glassware must be scrupulously cleaned. This procedure is detailed in the Organic Extraction Glassware Cleaning & Handling SOP/1953.

4.4 Contaminated solvents or reagents are also possible sources of contamination. All solvents used are pesticide grade or equivalent, and reagents are purchased as certified contaminant free.

4.5 Contamination by carry-over can occur whenever high-concentration and low-concentration samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered (concentrations greater than 2x the highest concentration) and the next sample has reportable hits this sample should to be re-analyzed for confirmation based on analyst discretion.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

5.1 Lab coats, safety glasses, and gloves must be worn when handling samples, extracts, standards or solvents.

5.2 All solvent and extract transfers must be handled in the vented bench area in the GC/MS laboratory.

5.3 All stock standards, working standards, and vialed sample extracts must be placed into the waste bucket in the lab for future disposal by the Health and Safety Officer. The container must be labeled properly with hazard warning labels indicating the container contents.

5.4 Flammable solvent bottles must be stored in the flammables cabinet.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection

Aqueous samples are collected in two 1L amber glass jars with teflon-lined lids.
LVI, aqueous samples are collected in two 275mL amber glass jars with teflon-lined lids.
RVT, aqueous samples are collected in two 100mL amber glass jars with teflon-lined lids.
Solid samples are collected in 250mL wide-mouth glass jars with teflon-lined lids.
All containers are purchased pre-cleaned and certified from commercial vendors.

6.2 Sample Preservation

Both aqueous and solid samples are then preserved by packing in coolers with ice or ice packs, to maintain a temperature of 4 ± 2ºC. Upon receipt at the laboratory, the samples are transferred into sample storage refrigerators to maintain at a temperature of 4 ± 2ºC.

6.3 Sample Handling

Aqueous samples must be extracted within 7 days of sample collection, solid samples within 14 days of collection. Once extracted, the samples must be analyzed within 40 days of the extraction date.

7. Equipment and Supplies

7.1 Gas Chromatograph/Mass Spectrometer System:

7.1.1 Gas Chromatograph, Hewlett Packard 6890 (or equivalent): An analytical system complete with a temperature-programmable gas chromatograph configured for split/splitless-injection and all required accessories, including syringes, analytical columns, and gases. The capillary column is directly coupled to the source.

7.1.2 Column: Rxi-5Sil MS30m x 0.32mm ID, 0.25µm film thickness or column of similar configuration.

7.1.3 Mass Spectrometer, Hewlett Packard 5973 (or equivalent): Scanning from 35 to 500 amu every 1 second or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer is capable of producing a mass spectrum for decafluorotriphenylphosphine (DFTPP) which meets the criteria in Table 1 when 1 µL of the GC/MS tuning standard is injected through the GC (50ng of DFTPP).

7.1.4 Data System: A computer system is interfaced to the Mass Spectrometer. The system allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer software allows the analyst to search for any GC/MS data file for ions of specific mass and plot such ion abundances versus time or scan number. *HP ChemServer* software is used for data acquisition and *MSD Chemstation/Enviroquant version E.02.02* is used for data reduction.

7.2 Syringe: 10 µL.

7.3 Volumetric Flasks, Class A: Appropriate sizes with ground-glass stoppers.

7.4 Vials: Glass autosampler vials with polytetrafluoroethylene (PTFE)-lined crimp top caps.

8. Reagents and Standards

8.1 Stock Standard Solutions

Certified stock standard solutions, traceable to NIST, when available, are purchased from commercial vendors. They can be replaced with different standards as long as they contain all target analytes.

All stock standards, lot number, catalog number, expiration date, preparation date and initials are recorded in a logbook. Standards are stored in the refrigerator or freezer. Store away from any light source at 6 °C when not in use (−10 °C is recommended).

Stock standard expire 6 months from the date of preparation or on the earliest expiration date of any of the stock solution used to prepare it.

Please note that the following preparation instructions and stock standards are included for illustration purposes and may be modified as needed (ex. to accommodate standard availability or client requests), however final concentrations for the initial calibration levels shall always follow the example in 8.1.4.

Vendor	Standard	Catalog#	Concentration
Restek			
	8270 Mega Mix	31850	500-1000ug/mL
	Benzoic Acid Mix	31879	2000ug/mL
	Acid Surrogate Mix	31087	10000ug/mL
	B/N Surrogate Mix	31086	5000ug/mL
	Benzaldehyde Standard	33017	2000ug/mL
	Custom AP9 ICAL Standard	571813-FL	2000ug/mL
	Custom ADP Standard	572745-FL	2000ug/mL
	Benzidine Mix	31834	2000ug/mL
	SV Internal Standard Mix	31206	2000ug/mL
	1,4-Dioxane	30287	2000ug/mL
	Custom CLP 04.1 BNA Surrogate Mix	571320-FL	1000ug/mL
Absolute	Aromatic Amines Mix	99410	2000ug/ml
Ultra	Semi-Volatiles GC/MS Tuning Standard	GCM-150-1	1000ug/mL

8.1.1 ABN Stock Standard, 200ug/mL

Use 5mL of each of the following:
Benzoic Acid Mix
Benzidine Mix

and use 10mL of each of the following:
8270 Mega Mix
Custom CLP 04.1 BNA Surrogate Mix

Bring up to 50mL volume with DCM.

8.1.2 AP9 Additional Compounds Stock Standard, 200ug/mL

Use 5mL of each of the following:
Custom AP9 ICAL Standard
Benzaldehyde Standard

Bring up to 50mL volume with DCM.

8.1.3 ADP Stock Standard, 200ug/ml

Use 5ml of:
Custom ADP Standard

Bring up to 50mL volume with DCM.

8.1.4 Calibration Standard

A minimum of 5 calibration standards must be included for each analyte:

Calibration Curve Levels	
Level	Concentration ug/mL
1	1.0
2	2.0
3	3.0
4	5.0
5	10
6	20
7	50
8	100
9	150
10	200

LVI/RVT Calibration Curve Levels	
Level	Concentration ug/mL
1	0.1
2	0.2
3	0.5
4	1.00
5	2.5
6	5.0
7	10
8	25
9	50

*LVI- Low Volume Initiative
*RVT-Reduce Volume Test

8.2 Internal Standard Solution

The internal standards are:

1,4-dichlorobenzene-d_4
naphthalene-d_8
acenaphthene-d_{10}
phenanthrene-d_{10}
chrysene-d_{12}
perylene-d_{12}

Each 500µL of standards, blank and sample extracts are spiked with 10µL of SV Internal Standard Mix, resulting in a concentration of 40ng/ µL.

For the LVI and RVT method, a 1:10 dilution is made of the Internal Standard Stock Solution. 500µL of standards, blank and sample extracts are spiked with 10µL of this preparation, resulting in a concentration of 4ng/ µL.

8.3 GC/MS Tuning Standard

The tuning standard is a methylene chloride solution containing 50ng/µL of decafluorotriphenylphosphine (DFTPP). The standard also contains 50ng/µL each of 4,4'DDT, pentachlorophenol, and benzidine to verify injection port inertness and GC column performance.

Prepare the GC/MS Tuning Standard with 25µL GCM-150 and 475µL Dichloromethane.

8.4 Surrogate Spiking Solution

8.4.1 Extraction Surrogate Preparation

In a 1000mL volumetric flask, add 5ml of 31086 and 31087. Bring up to volume with Acetone. The final concentration is 50µg/mL for the acid surrogates and 25µg/mL for the B/N surrogates.

8.4.2 LVI Extraction Surrogate Preparation

The LVI surrogate is a 10 fold dilution of the surrogate solution prepared in 8.4.1. For example, to make 200mL of LVI surrogate, add 20mL of 8.4.1 to a 200mL volumetric flask and fill to volume with Acetone. The resulting surrogate concentration is 5µg/mL for the acid surrogates and 2.5µg/mL for the B/N surrogates.

8.4.3 RVT Extraction Surrogate Preparation

The RVT surrogate is a 2.5 fold dilution of the surrogate solution prepared in 8.4.1. For example, to make 50mL of LVI surrogate, add 20mL of 8.4.1 to a 50mL volumetric flask and fill to volume with Acetone. The resulting surrogate concentration is 20µg/mL for the acid surrogates and 10µg/mL for the B/N surrogates.

8.5 Spike Solution (LCS, MS, MSD)

Spike Solution Preparation

ABN SPK1:
In a 500ml volumetric flask, add 20ml of 8270 Mega Mix #31850, 10ml of Benzoic Acid Mix #31879, 10ml Custom AP9 ICAL Standard #571813-FL and 10ml Benzaldehyde Standard #33017. Bring up to volume with Acetone. The final concentration is 40µg/ml.

LVI ABN SPK1 is prepared by making an 8 fold dilution of the 40µg/ml ABN SPK (in acetone), resulting in a 5µg/ml LVI ABN SPK1.

RVT ABN SPK1 is prepared by making a twofold dilution of the 40µg/ml ABN SPK (in acetone), resulting in a 20µg/ml RVT ABN SPK1.

ABN SPK2:
In a 500ml volumetric flask, add 10ml Benzidine Mix #31834 and 10mL Custom ADP Standard #572945-FL. Bring up to volume with Acetone. The final concentration is 40µg/ml.

LVI ABN SPK2 is prepared by making an 8 fold dilution of the 40µg/ml ABN SPK (in acetone), resulting in a 5µg/ml LVI ABN SPK2.

RVT ABN SPK2 is prepared by making a twofold dilution of the 40µg/ml ABN SPK (in acetone), resulting in a 20µg/ml RVT ABN SPK2.

8.6 Dichloromethane (DCM): Pesticide quality.

8.7 Acetone: Pesticide quality.

9. Quality Control

9.1 Blank(s)

Extraction blanks are performed with each extraction batch of 20 or less samples. The extraction blank must not contain any of the reportable analytes above the reporting limit. Corrective actions:

- No corrective action required if concentration of contaminant in sample is >10x concentration in blank or if contaminant not detected in sample

- If the blank have reportable hits and re-extraction could not be performed due to lack of additional sample volume, the sample results are reported and qualified with “B” flag for any associated samples that concentration is less than 10x the blank concentration

For NJ regulatory work the method blank must have all the target analytes less than RL except for Phthalates which must be less than 5x of the RL. Sample results are qualified with "B" flag for analytes observed in the blank greater than RL and the Phthalates observed in the blank greater than 5x RL

The surrogate recoveries must also be within the acceptance criteria listed in Table 2. If surrogate acceptance criteria are exceeded, the extraction batch must be evaluated to determine if re-extraction or re-analysis is necessary.

9.2 Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS / LCSD)

A Laboratory Control Sample/Laboratory Control Sample Duplicate pair (LCS/LCSD) are extracted and analyzed with each analytical batch of 20 or fewer samples.

The LCS/LCSD acceptance criteria are based the performance standard control limits. These performance standards are based on commonly used state programs RCP,MCP etc. See table 3. Less than 10% of total compounds may be outside of control limits provided that recoveries are >10%. Note: this does not apply to difficult analytes listed in Table 9 which may be accepted at recoveries <10. If >10% of analytes are recovered above control limits, this is deemed acceptable as long as the analytes in question are not detected in associated samples.

If these criteria are not met, the entire batch is re-extracted. If re-extraction is not possible, due to insufficient sample or holding time exceedance, the analyst must write up the failure on a narrative sheet for inclusion in the client report.

9.3 Initial Calibration Verification (ICV)

Refer to Section 10.2.7.

9.4 Continuing Calibration Verification (CCV)

Refer to Section 10.4.

9.5 Matrix Spike and Matrix Spike Duplicate (MS / MSD)

A matrix spike/matrix spike duplicate pair is extracted and analyzed for each batch of 20 or fewer samples per client request. The MS/MSD acceptance criteria are based on performance standards. See table 3 for individual control limits. If the recovery criteria are not met, but are met in the LCS/LCSD, this is noted on a narrative sheet for inclusion in the client report.

9.6 Laboratory Duplicate

Not applicable.

9.7 Method-specific Quality Control Samples

9.7.1 Surrogates

All extracted samples and associated QC are spiked with surrogates. The acceptable surrogate recovery limits are listed in Table 2.

Corrective action: Up to one surrogate can be out in each fraction (Acid and Base/Neutral) but not less than 10% recovery, before any corrective action is necessary. Otherwise, analysis must be repeated once to see if an analytical error has occurred. If the % recovery still exceeds the control limits the sample must be re-extracted and re-analyzed to confirm sample matrix. If matrix effect is confirmed, this must be noted on a narrative sheet for inclusion in the client report.

Re-extraction is not required if surrogate recoveries are high and target analytes are not detected in the sample.

9.7.2 Internal Standards

If the area for any of the internal standards in the samples changes by a factor of two (-50% to +100%) from that in the CCV, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

9.8 Method Sequence

In a 12-hour period, the typical analytical sequence is:

- Degradation Check
- DFTPP
- Continuing or Daily Standards (1 – 3)*
  - (1) ABN 50 ppm
  - (2) AP9 50 ppm
  - (3) ADP 50 ppm
- Method/Instrument Blank
- Samples
- QC (as required)

***Additional Continuing standards may be run at the analyst's discretion or by client request.**

10. Procedure

10.1 Equipment Set-up

10.1.1 GC/MS Operating Conditions:

Typical GC/MS operating conditions are listed below, but may be altered as long as method performance criteria are met.

Mass range:	35 – 500 amu
Scan time:	3.15 second / scan
Initial temperature:	50°C, hold for 1.5 minutes
Temperature program:	28°C/minute to 250°C then 9°C/minute to 320°C
Final temperature:	320°C for 1.50 min
Injector temperature:	300°C
Transfer line temperature:	280°C
Source temperature:	230ºC
Injector:	split ratio 5:1; 11.7mL/min
Injection volume:	1µL
Carrier gas:	helium at 523 cm/second (2.0 mL/min) constant flow

GC/MS Operating Conditions for LVI/RVT method:

Mass range:	35 – 550 amu
Scan time:	3.15 second / scan
Initial temperature:	45°C, hold for 4 minutes
Temperature program:	25°C/minute to 250°C then 20°C/minute to 320°C

Final temperature:	320°C for 4.3 min
Injector temperature:	270°C
Transfer line temperature:	280°C
Source temperature:	320ºC
Injector:	split ratio 5:1; 8.57mL/min
Injection volume:	3µL
Carrier gas:	helium at 1.7148mL/min) constant flow

10.1.2 GC/MS Tune:

At the beginning of every 12 hour sequence, analyze DFTPP tuning solution (Section 8.3).

The resultant mass spectrum for DFTPP must meet the criteria given in Table 1 before sample analysis begins. The mass spectrum of DFTPP should be acquired in the following manner:

(1) Three scans (the peak apex scan, the scan immediately preceding the apex and the scan immediately following the apex) are acquired and averaged.
(2) Background subtraction is performed using a single scan of no more than 20 scans prior to the elution of DFTPP.

The GC/MS tuning standard is also used to assess GC column performance and injection port inertness. Degradation of DDT to DDE and DDD must not exceed 20%. Benzidine and pentachlorophenol must be present at their normal responses and no peak tailing must be visible.

The tailing factor for benzidine and pentachlorophenol must be calculated in every DFTPP run. (See Table 4)

If degradation is excessive and/or poor chromatography is noted, the system needs maintenance (see Section 10.5).

10.2 Initial Calibration

10.2.1 Prepare calibration standards for all target analytes at a minimum of five concentration levels as specified in Section 8.1.4.

10.2.2 Add 10µL of Internal Standard to each calibration standard directly into the autosampler vial containing 500µL of standard. Analyze each calibration standard under the conditions specified in Section 10.1.1.

10.2.3 Record the calibration standard, unique lab identifier code (lot), concentration, and analyst's initials in the analytical sequence list.

10.2.4 In each standard, calculate the response factor (RF) for each analyte, the average RF, and the relative standard deviation (RSD) of the RFs, using the Enviroquant data processing software. The calculations are performed automatically, using the formulae listed in Alpha's Quality Manual.

It is recommended that a minimum response factor for the most common target analytes, as noted in Table 8, be demonstrated for each individual calibration level as a

means to ensure that these compounds are behaving as expected. In addition, meeting the minimum response factor criteria for the lowest calibration standard is critical in establishing and demonstrating the desired sensitivity.

10.2.5 Initial Calibration %RSD Criteria:

For all analytes, the RSD must be ≤ 20% for the mean response factor to be used for sample quantitation.

If the RSD for any target analyte exceeds 20%, the fit must be ≥0.99 quadratic or ≥ 0.995 linear fit for all target analytes. A minimum of 5 levels are required for a linear calibration model and a minimum of 6 levels are required for a quadratic calibration model. When calculating calibration using the linear regression model, a quantitation check must be performed on the lowest calibration point, or the point that corresponds to that compound's established reporting limit.

Percent Relative Error (%RE): For linear and quadratic fit compounds, the %RE must be calculated for the standard at or near the midpoint and at the lowest level of the initial calibration. The %RE between the calculated and expected concentration of an analyte must be ≤ 30% for the midpoint and ≤ 50% for the lowest point otherwise recalibration is necessary.

10.2.6 Evaluation of Retention Times:

The relative retention time (RRT) of each target analyte in each calibration standard should agree within 0.06 RRT units.

10.2.7 Initial Calibration Verification (Second Source Verification)

10.2.7.1 The initial calibration (Section 10.2) for each compound of interest must be verified prior to sample analysis. This is accomplished by analyzing second source calibration standards at a concentration near the midpoint concentration for the calibrating range of the GC/MS.

10.2.7.2 Analyze the standards and calculate the % Difference for each analyte according to the formula in Alpha's Quality Manual.

If the % Difference for each analyte is ± 30%, then the calibration is assumed to be valid. If this criterion is not met, then corrective action must be taken prior to the analysis. For RCP Difficult compounds may recover between 40-160%

10.2.7.3 In cases where compounds fail (greater than 30% difference), they may still be reported as non-detects.

10.2.7.4 Once the calibration curve is accepted and prior to processing any samples, the analyst must demonstrate through the analysis of a Method Blank or Instrument Blank that equipment and reagents are free from contaminants and interferences. If a peak is found in the blank that would prevent the identification or bias the measurement of an analyte, the analyst should determine the source of the contaminant peak and eliminate it, if possible. Blank are generally considered to be acceptable if target analyte concentration are less than one half the LLOQ or are less than project specific

requirements. Blanks may contain analyte concentrations are greater than acceptance limits if the associated samples in the batch are unaffected.

10.3 Equipment Operation and Sample Processing

10.3.1 GC/MS Analysis of Samples

10.3.1.1 Allow the sample extracts to warm to room temperature.

10.3.1.2 Transfer all of the sample extract to a 1.5mL vial. Remove 500µL of sample extract to another vial, and add 10µL of the internal standard solution (Section 8.2).

10.3.1.3 The autosampler is programmed to inject 1µL aliquot of the sample extract into the GC/MS system, using the same instrument conditions that were used for calibration. The injection volume of the sample must be the same as the volume used for the calibration standard.

10.3.1.4 If the response of any quantitation ion exceeds the initial calibration range of the GC/MS system, the sample extract must be diluted and reanalyzed.

10.3.2 Qualitative Identification

Perform first level data review. Obtain the primary m/z (Table 5) masses for each parameter of interest. The following criteria must be met to make qualitative identification:

- Compare the background subtracted mass spectra for the sample to the reference spectra. The characteristic masses of each parameter of interest must maximize in the same or within one scan of each other.
- The retention time must fall within ± 0.1 minutes of the retention time of the compound in the analytical standard. However, analyst experience must be used in making the qualitative identification.
- The relative peak height of the one characteristic mass must fall within 30% of the relative intensity of the mass in a reference mass spectrum. The reference spectrum is obtained from a standard analyzed on the GC/MS system.

Structural isomers that have very similar mass spectra are identified only if the resolution between authentic isomers in a standard mix is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

10.4 Continuing Calibration

10.4.1 The initial calibration (Section 10.2) for each compound of interest must be verified once every 12 hours prior to sample analysis. This is accomplished by analyzing calibration standards at a concentration near the midpoint concentration for the calibrating range of the GC/MS.

10.4.2 Analyze the standards and calculate the % Difference for each analyte according to the formula in Alpha's Quality Manual.

If the % Difference for each CCV analyte is ≤ 20%, then the calibration is assumed to be valid. If the criterion is not met for more than 20% of the compounds then corrective action must be taken.

Due to the large number of analytes present, allowances may be made for a RF that drifts out high, as long as there are no positive hits for that particular analyte in any of the associated samples.

10.4.3 If this criterion is exceeded, inspect the gas chromatographic system to determine the cause and perform whatever maintenance is necessary before verifying calibration and proceeding with sample analysis.

10.4.4 If routine maintenance does not return the instrument performance to meet the QC requirements based on the last initial calibration, then a new initial calibration must be performed.

10.4.5 Internal Standard Retention Time

The retention times of the internal standards in the calibration verification standard is evaluated after data acquisition. If the retention time for any internal standard changes by more than 30 seconds from that in the mid-point standard of the most recent initial calibration, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

10.4.6 Internal Standard Response

Refer to section 9.7.2

10.5 Preventive Maintenance

When poor sensitivity is observed, replacement of the injector liner and seal may solve the problem. If not, clip approximately 3 – 6 inches from the injector end of the GC column. If the sensitivity does not improve it may be necessary to replace the split line or the injector weldment assembly. If the problem persists, it may be necessary to replace the GC column.

Periodic cleaning (typically twice per year) of the mass spectrometer ion source is required. More frequent source cleaning may be needed, especially if dirty samples are analyzed.

11. Data Evaluation, Calculations and Reporting

When a parameter is identified, the quantitation of that parameter must be based on the integrated abundance of the quantitation characteristic m/z given in Table 5

Calculate the concentration in the sample using the average response factor (RF) from the initial calibration curve according to the formula in Alpha's Quality Manual.

After performing technical data review, validating that all QC criteria have been met and confirming all positive hits, the data report is sent electronically to the LIMS computer for generation of the client report. There are two levels of review of the data in the LIMS system prior to release of data. These reviews must be done by two separate individuals.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

Holding time exceedence and improper preservation are noted on the nonconformance report form.

Perform instrument maintenance as described throughout this SOP as needed when instrument calibration criteria are not met. Record all maintenance in the instrument logbook.

All batch and sample specific QC criteria outlined in Section 9 are evaluated by the analyst prior to approval of the data. When any QC criteria fail, the cause for the failure must be identified and corrected. This may include instrument recalibration followed by sample reanalysis, sample cleanup, or sample re-extraction. If it is determined that the failure is due to sample matrix effects, a project narrative report is written by the analyst for inclusion in the data report. If there is insufficient sample volume to perform the re-analysis for confirmation, this is also noted in the narrative and included in the client report.

13. Method Performance

13.1 Detection Limit Study (DL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the DL, LOD, and/or LOQ as outlined in Alpha SOP/1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP/1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

Alpha SOP/1732 DL/LOD/LOQ Generation

Alpha SOP/1739 IDC/DOC Generation

Alpha SOP/1729 Waste Management and Disposal SOP

16. Attachments

Table 1: DFTPP Key Ions and Ion Abundance Criteria

Table 2: Acceptable Surrogate Spike Recovery Limits

Table 3A: Acceptable Aqueous QC Limits

Table 3B: Acceptable Soil QC Limits

Table 4: Tailing Factor Calculation

Table 5: Characteristic Ions for Semivolatile Compounds

Table 6: Reported Detection Limits

Table 7: Semivolatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Table 8: Recommended Minimum Response Factor Criteria

Table 9: Difficult analytes

TABLE 1

DFTPP KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
68	< 2% of mass 69
69	Present
70	< 2% of mass 69
197	< 2% of mass 198
198	Base peak or present
199	5-9% of mass 198
365	> 1% of Base Peak
441	Present but less than 24% mass 442
442	Base peak, or present
443	15-24% of mass 442

TABLE 2

ACCEPTABLE SURROGATE SPIKE RECOVERY LIMITS

Analytical Fraction	Surrogate Compound	Water	Soil/Sediment
BN-8270D	Nitrobenzene-d_5	23-120%	23-120%
BN-8270D	2-Fluorobiphenyl	15-120%	30-120%
BN-8270D	p-Terphenyl-d_{14}	41-149%	18-120%
Acid-8270D	Phenol-d_6	10-120%	10-120%
Acid-8270D	2-Fluorophenol	21-120%	25-120%
Acid-8270D	2,4,6-Tribromophenol	10-120%	10-136%

It is allowable for one surrogate from each fraction be outside acceptance criteria, provided a minimum recovery of 10% has been achieved.

TABLE 3A

ACCEPTABLE AQUEOUS QC LIMITS

	STANDARD TARGET COMPOUND LIST (Aqueous)		NEW JERSEY TARGET COMPOUND LIST (Aqueous)		CT TARGET COMPOUND LIST (Aqueous)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**
1,2,4,5-Tetrachlorobenzene			70-130	20	40-140	20
1,2,4-Trichlorobenzene	39-98	30	70-130	20	40-140	20
1,2-Dichlorobenzene	40-140	30	70-130	20		
1,3-Dichlorobenzene	40-140	30	70-130	20		
1,3-Dinitrobenzene	15-130	30				
1,4-Dichlorobenzene	36-97	30	70-130	20		
1,4-Dioxane					40-140	30
1-Methylnaphthalene	41-103	30				
2,3,4,6-Tetrachlorophenol			70-130	20		
2,4,5-Trichlorophenol	30-130	30	70-130	20	30-130	20
2,4,6-Trichlorophenol	30-130	30	70-130	20	30-130	20
2,4-Dichlorophenol	30-130	30	70-130	20	30-130	20
2,4-Dimethylphenol	30-130	30	70-130	20	30-130	20
2,4- Dimethylaniline	40-140	30	70-130	20		
3,4- Dimethylaniline	40-140	30	70-130	20		
2,3- Dimethylaniline	40-140	30	70-130	20		
2,4,5-Dimethylaniline	40-140	30	70-130	20		
4-Chlorotoluidine	40-140	30	70-130	20		
2-Ethylaniline	40-140	30	70-130	20		
O-toluidine	40-140	30	70-130	20		
2-Napthylamine	40-140	30	70-130	20		
2,4-Dinitrophenol	20-130	30	20-130	20	30-130	20
2,4-Dinitrotoluene	24-96	30	70-130	20	40-140	20
2,6-Dinitrotoluene	40-140	30	70-130	20	40-140	20
2-Chloronaphthalene	40-140	30	70-130	20	40-140	20
2-Chlorophenol	27-123	30	70-130	20	30-130	20
2-Methylnaphthalene	40-140	30	70-130	20	40-140	20
2-Methylphenol	30-130	30	70-130	20	30-130	20
2-Nitroaniline	52-143	30	70-130	20	40-140	20
2-Nitrophenol	30-130	30	70-130	20	30-130	20
3,3'-Dichlorobenzidine	40-140	30	70-130	20	40-140	20
3,3'-Dimethylbenzidine			20-160	20		
3-Methylphenol/4-Methylphenol	30-130	30	20-160	20	30-130	20
3-Nitroaniline	25-145	30	70-130	20	40-140	20
4,6-Dinitro-o-cresol	20-164	30	70-130	20	30-130	20
4-Bromophenyl phenyl ether	40-140	30	70-130	20	40-140	20
4-Chloroaniline	40-140	30	20-160	20	40-140	20
4-Chlorophenyl phenyl ether	40-140	30	70-130	20	40-140	20
4-Nitroaniline	51-143	30	70-130	20	40-140	20
4-Nitrophenol	10-80	30	20-160	20	30-130	20
Acenaphthene	37-111	30	70-130	20	40-140	20

	STANDARD TARGET COMPOUND LIST (Aqueous)		NEW JERSEY TARGET COMPOUND LIST (Aqueous)		CT TARGET COMPOUND LIST (Aqueous)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**
Acenaphthylene	45-123	30	70-130	20	40-140	20
Acetophenone	39-129	30	70-130	20		
Aniline	40-140	30	20-160	20	40-140	20
Anthracene	40-140	30	70-130	20	40-140	20
Atrazine			70-130	20		
Azobenzene	40-140	30	70-130	20		
Benzaldehyde			20-160	20		
Benzidine	10-75	30	20-160	20		
Benzo(a)anthracene	40-140	30	70-130	20	40-140	20
Benzo(a)pyrene	40-140	30	70-130	20	40-140	20
Benzo(b)fluoranthene	40-140	30	70-130	20	40-140	20
Benzo(ghi)perylene	40-140	30	70-130	20	40-140	20
Benzo(k)fluoranthene	40-140	30	70-130	20	40-140	20
Benzoic Acid	10-164	30	20-160	20		
Benzyl Alcohol	26-116	30	20-160	20		
Biphenyl	40-140	30	70-130	20		
Bis(2-chloroethoxy)methane	40-140	30	70-130	20	40-140	20
Bis(2-chloroethyl)ether	40-140	30	70-130	20	40-140	20
Bis(2-chloroisopropyl)ether	40-140	30	70-130	20	40-140	20
Bis(2-Ethylhexyl)phthalate	40-140	30	70-130	20	40-140	20
Butyl benzyl phthalate	40-140	30	70-130	20	40-140	20
Caprolactam			20-160	20		
Carbazole	55-144	30	70-130	20	40-140	20
Chrysene	40-140	30	70-130	20	40-140	20
Dibenzo(a,h)anthracene	40-140	30	70-130	20	40-140	20
Dibenzofuran	40-140	30	70-130	20	40-140	20
Diethyl phthalate	40-140	30	70-130	20	40-140	20
Dimethyl phthalate	40-140	30	70-130	20	40-140	20
Di-n-butylphthalate	40-140	30	70-130	20	40-140	20
Di-n-octylphthalate	40-140	30	70-130	20	40-140	20
Fluoranthene	40-140	30	70-130	20	40-140	20
Fluorene	40-140	30	70-130	20	40-140	20
Hexachlorobenzene	40-140	30	70-130	20	40-140	20
Hexachlorobutadiene	40-140	30	70-130	20	40-140	20
Hexachlorocyclopentadiene	40-140	30	20-160	20	40-140	20
Hexachloroethane	40-140	30	20-160	20	40-140	20
Indeno(1,2,3-cd)Pyrene	40-140	30	70-130	20	40-140	20
Isophorone	40-140	30	70-130	20	40-140	20
Naphthalene	40-140	30	70-130	20	40-140	20
Nitrobenzene	40-140	30	70-130	20	40-140	20
NitrosoDiPhenylAmine(NDPA)/ Diphenylamine (DPA)	40-140	30	70-130	20	40-140	20
n-Nitrosodimethylamine	22-74	30	20-160	20		
n-Nitrosodi-n-propylamine	29-132	30	70-130	20	40-140	20
P-Chloro-M-Cresol	23-97	30	70-130	20	30-130	20
Pentachlorophenol	9-103	30	20-160	20	30-130	20

	STANDARD TARGET COMPOUND LIST (Aqueous)			NEW JERSEY TARGET COMPOUND LIST (Aqueous)		CT TARGET COMPOUND LIST (Aqueous)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**		**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**
Pentachloronitrobenzene						40-140	20
Phenanthrene	40-140	30		70-130	20	40-140	20
Phenol	12-110	30		20-160	20	30-130	20
Pyrene	26-127	30		70-130	20	40-140	20
Pyridine	10-66	30				40-140	20
2-Fluorophenol	*21-120*			*15-110*		*15-110*	
Phenol-d6	*10-120*			*15-110*		*15-110*	
Nitrobenzene-d5	*23-120*			*30-130*		*30-130*	
2-Fluorobiphenyl	*15-120*			*30-130*		*30-130*	
2,4,6-Tribromophenol	*10-120*			*15-110*		*15-110*	
4-Terphenyl-d14	*41-149*			*30-130*		*30-130*	

TABLE 3B

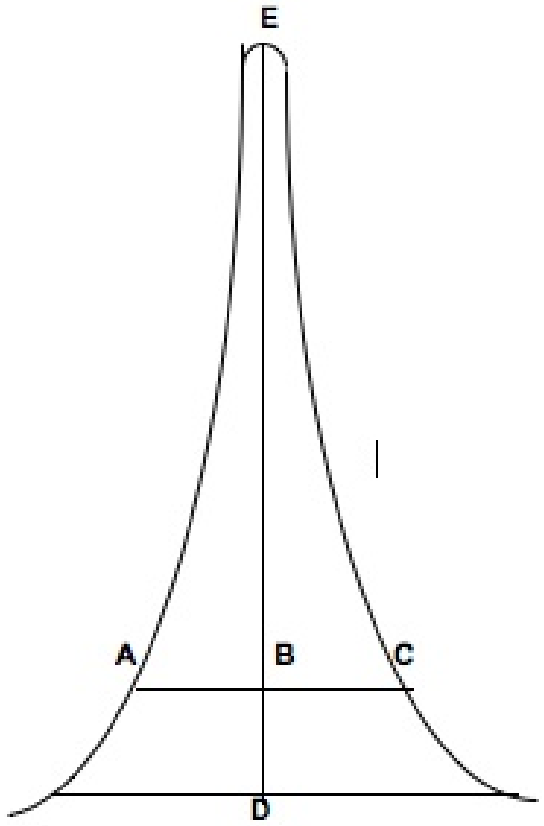
ACCEPTABLE SOIL QC LIMITS

	STANDARD TARGET COMPOUND LIST (Soil)		NEW JERSEY TARGET COMPOUND LIST (Soil)		CT TARGET COMPOUN LIST (Soil)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplica RPD**
1,2,4,5-Tetrachlorobenzene	40-117	50	70-130	30	40-140	30
1,2,4-Trichlorobenzene	38-107	50	70-130	30	40-140	30
1,2-Dichlorobenzene	40-140	50	70-130	30		
1,3-Dichlorobenzene	40-140	50	70-130	30		
1,3-Dinitrobenzene	40-140	50				
1,4-Dichlorobenzene	28-104	50	70-130	30		
1,4-Dioxane					40-140	30
1-Methylnaphthalene	26-130	50				
2,3,4,6-Tetrachlorophenol	40-140	50	70-130	30		
2,4,5-Trichlorophenol	30-130	50	70-130	30	30-130	30
2,4,6-Trichlorophenol	30-130	50	70-130	30	30-130	30
2,4-Dichlorophenol	30-130	50	70-130	30	30-130	30
2,4-Dimethylphenol	30-130	50	70-130	30	30-130	30
2,4-Dinitrophenol	4-130	50	20-160	30	30-130	30
2,4-Dinitrotoluene	28-89	50	70-130	30	40-140	30
2,6-Dinitrotoluene	40-140	50	70-130	30	40-140	30
2-Chloroaniline	30-130	50				
2-Chloronaphthalene	40-140	50	70-130	30	40-140	30
2-Chlorophenol	25-102	50	70-130	30	30-130	30
2-Methylnaphthalene	40-140	50	70-130	30	40-140	30
2-Methylphenol	30-130.	50	70-130	30	30-130	30
2-Nitroaniline	47-134	50	70-130	30	40-140	30
2-Nitrophenol	30-130	50	70-130	30	30-130	30
3,3'-Dichlorobenzidine	40-140	50	70-130	30	40-140	30
3,3'-Dimethylbenzidine	15-115	50				
3-Methylphenol/4-Methylphenol	30-130	50	20-160	30	30-130	30
3-Nitroaniline	26-129	50	70-130	30	40-140	30
4,6-Dinitro-o-cresol	10-130	50	70-130	30	30-130	30
4-Bromophenyl phenyl ether	40-140	50	70-130	30	40-140	30
4-Chloroaniline	40-140	50	20-160	30	40-140	30
4-Chlorophenyl phenyl ether	40-140	50	70-130	30	40-140	30
4-Nitroaniline	41-125	50	70-130	30	40-140	30
4-Nitrophenol	11-114	50	20-160	30	30-130	30
Acenaphthene	31-137	50	70-130	30	40-140	30

	STANDARD TARGET COMPOUND LIST (Soil)		NEW JERSEY TARGET COMPOUND LIST (Soil)		CT TARGET COMPOUN LIST (Soil)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplica RPD**
Acenaphthylene	40-140	50	70-130	30	40-140	30
Acetophenone	14-144	50	70-130	30	40-140	30
Aniline	40-140	50	20-160	30	40-140	30
Anthracene	40-140	50	70-130	30	40-140	30
Atrazine	40-140	50	70-130	30		
Azobenzene	40-140	50	70-130	30		
Benzaldehyde	40-140	50	20-160	30		
Benzidine	10-66	50	20-160	30		
Benzo(a)anthracene	40-140	50	70-130	30	40-140	30
Benzo(a)pyrene	40-140	50	70-130	30	40-140	30
Benzo(b)fluoranthene	40-140	50	70-130	30	40-140	30
Benzo(e)pyrene	40-140	50				
Benzo(ghi)perylene	40-140	50	70-130	30	40-140	30
Benzo(k)fluoranthene	40-140	50	70-130	30	40-140	30
Benzoic Acid	10-110	50	20-160	30		
Benzyl Alcohol	40-140	50	20-160	30		
Biphenyl	37-127	50	70-130	30		
Bis(2-chloroethoxy)methane	40-117	50	70-130	30	40-140	30
Bis(2-chloroethyl)ether	40-140	50	70-130	30	40-140	30
Bis(2-chloroisopropyl)ether	40-140	50	70-130	30	40-140	30
Bis(2-Ethylhexyl)phthalate	40-140	50	70-130	30	40-140	30
Butyl benzyl phthalate	40-140	50	70-130	30	40-140	30
Caprolactam	15-130	50	20-160	30		
Carbazole	54-128	50	70-130	30	40-140	30
Chrysene	40-140	50	70-130	30	40-140	30
Dibenzo(a,h)anthracene	40-140	50	70-130	30	40-140	30
Dibenzofuran	40-140	50	70-130	30	40-140	30
Diethyl phthalate	40-140	50	70-130	30	40-140	30
Dimethyl phthalate	40-140	50	70-130	30	40-140	30
Di-n-butylphthalate	40-140	50	70-130	30	40-140	30
Di-n-octylphthalate	40-140	50	70-130	30	40-140	30
Diphenamid	40-140	50				
Fluoranthene	40-140	50	70-130	30	40-140	30
Fluorene	40-140	50	70-130	30	40-140	30
Hexachlorobenzene	40-140	50	70-130	30	40-140	30
Hexachlorobutadiene	40-140	50	70-130	30	40-140	30
Hexachlorocyclopentadiene	40-140	50	20-160	30	40-140	30
Hexachloroethane	40-140	50	20-160	30	40-140	30
Indeno(1,2,3-cd)Pyrene	40-140	50	70-130	30	40-140	30
Isophorone	40-140	50	70-130	30	40-140	30
Naphthalene	40-140	50	70-130	30	40-140	30
Nitrobenzene	40-140	50	70-130	30	40-140	30

	STANDARD TARGET COMPOUND LIST (Soil)		NEW JERSEY TARGET COMPOUND LIST (Soil)		CT TARGET COMPOUN LIST (Soil)	
Analyte	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplicate RPD**	**Acceptance Criteria**	**Duplica RPD**
NitrosoDiPhenylAmine(NDPA)/ Diphenylamine (DPA)	36-157	50	70-130	30	40-140	30
n-Nitrosodimethylamine	22-100	50	20-160	30		
n-Nitrosodi-n-propylamine	32-121	50	70-130	30	40-140	30
Parathion, ethyl	40-140	50	20-160	30		
P-Chloro-M-Cresol	26-103	50	70-130	30	30-130	30
Pentachloronitrobenzene	42-153	50			40-140	30
Pentachlorophenol	17-109	50	20-160	30	30-130	30
Phenanthrene	40-140	50	70-130	30	40-140	30
Phenol	26-90	50	20-160	30	30-130	30
Pyrene	35-142	50	70-130	30	40-140	30
Pyridine	10-93	50	20-160	30	40-140	30
Thionazin	40-140	50				
2-Fluorophenol	*25-120*		*30-130*		*30-130*	
Phenol-d6	*10-120*		*30-130*		*30-130*	
Nitrobenzene-d5	*23-120*		*30-130*		*30-130*	
2-Fluorobiphenyl	*30-120*		*30-130*		*30-130*	
2,4,6-Tribromophenol	*10-136*		*30-130*		*30-130*	
4-Terphenyl-d14	*18-120*		*30-130*		*30-130*	

TABLE 4 – Tailing Factor Calculation



Tailing Factor = $\frac{BC}{AB}$

Example calculation:

Peak Height = DE = 100mm
10% Peak Height = BD = 10mm
Peak Width at 10% Peak Height = AC = 23mm

AB = 11mm
BC = 12mm

Therefore: Tailing Factor = $\frac{12}{11}$ = 1.1

Tailing factor for benzidine < 2.0

Tailing factor for pentachlorophenol <2.0

TABLE 5

CHARACTERISTIC IONS FOR SEMIVOLATILE COMPOUNDS

Compound	Primary Ion	Secondary Ion(s)
Acenaphthene	**154**	**153, 152**
Acenaphthylene	**152**	**151, 153**
Acetophenone	**105**	**71, 51, 120**
Aniline	**93**	**66, 65**
Anthracene	**178**	**176, 179**
Atrazine	**200**	**202, 215**
Azobenzene	**77**	**182, 105**
Benzaldehyde	**105**	**77**
Benzidine	**184**	**92, 185**
Benzo(a)anthracene	**228**	**229, 226**
Benzo(a)pyrene	**252**	**253, 125**
Benzo(b)fluoranthene	**252**	**253, 125**
Benzo(g,h,i)perylene	**276**	**138, 277**
Benzo(k)fluoranthene	**252**	**253, 125**
Benzoic acid	**105**	**122, 77**
Benzyl alcohol	**79**	**77,108**
Biphenyl	**154**	**153,152**
Bis (2-chloroethoxy) methane	**93**	**95, 123**
Bis (2-chloroethyl) ether	**93**	**63, 95**
Bis (2-chloroisopropyl) ether	**45**	**77, 121**
Bis (2-ethylhexyl) phthalate	**149**	**167, 279**
4-Bromophenyl phenyl ether	**248**	**250, 141**
Butyl Benzyl phthalate	**149**	**91, 206**
Caprolactam	**55**	**85, 113**
Carbazole	**167**	**168, 166**
4-Chloro-3-methylphenol	**107**	**144, 142**
2-Chloroaniline	**127**	**129, 65**
3-Chloroaniline	**65**	**127, 129**
4-Chloroaniline	**65**	**127,129**
2-Chloronaphthalene	**162**	**127, 164**
4-Chlorophenyl phenyl ether	**204**	**206, 141**
2-Chlorophenol	**128**	**64,130**
Chrysene	**228**	**226, 229**
Dibenzo(a,h)anthracene	**278**	**139, 279**
Dibenzofuran	**168**	**139**
1,2-Dichlorobenzene	**146**	**148, 111**
1,3-Dichlorobenzene	**146**	**148, 111**
1,4-Dichlorobenzene	**146**	**148, 111**
3,3'-Dichlorobenzidine	**252**	**254, 126**
2,4-Dichlorophenol	**162**	**164, 98**
Diethyl phthalate	**149**	**177, 150**

TABLE 5 (continued)

CHARACTERISTIC IONS FOR SEMIVOLATILE COMPOUNDS

Compound	Primary Ion	Secondary Ion(s)
3,3-Dimethylbenzidine	212	211, 213
Dimethyl phthalate	163	194, 164
2,4-Dimethylphenol	107	121,122
Di-n-butyl phthalate	149	150, 104
Di-n-octyl phthalate	149	167, 43
4,6-Dinitro-2-methylphenol	198	51, 105
O-Toluidine	106	107, 77
2-Ethylaniline	106	121, 77
2,4-Dimethylaniline	121	120, 106
2,3-Dimethylaniline	106	121, 120
3,4- Dimethylaniline	121	120,106
2,4,5-Trimethylaniline	120	135, 134
4-Chlorotoluidine	106	141, 140
2-Napthylamine	143	115, 116
2,4-Dinitrophenol	184	107,91
2,4-Dinitrotoluene	165	63, 89
2,6-Dinitrotoluene	165	63, 89
Diphenamide	167	72, 165
1,4-Dioxane	88	58,43
Ethyl parathion	109	97, 291
Fluoranthene	202	101, 203
Fluorene	166	165, 167
Hexachlorobenzene	284	142, 249
Hexachlorobutadiene	225	223, 227
Hexachlorocyclopentadiene	237	235, 272
Hexachloroethane	117	201, 199
Indeno(1,2,3-cd)pyrene	276	138, 227
Isophorone	82	95, 138
1-Methylnaphthalene	115	141, 142
2-Methylnaphthalene	142	141
2-Methylphenol	108	107,90
3/4-Methylphenol	108	107,90
Naphthalene	128	129, 127
2-Nitroaniline	65	92, 138
3-Nitroaniline	138	92,65
4-Nitroaniline	138	65, 108, 92, 80, 39
Nitrobenzene	77	123, 65

TABLE 5 (continued)

CHARACTERISTIC IONS FOR SEMIVOLATILE COMPOUNDS

Compound	Primary Ion	Secondary Ion(s)
2-Nitrophenol	139	109, 65
4-Nitrophenol	65	109, 139
n-Nitrosodimethylamine	74	42,44
n-Nitrosodi-n-butylamine	84	57, 41, 116, 158
n-Nitrosodi-n-propylamine	70	42, 101, 130
n-Nitrosodiphenylamine/Diphenylamine	169	168, 167
Pentachlorobenzene	250	252, 108, 248, 215, 254
Pentachloronitrobenzene	237	142, 214, 249, 295, 265
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Phenol	94	65, 66
Pyrene	202	200, 203
Pyridine	79	52
1,2,4,5-Tetrachlorobenzene	216	214, 179, 108, 143, 218
2,3,4,6-Tetrachlorophenol	232	131, 230, 166, 234, 168
m-Toluidine	106	107, 79
1,2,4-Trichlorobenzene	180	182, 145
2,4,5-Trichlorophenol	196	200,198
2,4,6-Trichlorophenol	196	198, 200
Acenaphthene-d_{10} (IS)	164	162, 160
Chrysene-d_{12} (IS)	240	120, 236
1,4-Dichlorobenzene-d_4 (IS)	152	150, 115
Naphthalene-d_8 (IS)	136	68
Perylene-d_{12} (IS)	264	260, 265
Phenanthrene-d_{10} (IS)	188	94, 80
2-Fluorobiphenyl (Surrogate)	172	171
2-Fluoroophenol (Surrogate)	112	64
Nitrobenzene-d_5 (Surrogate)	82	128, 54
Phenol-d_6 (Surrogate)	99	42, 71
Terphenyl-d_{14} (Surrogate)	244	122, 212
2,4,6-Tribromophenol (Surrogate)	330	62,141

TABLE 6

REPORTED DETECTION LIMITS FOR SEMIVOLATILE ORGANIC COMPOUNDS*

Analyte	RDL (µg/L)	RDL (µg/Kg)
Acenaphthene	2	133.34
Acenaphthylene	2	133.34
Acetophenone	5	333.34
Aniline	2	133.34
Anthracene	2	133.34
Atrazine	10	666.67
Azobenzene	2	500
Benzaldehyde	5	333.34
Benzidine	20	1333.34
Benzo(a)anthracene	2	133.34
Benzo(b)fluoranthene	2	133.34
Benzo(k)fluoranthene	2	133.34
Benzo(ghi)perylene	2	133.34
Benzo(a)pyrene	2	133.34
Benzoic acid	50.0	3333.34
Benzyl alcohol	2	133.34
Biphenyl	2	366.67
Bis(2-chloroethyl)ether	2	133.34
Bis(2-chloroisopropyl)ether	2	133.34
Bis(2-chloroethoxy)methane	5.0	333.34
Bis(2-ethylhexyl)phthalate	3	200
4-Bromophenyl phenyl ether	2	133.34
Butyl benzyl phthalate	5.0	333.34
Caprolactam	10	666.67
Carbazole	2	166.67
2-Chloroaniline	2	na
3-Chloroaniline	10	na
4-Chloroaniline	5	333.34
p-Chloro-m-cresol (4-chloro-3-cresol)	2	133.34
2-Chloronaphthalene	2	133.34
2-Chlorophenol	2	133.34
4-Chlorophenyl phenyl ether	2	133.34
Chrysene	2	133.34
m/p-Methylphenol (3/4-methylphenol)	5.0	333.34
o-Methylphenol (2-methylphenol)	5.0	333.34
Dibenzo(a,h)anthracene	2	133.34
Dibenzofuran	2	133.34
Di-n-butylphthalate	5.0	333.34
1,2-Dichlorobenzene	2	133.34

TABLE 6 (continued)

REPORTED DETECTION LIMITS FOR SEMIVOLATILE ORGANIC COMPOUNDS*

Analyte	RDL (µg/L)	RDL (µg/Kg)
1,3-Dichlorobenzene	2	133.34
1,3-Dinitrobenzene	2	N/A
1,4-Dichlorobenzene	2	133.34
3,3-Dichlorobenzidine	5	333.34
2,4-Dichlorophenol	5	333.34
O-Toluidine	2	N/A
2-Ethylaniline	2	N/A
2,4-Dimethylaniline	2	N/A
2,3-Dimethylaniline	2	N/A
3,4-Dimetylaniline	2	N/A
2,4,5-Trimethylaniline	2	N/A
4-Chlorotoluidine	2	N/A
2-Napthylamine	2	N/A
2,6-Dichlorophenol	10.0	666.67
Diethyl phthalate	5.0	333.34
3,3-Dimethylbenzidine	4	500
2,4-Dimethylphenol	5	333.34
Dimethyl phthalate	5.0	333.34
4,6-Dinitro-o-cresol	10	666.67
2,4-Dinitrophenol	20	1333.4
2,4-Dinitrotoluene	5.0	333.34
2,6-Dinitrotoluene	5.0	333.34
Di-n-octylphthalate	5.0	333.34
Diphenamide	5	N/A
1,4-Dioxane	5	166.67
Ethyl Parathion	N/A	166.67
Fluoranthene	2	133.34
Fluorene	2	133.34
Hexachlorobenzene	2	133.34
Hexachlorobutadiene	2	133.34
Hexachlorocyclopentadiene	20	1333.34
Hexachloroethane	2	133.34
Indeno(1,2,3-cd)pyrene	2	133.34
Isophorone	5.0	333.34
1-Methylnaphthalene	2	166.67
2-Methylnaphthalene	2	133.34
Naphthalene	2	133.34
2-Nitroaniline	5.0	333.34

TABLE 6 (continued)

REPORTED DETECTION LIMITS FOR SEMIVOLATILE ORGANIC COMPOUNDS*

Analyte	RDL (µg/L)	RDL (µg/Kg)
3-Nitroaniline	5.0	333.34
4-Nitroaniline	5.0	333.34
Nitrobenzene	2	133.34
2-Nitrophenol	10.0	666.67
4-Nitrophenol	10.0	666.67
Nitrosodi-n-butylamine	10.0	666.67
n-Nitrosodimethylamine	2	133.34
n-Nitrosodiphenylamine/Diphenylamine	2	133.34
Nitrosodipiperidine	20.0	2000
n-Nitrosodi-n-propylamine	5.0	333.34
Pentachlorobenzene	20.0	1333.34
Pentachloronitrobenzene	10.0	150
Pentachlorophenol	10.0	666.67
Phenanthrene	2	133.34
Phenol	5.0	333.34
Pyrene	2	133.34
Piridine	5	666.67
1,2,4,5-Tetrachlorobenzene	10	666.67
1,2,4-Trichlorobenzene	5.0	333.34
2,4,5-Trichlorophenol	5.0	333.34
2,4,6-Trichlorophenol	5.0	333.34
2,3,4,6-Tetrachlorophenol	5.0	166.66
m-Toluidine	5	300

*** Note**: Reporting Limits are based on standard 8270 reporting list. RLs may vary for other reporting lists.

Table 7
Semivolatile Internal Standards with Corresponding
Target Compounds and Surrogates Assigned for Quantitation

1,4-dichlorobenzene-d4	Naphthalene-d8	Acenaphthene-d10	Phenanthrene-d10	Chrysene-d12	Perylene-d12
O-Toluidine	2-Ethylaniline	2-Naphthylamine	3,3-Dimethylbenzidine	3,3'-Dichlorobenzidine	Benzo(g,h,i)perylene
1,2,4-Trichlorobenzene	2,4-Dimethylaniline	2,3,4,6-Tetrachlorophenol	Anthracene	Benzo(a)Anthracene	Dibenzo(a,h)anthracene
1,2-Dichlorobenzene	3,4-Dimethylaniline	2,3,5,6-Tetrachlorophenol	Benzidine	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene
1,3-Dichlorobenzene	2,3-Dimethylaniline	2,4,6-Tribromophenol, surr	Benzyl butyl phthalate	Benzo(b)fluoranthene	
1,4-Dichlorobenezne	2,4,5-Trimethylaniline	2,4-Dinitrophenol	Carbazole	Benzo(k)fluoranthene	
2,4-Dichlorophenol	4-Chlorotoludine	2,4-Dinitrotoluene	Di-n-Butylphthalate	Bis(2-ethylhexyl) phthalate	
2,4-Dimethylphenol	1,2,4,5-Tetrachlorobenzene	3-Nitroaniline	Diphenamid	Chrysene	
2-Chloroaniline	1,2-Dichlorobenzene	4,6-Dinitro-2-methylphenol	Fluoranthene	Di-n-octylphthalate	
2-Chlorophenol	1,3-Dichlorobenzene	4-Bromophenyl-phenyl ether	n-Octadecane		
2-Fluorophenol, surr	1,4-Diclorobenzene	4-Chlorophenyl-phenyl ether	Parathion		
2-Methylphenol	1-chloror-2-nitrobenzene	4-Nitroaniline	Phenanthrene		
2-Nitrophenol	1-Methylnapthalene	4-Nitrophenol	Pyrene		
3-Methylphenol / 4-Methylphenol	2,4,5-Trichlorphenol	Acenaphthene	Terphenyl-d14, surr		
Acetophenone	2,4,6-Trichlorophenol	Atrazine			
Aniline	2,6-Dichlorophenol	Azobenzene			
Benzaldehyde	2,6-Dinitrotoluene	Dibenzofuran			
Benzyl Alcohol	2-Chloronaphthalene	Dichloran			
Bis(2-chloroethoxy)methane	2-Fluorobiphenyl, surr	Diethyl phthalate			
Bis(2-chloroethyl)ether	2-Methylnaphthalene	Fluorene			

Table 7 (cont.)
Semivolatile Internal Standards with Corresponding
Target Compounds and Surrogates Assigned for Quantitation

1,4-dichlorobenzene-d4	Naphthalene-d8	Acenaphthene-d10	Phenanthrene-d10	Chrysene-d12	Perylene-d12
bis(2-Chloroisopropyl)ether	2-Nitroaniline	Hexachlorobenzene			
Hexachloroethane	3-Choloroaniline	NDPA/DPA			
Isophorone	4-Chloro-3-Methylphenol	Pentachloronitrobenzene			
m-Toluidine	4-Chloroaniline	Pentachlorophenol			
n-Decane	Acenaphthylene				
Nitrobenzene	a-Terpineol				
Nitrobenzene-d5, surr	Benzoic Acid				
N-Nitrosodimethylamine	Biphenyl				
N-Nitrosodi-n-propylamine	Caprolactam				
Phenol	Dimethyl Phthalate				
Phenol-d6, surr	Hexachlorobutadiene				
Pyridine 1,4-Dioxane	Hexachlorocyclopentadiene				
Phenol-d6, surr	Naphthalene				

Table 8

Recommended Minimum Response Factor Criteria from Initial and Continuing Calibration Verification Using the Suggested Ions in Table 5

Analyte	MRF
Benzaldehyde	0.010
Phenol	0.800
Bis(2-chloroethyl)ether	0.700
2-Chlorophenol	0.800
2-Methylphenol	0.700
2,2'-Oxybis-(1-chloropropane)	0.010
Acetophenone	0.010
4-Methylphenol	0.600
N-Nitroso-di-n-propylamine	0.500
Hexachloroethane	0.300
Nitrobenzene	0.200
Isophorone	0.400
2-Nitrophenol	0.100
2,4-Dimethylphenol	0.200
Bis(2-chloroethoxy)methane	0.300
2,4-Dichlorophenol	0.200
Naphthalene	0.700
4-Chloroaniline	0.010
Hexachlorobutadiene	0.010
Caprolactam	0.010
4-Chloro-3-methylphenol	0.200
2-Methylnaphthalene	0.400
Hexachlorocyclopentadiene	0.050
2,4,6-Trichlorophenol	0.200
2,4,5-Trichlorophenol	0.200
1,1'-Biphenyl	0.010
2-Chloronaphthalene	0.800
2-Nitroaniline	0.010
Dimethyl phthalate	0.010
2,6-Dinitrotoluene	0.200
Acenaphthylene	0.900
3-Nitroaniline	0.010
Acenaphthene	0.900
2,4-Dinitrophenol	0.010
4-Nitrophenol	0.010
Dibenzofuran	0.800
2,4-Dinitrotoluene	0.200
Diethyl phthalate	0.010
1,2,4,5-Tetrachlorobenzene	0.010

Table 8 (cont.)

Recommended Minimum Response Factor Criteria from Initial and Continuing Calibration Verification Using the Suggested Ions in Table 5

Analyte	MRF
4-Chlorophenyl-phenyl ether	0.400
Fluorene	0.900
4-Nitroaniline	0.010
4,6-Dinitro-2-methylphenol	0.010
4-Bromophenyl-phenyl ether	0.100
N-Nitrosodiphenylamine	0.010
Hexachlorobenzene	0.100
Atrazine	0.010
Pentachlorophenol	0.050
Phenanthrene	0.700
Anthracene	0.700
Carbazole	0.010
Di-n-butyl phthalate	0.010
Fluoranthene	0.600
Pyrene	0.600
Butyl benzyl phthalate	0.010
3,3'-Dichlorobenzidine	0.010
Benzo(a)anthracene	0.800
Chrysene	0.700
Bis-(2-ethylhexyl)phthalate	0.010
Di-n-octyl phthalate	0.010
Benzo(b)fluoranthene	0.700
Benzo(k)fluoranthene	0.700
Benzo(a)pyrene	0.700
Indeno(1,2,3-cd)pyrene	0.500
Dibenz(a,h)anthracene	0.400
Benzo(g,h,i)perylene	0.500
2,3,4,6-Tetrachlorophenol	0.010

Table 9
Difficult analytes

Aniline

Benzaldehyde
Benzidine
Benzoic acid
Benzyl alcohol

Caprolactam
4-Chloroaniline
4-chloro-3-methylphenol (p-chloro-m-cresol)

3,3-Dimethylbenzidine
1,4-Dioxane
Dimethylphthalate
2,4 Dinitrophenol
4,6-dinitro-2-methylphenol (4,6-dinitro-o-cresol)

Hexachlorocyclopentadiene
Hexachloroethane

2-Methylphenol
3-Methylphenol/4-Methylphenol

2-nitroaniline
3-nitroaniline
4-nitroaniline
4-Nitrophenol
Nitrosodiphenylamine and diphenylamine (NDPA/DPA)
n-Nitrosodimethylamine

Parathion
Pentachloronitrobenzene
Pentachlorophenol
Phenol
Pyridine

Test Method Standard Operating Procedure (SOP): Pace® Analytical Services

Pace ANALYTICAL SERVICES	**ENV-SOP-ELON-0065 v05_TOC Solid**
	Effective Date: 07/25/2025

Management Approval:
Lawton William Averill Approved on 7/14/2025 1:20:07 PM
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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the laboratory procedure used by PAS-ELON for the determination of Total Organic Carbon (TOC) in soils, sediments, and solids by method EPA 9060A and the Lloyd Kahn Method.

1.1 Target Analyte List and Limits of Quantitation (LOQ)

The target analytes that can be determined by this SOP and the associated LOQ are provided below.

TOC Soil/Solid Reporting Limit = 100mg/kg

2.0 SUMMARY OF METHOD

Total Organic Carbon of soils, solids and sediments is determined by first performing a manual pre-acidification and bake out step to eliminate the TIC content before the sample is run through the soil module. The sample is then heated to a temperature of 500° - 900° C. The sample is combusted, and the resulting carbon dioxide gas is detected by a non-dispersive infrared (NDIR) detector in the Lotix TOC Analyzer that is calibrated to directly display the detected carbon dioxide mass. The result is the amount of TOC in the sample. Samples analyzed in quadruplicate. For method EPA 9060A, both the average and the range are reported.

Total Carbon can be determined by eliminating the manual pre-acidification step. Total Inorganic Carbon can be determined by calculation. Total Carbon – Total Organic Carbon = Total Inorganic Carbon.

3.0 INTERFERENCES

Volatile organics in soils, solids and sediments may be lost in the de-carbonation (pre-acidification) step resulting in a low bias.

Bacterial decomposition and volatilization of the organic compounds can be minimized by maintaining the sample at 4°C ± 2°C and analyzing within the specified holding times.

4.0 DEFINITIONS

Refer to the Laboratory Quality Manual for a glossary of common lab terms and definitions.

- PAS: Acronym for Pace® Analytical Services, LLC
- ELON: Acronym for East Longmeadow, MA location

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5.0 HEALTH AND SAFETY

Contact your supervisor or local safety coordinator with questions or concerns regarding safety protocol or safe handling procedures for this procedure.

The following sections provide general health and safety information about chemicals and materials that may be present in the laboratory.

- The toxicity or carcinogenicity of each chemical material used in the laboratory has not been fully established. Each chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable.
- The laboratory maintains documentation of hazard assessments and OSHA regulations regarding the safe handling of the chemicals specified in each method. Safety data sheets for all hazardous chemicals are available to all personnel. Employees must abide by the health, safety and environmental (EHS) policies and procedures specified in this SOP and in the Pace® Chemical Hygiene / Safety Manual (COR-MAN-0001)
- Personal protective equipment (PPE) such as safety glasses, gloves, and a laboratory coat must be worn in designated areas and while handling samples and chemical materials to protect against physical contact with samples that contain potentially hazardous chemicals and exposure to chemical materials used in the procedure.
- Concentrated corrosives present additional hazards and are damaging to skin and mucus membranes. For procedures that require use of acids, use acids in a fume hood whenever possible with PPE designed for handing these materials. If eye or skin contact occurs, flush with large volumes of water. When working with acids, always add acid to water to prevent violent reactions. For procedures that that emit large volumes of solvents (evaporation/concentration processes), these activities must be performed in a fume hood or apparatus that reduces exposure.

6.0 SAMPLE COLLECTION, PRESERVATION, HOLDING TIME & STORAGE

The laboratory provides containers for the collection of samples upon client request. Refer to laboratory SOP ENV-SOP-ELON-0017 *Bottle Prep* for procedures related to preparation of bottle kits for the test method(s) associated with this SOP.

The laboratory does not perform sample collection or field measurements for this test method. Samples should be collected in accordance with a sampling plan and sampling procedures appropriate to achieve the regulatory, scientific, and data quality objectives for the project.

Container Type, Minimum Sample Amount, Preservation, and Holding Time Requirements:

Matrix	Container Size & Type	Required Sample Amount[1]	Preservation	Holding Time
Soil/Solids/Sediment	8oz amber glass jar	50mg	Thermal: ≤6°C	Collection to Analysis: Lloyd Kahn = 14 days EPA 9060A = 28 days
EPA 9060A Domestic and Industrial Waste	Amber glass Container	40mL	Thermal: ≤6°C In instances where analysis cannot be performed within 2 hours from time of sampling,	EPA 9060A = 2 hours if unpreserved and 28 days if acidified.

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			the sample is acidified with H_2SO_4.	

[1] *Amount of sample required for each discrete test.*

Thermal preservation is checked and recorded on receipt in accordance with laboratory SOP ENV-SOP-ELON-0100 *Sample Log-in Procedures*. Chemical preservation is checked and recorded at time of receipt or prior to sample preparation.

After receipt, samples are stored at 4°C ± 2°C until sample preparation. Prepared samples (extracts, digestates, distillates, other) are stored at ambient temperature until sample analysis.

After analysis, samples are retained as stated in the Pace® standard terms and conditions, unless otherwise specified in the analytical services contract. Samples are then disposed of in accordance with Federal, State, and Local regulations.

7.0 EQUIPMENT & SUPPLIES

7.1 Equipment

- Teledyne Texmar, Lotix Instrument, and soil module
- Analytical balance capable of weighing 0.001g
- Lotix Combustion TOC – Teklink Software
- 103℃ drying oven
- 1000µL Eppendorf or equivalent single channel pipette

7.2 Supplies

- 100uL Syringe
- 99.99% Oxygen for the carrier gas set for 55 psi pressure and flow rate set at 30 mL/min.
- Fiber Quartz wool
- Aluminum boat
- Glass quartz boat
- Tweezers

8.0 REAGENTS & STANDARDS

Refer to laboratory SOP ENV-SOP-ELON-0008 *Inventory and Chemical Receipt,* or however named, for information regarding standard and reagent tracking and traceability. All reagents and stock standards are commercially prepared when available. Expiration and storage requirements are defined per manufacturer. Ensure an Element Standard ID is assigned to all standards and reagents, and any prepared standards or reagents have the preparation documented in Element. Label standard or reagent with standard ID number and expiration date.

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8.1 Reagents

- Carbon dioxide-free water (Type II Ultra-Pure deionized water).
- Phosphoric acid solution (H_3PO_4) – 1:1 by volume
- Ottawa Sand

8.2 Standards

- Potassium hydrogen phthalate ACS grade - primary standard, 471000mg/L TOC, purchase from Thermo Scientific or equivalent.
- TOC Soil stock solution(10,000mg/L) To a 500mL volumetric flask add 10.627g potassium hydrogen phthalate, primary standard, in carbon-free DI water and bring up to volume. Preserve with H_3PO_4 to pH <2. Expires in 6 months.
- TOC Soil Intermediate (750mg/L) – 7.5mL of TOC Soil stock solution brought to final volume of 100mL with DI. Made fresh daily; used to spike Matrix Spike.
- Potassium hydrogen phthalate – second source, 471000mg/L TOC, purchase from different manufacturer than primary source.
- TOC Soil QC Stock Solution (10,000 mg/L) – To a 500mL volumetric flask add 10.627g potassium hydrogen phthalate, second source, in carbon-free DI water and bring up to volume. Preserve with H_3PO_4 to pH <2. Expires in 6 months.
- TOC Soil QC Intermediate (750mg/L) – 7.5mL of TOC Soil QC stock solution brought to final volume of 100mL with DI. Made fresh daily.

9.0 PROCEDURE

9.1 Equipment Preparation

9.1.1 Procedure to Switch from Water to Soil Mode

Ensure all units are off and exit all TOC software.

Unhook the small clear TOC furnace tube from the blue column drying unit and attach the small clear line from the Lotix LSS unit.

Using two 7/16th inch wrenches, detach the furnace line from the Lotix TSS unit and attach it to the Lotix LSS soil furnace line.

9.1.2 Instrument Startup

Ensure units are attached properly (See above section 9.1.1)

Turn on oxygen tank and confirm pressure is set to 55 psi.

Clean out condenser rinse tube.

Check DI levels in large brown reservoir.

Turn on both Lotix and LSS units via switches on back. Allow to warm up for 30 minutes.

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Open Lotix software and ensure the computer is communicating with both units.

9.2 Calibration

9.2.1 Calibration Frequency

Performed at least every 6 months.

9.2.2 Calibration Levels

Calibration curve is added directly onto fiber quartz wool in glass quartz boat.

mL of 10000 mg/L Standard Solution	Final Volume (mL)	Final Concentration (mg/C)
0	50	0
0.5	50	100
2.5	50	500
3.75	50	750
5.0	50	1000
25	50	5000
50	50	10000

9.2.3 Calibration Sequence

A new sequence must be created for each calibration that is performed.

From Lotix software home screen, select calibration.

Select new and name the curve according to date.

The following samples should be added to each sequence when creating a new calibration:

- Clean cycle (6 reps)
- Cal curve points (See Section 5.3)

Click Save

Click the ready button.

Once ready, and baseline has stabilized, press the start button.

Inject 100µL of sample into the glass quartz boats for each rep run and place boat on the boat loader.

Type volume into the Lotix software when prompted for each rep. When entered, press OK to begin rep. Repeat through end of curve.

9.2.4 Calibration Evaluation

Refer to corporate POL ENV-POL-CORQ-0005, Acceptable Calibration Practices for Instrument Testing, for general laboratory calibration policies and procedures.

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9.2.4.1 Curve Fit

Once the calibration sequence is complete, review the calibration table and curve. This can be done by clicking on Monitor, then the Calibration tab. Check the reported R2 Value; it should be ≥ 0.995. If not, reanalyze the calibration sequence or perform instrument maintenance as necessary. Back calculated concentrations for the low and mid points and determine the %RE.

Calculate relative error for the low calibration standard and the mid-point calibration standard using the equation in Section 10.2.4. Before performing this calculation, quantify the measured concentration of both of these standards against the new calibration curve and use these values as the measured concentration of standard (x'i).

The %RE for the low and mid-calibration standards must be within ±50% and ±30%, respectively. Record the results of the calculation on the raw data.

If the criterion is not met, the calibration is not acceptable for use. Investigate and troubleshoot to correct the problem and perform a new calibration. Do not proceed to analyze samples; sample analysis may not proceed if this quality control measure is not within criteria.

9.2.4.2 Initial Calibration Verification (ICV)/Laboratory Control Sample (LCS)

Analyze once daily to determine any bias of the analysis. The ICV/LCS is from an independent source (i.e., external to the calibration-curve stock), and is thus a true validation of the analytical system. In general, use the laboratory-generated limits for acceptance criteria, or if none are available, use those provided by the supplier.

Refer to section 8.2 on how to prepare the intermediate solution.

Pipette 100µL of 750mg/L TOC Soil QC intermediate solution directly onto fiber quartz wool in glass cuvette. True value = 750 mg/C.

Follow laboratory-generated limits. Until 20 data points are achieved use default limits of 85-115%.

9.2.4.3 Continuing Calibration Verification (CCV)

CCVs are standards that determine the validity and stability of the initial calibration of an instrument. It is advisable to analyze on a 10% basis. Choose a mid-level standard as the CCV.

If calibration is performed on the same day the 750mg/L calibration standard will be used otherwise an intermediate solution will have to be made, see section 8.2.

Pipette 100µl of 750mg/L calibration standard or TOC Soil intermediate solution directly onto fiber quartz wool in glass cuvette. True value = 750 mg/C.

Acceptance criteria = 85-115%

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If after corrective action(s) the CCV still falls outside the acceptance criteria, a new calibration curve must be reanalyzed and all samples since the last successful calibration verification standard also reanalyzed.

9.2.5 Calibration Blanks

9.2.5.1 Continuing Calibration Blank (CCB)

CCBs are a blank analyzed to determine analytical sensitivity and evaluate instrument drift and contamination. It is run after every 10 samples, following a CCV.

CCB must be below the reporting limit and for North Carolina it must not exceed 50% of the reporting limit.

If CCB is above the RL or ½ RL for North Carolina, recalibrate/reanalyze all samples since last compliant CCB.

9.3 Sample Preparation

9.3.1 Pre-acidification and Bake Out Step

Weigh out 1g of each sample, duplicate and matrix spike, into an aluminum weigh boat and place on a tray. Weigh out 1g of Ottawa sand for the Method Blank and LCS's. Quality Control samples need to be matrix matched.

Once all samples are weighed out add 2-3 drops 1:1 Phosphoric acid solution to each sample (inside of a hood), being sure to moisten the entire sample and until effervescence stops. Spike the matrix spike samples with 100µL of TOC Soil intermediate standard using a pipette.

The aluminum tray is then placed into the 103°C drying oven for at least one hour.

Percent Solids should also be determined separately as per ENV-SOP-ELON-0069 *Percent Solids*.

9.4 Sample Analysis

9.4.1 Sequence Creation using previously acceptable Calibration

Open schedule from Lotix software home screen.

Create a new sequence.

The following samples should be added to each sequence:

- Clean (6 reps)
- QC Method Blank (Run as unknown sample)
- LCS (ICV Check standard)
- LCS duplicate
- Any other samples needed

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- CCV (Check standard)
- CCB

A Sample ID will need to be added for each. The default Clean Up method is automatically set for the Clean Ups. For all other samples/QCs the latest calibration should be selected as the method, and each will have 4 reps (except for the Clean Up).

Click Save.

Click ready button.

Once ready and baseline has stabilized, press start button.

Inject 100µL of sample or weigh out sample in glass boat.

Input volume or weight into software when prompted for each rep. When entered, press ok to begin rep.

While waiting, prepare the next sample.

10.0 DATA ANALYSIS & CALCULATIONS

10.1 Data Analysis

Once the sequence is complete, review the results by clicking on Monitor, then the Result Log tab. Verify all QC samples are within acceptable limits. If not, reanalyze the calibration sequence or perform instrument maintenance as necessary.

Evaluate sample absorbances against the highest calibration standard absorbance. If sample absorbance exceeds the highest calibration standard, then sample results must be flagged as “Estimated”. Dilution is not possible with this analysis due to limitations of the test.

Be sure that the Instrument ID and Analyst Initial are on the raw data printouts. Samples analyzed in quadruplicate. For method EPA 9060A, both the average and the range are reported.
For the Lloyd Kahn Method, the precision and accuracy will differ with various instruments and matrices and must be determined by the lab reporting data. To initiate a control chart, a representative sample of well mixed sediment should be analyzed 15 times to determine the analytical precision. Set up a control chart showing 3 times the standard deviation limits for precision.

Subsequently during analysis of env. Samples, take one sample per batch of 20 or less and run in quadruplicate. Calculate standard deviation and report with initial control chart data. If the sample being run in quadruplicate exceeds 3 standard deviation limit, identify error and rerun env. Samples in that batch along with quadruplicate sample.

10.2 Calculations

10.2.1 Total Organic Carbon Calculation

$$\text{TOC, mg/kg} = \frac{A}{B} \times 1000$$

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where:

A = concentration from instrument, mg/C
B = weight of sample (mg)

10.2.2 Relative Percent Difference (RPD)

RPD = [(A – B)/C] x 100

where:

A = sample result or duplicate result (whichever is larger)
B = sample result or duplicate result (whichever is smaller)
C = average of sample and duplicate results

10.2.3 Percent Recovery

%R = [(A – B)/C] x 100

where:

A = matrix spike result
B = sample result
C = true value of spike

10.2.4 Relative Error (%RE)

$$\%\ Relative\ Error = \left(\frac{x'i - xi}{xi}\right) x\ 100$$

Where:

xi = True value of the calibration standard

x'i = Measured concentration of the calibration standard

10.3 Reporting

When reporting results, record the analysis date in the bench sheets, and in the LIMS.

11.0 Quality Control & Method Performance

11.1 Quality Control

Prepare the following QC samples with each batch of samples. Refer to Appendix A for acceptance criteria and required corrective action(s).

QC Check	Acronym	Frequency
Method Blank	MB	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
Laboratory Control Sample	LCS	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.
LCS Duplicate	LCSD	1 per batch of 20 or fewer samples. If batch exceeds 20 samples, every 20 samples.

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Matrix Spike	MS	1 per 10 or fewer samples. If batch exceeds 10 samples, every 10 samples.
Matrix Spike Duplicate	MSD	1 per 10 or fewer samples. If batch exceeds 10 samples, every 10 samples.
Sample Duplicate	SD	1 per 10 or fewer samples, an MSD is typically prepared in lieu of.

11.1.1 Reagent Blank

Analyzed as part of the calibration curve to determine any bias or contamination associated with reagents. The concentration of the blank must be below the reporting limit and for North Carolina it must be ≤1/2 of the reporting limit.

11.1.2 Method Blank (MB)

Analyzed to determine any bias associated with reagents and any contamination from the procedure. Method blanks are run 1 per batch of 20 samples or less. The concentration of the blank must be below the Reporting Limit and for North Carolina it must be ≤1/2 of the reporting limit. This is reported to the client.

Weigh out 1gram of Ottawa sand to matrix match the Method Blank.

11.1.3 Laboratory Control Sample (LCS)/LCSD

Analyze once daily to determine any bias of the analysis. The LCS and LCS duplicate is from an independent source (i.e., external to the calibration-curve stock), and is thus a true validation of the analytical system. In general, use the laboratory-generated limits for acceptance criteria, or if none are available, use those provided by the supplier.

The LCS and LCS duplicate reflect achieved accuracy under ideal conditions for a methodology and analysis procedure. Analyze one LCS and a LCS duplicate for each batch of 20 or fewer samples.

Weigh out 1gram of Ottawa sand to matrix match the LCS and LCSD. LCS and LCSD are independently prepped and analyzed.

Pipette place 100µL of 750mg/L QC intermediate solution (as prepared in 8.2) directly onto sand in glass cuvette. True value = 750 mg/C.

Follow laboratory-generated limits. Until 20 data points are achieved use default limits of 85-115%.

11.1.4 Matrix Duplicates (DUP)

Analyze on > 10% basis (one per batch of 10 or less samples or two per batch of 11-20 samples) to assess precision by use of a calculated RPD. An MSD is typically prepared in lieu of a DUP. Sample and Duplicates are independently prepped and analyzed.

Follow laboratory-generated control limits.

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11.1.5 Matrix Spikes (MS)/Matrix Spike Duplicates (MSD)

Defined as an aliquot of sample spiked with a known concentration of target analyte. Spiking occurs prior to sample preparation and analysis. Matrix spikes provide a means of assessing accuracy for the method used on a specific sample matrix.

Pipette 100µL of 750mg/L calibration standard, or intermediate solution (as prepared in 8.2), directly onto sample in glass cuvette. True value = 750 mg/C.

MS and MSD are independently prepped and analyzed.

Follow laboratory generated control limits. Until 20 points are achieved use default limits of 85-115% for recovery and 20 for RPD.

11.2 Instrument QC

Perform the following checks to verify instrument performance. Refer to Appendix A for acceptance criteria and required corrective action.

Instrument Check	Acronym	Frequency
Initial Calibration Verification	ICV	Immediately after calibration
Continuing Calibration Verification	CCV	After every 10 samples and end
Continuing Calibration Blank	CCB	After every 10 samples and end

11.3 Method Performance

11.3.1 Method Validation

Refer to corporate SOP ENV-SOP-CORQ-0011 for general requirements and procedures for method validation.

Establish detection limits (DL) and limits of quantitation (LOQ) at initial method set up and verify the DL and LOQ on an on-going basis thereafter. Refer to corporate policy and/or SOP for DL and LOQ requirements and procedures.

11.3.2 Demonstration of Capability (DOC)

Refer to laboratory SOP ENV-SOP-ELON-0134 Training Requirements, or however named, for information regarding the laboratory's procedures for initial and ongoing Demonstration of Capability.

12.0 Data Review & Corrective Action

12.1 Data Review

The data review process of Pace® Analytical Services includes a series of checks performed at different stages of the process by different people to ensure that SOPs were followed, the analytical record is complete, and properly documented, QC criteria were met, proper corrective actions were taken for QC failure and other nonconformance(s), and test results are reported with proper qualification, when necessary.

The review and checks that are performed by the employee performing the task is called primary review.

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All data and test results are also peer reviewed.

This process, known as secondary review is performed to verify SOPs were followed, that calibration, instrument performance, and QC criteria were met and/or proper corrective actions were taken, qualitative ID and quantitative measurement is accurate, all manual integrations are justified and documented, and approved in accordance with the Pace® Analytical Services SOP for manual integration, calculations are correct, the analytical record is complete and traceable, and that results are properly qualified.

Lastly, a third-level review, called a completeness check, is performed by reporting or project management staff to verify the test report is complete.

Refer to laboratory SOP ENV-SOP-ELON-0035 *Data Review* for specific instructions and requirements for each step of the data review process.

12.2 Corrective Action

Corrective action is required when QC or sample results are not within acceptance criteria.

Refer to Appendix A for a complete summary of QC, acceptance criteria, and recommended corrective actions for QC associated with this test method.

If corrective action is not taken or was not successful, the decision/outcome must be documented in the analytical record. The primary analyst has primary responsibility for taking corrective action when QA/QC criteria are not met. Secondary data reviewers must verify that appropriate action was taken and/or that results reported with QC failure are properly qualified.

Corrective action is also required when carryover is suspected and when results are over range.

Samples analyzed after a high concentration sample must be checked for carryover and reanalyzed if carryover is suspected. Carryover is usually indicated by low concentration detects of the analyte in successive samples analyzed after the high concentration sample.

Sample results at concentrations above the upper limit of quantitation must be diluted and reanalyzed. The result in the diluted samples should be within the upper half of the calibration range. Results less than the mid-range of the calibration indicate the sample was over diluted and analysis should be repeated with a lower level of dilution. If dilution is not performed, any result reported above the upper range is considered a qualitative measurement and must be qualified as an estimated value.

13.0 Pollution Prevention & Waste Management

Pace® proactively seeks ways to minimize waste generated during work processes. Some examples of pollution prevention include but are not limited to reduced solvent extraction, solvent capture, use of reusable cycletainers for solvent management, and real-time purchasing.

The EPA requires that laboratory waste management practices comply with all applicable federal and state laws and regulations. Excess reagents, samples, and method process wastes are characterized and disposed of in an acceptable manner in accordance with the Pace® Chemical Hygiene Plan / Safety Manual. Refer to this manual for these procedures.

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14.0 MODIFICATIONS

The procedures in this SOP have not been modified from the reference test method(s) cited.

15.0 RESPONSIBILITIES

- All employees of Pace® Analytical Services that perform any part of this procedure in their work activities must have a signed Read and Acknowledgement Statement (R&A) in their training file for the version(s) of the SOP that were in effect during the time the employee performed the activity.
- Local quality personnel are responsible for tracking the currency of the R&A on this SOP for employees at the locations they are assigned to and for notifying the General Manager (GM), however named, when R&A are overdue or outstanding. The GM and the employee's direct supervisor are responsible for ensuring the employee completes the R&A assignments as required.
- The supervisors and managers of Pace® Analytical Services, however named, are responsible for training employees on the procedures in this SOP, implementing the SOP in the work area, and monitoring on-going adherence to the SOP the work area(s) they oversee.
- All employees of Pace® Analytical Services are responsible for following the procedures in this SOP. Unauthorized deviations or departures from this SOP are not allowed except with documented approval from the local Quality Manager and only when those deviations do not violate the Pace® Code of Ethics or Professional Conduct (COR-POL-0004) or associated policy and procedure(s). Hand-edits or manual changes to the SOP are not permitted. If a change is desired or necessary, Pace® employees must follow the procedures for document revision specified in corporate SOPs ENV-SOP-CORQ-0015 *Document Management* and ENV-SOP-CORQ-0016 *SOP for Creation of SOP and SWI*.
- Local quality personnel are responsible for monitoring conformity to this SOP during routine internal audits of work areas that utilize this SOP and for communicating gaps and deviations found during monitoring to the work area supervisor, who is responsible for correction of the situation.

16.0 ATTACHMENTS

- Appendix A: QC Summary & Corrective Action Table

17.0 REFERENCES

- ENV-POL-CORQ-0005, *Acceptable Calibration Practices*, current version.
- ENV-SOP-CORQ-0011, *Method Validation and Instrument Verification*, current version.
- ENV-SOP-CORQ-0015, *Document Management*, current version.
- ENV-SOP-CORQ-0016, *Standard Operating Procedures and Standard Work Instructions,* current version.
- COR-POL-0004, *Code of Ethics and Professional Conduct*, current version.
- COR-MAN-001, *Pace® Safety Manual*, current version.

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- ENV-MAN-ELON-0001, *Quality Manual*, current version.
- EPA, Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, SW-846, Rev. 1, November 2004, Method 9060A.
- "Determination of Total Organic Carbon in Sediment", Lloyd Kahn Method, July 27, 1988.
- Instrument Manual, "Lotix User Manual", P/N 15-1600-074, Rev D, July 2016, Teledyne Texmar.
- Balance manual.

18.0 REVISION HISTORY

Revisions Made from Prior Version

Section	Description of Change
1.0	Added PAS-ELON
2.0	Added for EPA 9060A both Average and range are reported.
4.0	Added definitions for PAS and ELON.
6.0	Added EPA 9060A preservation requirements.
8.0	Added statement on standard/reagent traceability and documentation.
8.1	Added Ottawa sand.
9.2.4 + 9.2.4.1+ AppA	Added new Calibration criteria and added %RE.
9.3.1	Added to weigh out Ottawa sand for MB and LCS/LCSD for matrix matching.
10.1	Added for EPA 9060A to report both average and range and control chart procedure for Lloyd Kahn method.
10.2.4	Added %RE calculation.
11.1.2	Added to matrix match MB.
11.1.3	Added to matrix match LCS and LCSD.
11.1.4	Added dups are prepared independently from each other.
11.1.5	Added MS dups are prepared independently from each other.
11.3.2	Added DOC section.

Document Succession: This version replaces the following documents:

Document Number & Version	Document Title	Effective Date:
ENV-SOP-ELON-0065 v04	TOC Solid	02/14/2025

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Appendix A: QC Summary and Corrective Action Table

QC Item	Frequency	Acceptance Criteria	Corrective Action	Qualification
ICAL	At instrument set up, after CCV failure and at least every 6 months.	R2 Value; it should be ≥ 0.995. %RE ±50% for low and ±30% mid points	Identify and correct source of problem. Reanalyze the calibration sequence or perform instrument maintenance as necessary.	None. Do not proceed with analysis
ICV	After Each ICAL – use LCS	use laboratory generated control limits	Identify source of problem, re-analyze. If repeat failure, repeat ICAL. Analysis may proceed if it can be demonstrated that the ICV exceedance has no impact on analytical measurements. For example, the ICV %R is high, CCV is within criteria, and the analyte is not detected in sample(s).	None. Do not proceed with analysis
CCV	After every 10 samples, and at end of sequence.	85-115%	Identify source of problem, re-analyze. If repeat failure, repeat ICAL. Re-analyze samples since last successful CCV.	None. Do not proceed with analysis
Method Blank	1 per batch of 20 or less samples.	<RL for NC ≤1/2 RL	Identify source of problem, re-analyze. If repeat failure, repeat ICAL or qualify if applicable.	Qualify outlier if applicable otherwise do not proceed with analysis.
LCS/LCSD	1 per batch of 20 or less samples	use laboratory generated control limits	Identify source of problem, re-analyze.	Qualify Outlier
MS/MSD	1 per 10 or less samples	use laboratory generated control limits	Identify source of problem, re-analyze.	Qualify Outlier
Sample Duplicate	1 per 10 or less samples, if MSD is not performed.	use laboratory generated control limits	Identify source of problem, re-analyze.	Qualify Outlier
CCB	After every 10 samples, and at end of sequence following the CCV.	<RL for NC <1/2 RL	Identify source of problem, re-analyze. If repeat failure, repeat ICAL. Re-analyze samples since last successful CCB.	Qualify outlier if applicable otherwise do not proceed with analysis.

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Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

References: **Method 8260D**, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update VI (Phase II), June 2018.

Method 5035A, SW-846, Closed System Purge & Trap and Extraction for Volatile Organics in Soil and Waste Samples. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Draft Revision I, July 2002.

Method 5030B, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December 1996.

Method 5030C, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update IV, May 2003.

1. Scope and Application

Matrices: Method 8260 is used to determine volatile organic compounds in a variety of solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including various air sampling trapping media, ground and surface water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

Definitions: Refer to Alpha Analytical Quality Manual.

The compounds listed in Table 5 may be determined by this method.

There are various techniques by which these components may be introduced into the GC/MS system. Purge-and-trap, by Methods 5030C (aqueous samples) and 5035A (solid and waste oil samples), is the most commonly used technique for volatile organic analytes. However, other techniques are also appropriate and necessary for some analytes. One technique is direct injection of an aqueous sample (concentration permitting).

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Department Manager, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the gas chromatograph/mass spectrometers and in the interpretation of mass spectra and their use as a quantitative tool. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by direct injection. The analytes are introduced to a narrow-bore capillary column for analysis. The Gas Chromatograph (GC) is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the GC.

Analytes eluted from the capillary column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard, comparing sample response to the calibration standards.

2.1 Method Modifications from Reference

None.

3. Reporting Limits

Table 1 lists our typical reporting limits.

4. Interferences

4.1 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be free from contamination under the conditions of the analysis. Running laboratory reagent blanks as described in Section 9.1 and 10.3 demonstrates the system is free of contamination. The use of non-Teflon plastic tubing, non-Teflon thread sealants, or flow controllers with rubber components in the purge and trap system must be avoided.

4.2 Sample contamination occurs by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during shipment and storage. A trip blank or a field reagent blank prepared from reagent water and carried through the sampling and handling protocol serves as a check on such contamination.

4.2.1 Storage blanks shall be analyzed if contamination is suspect. If contamination is confirmed by positive detections in the sample storage blanks, all data from samples contained in the relative refrigerator or freezer shall be evaluated for possible contamination. If the samples contain suspected contamination, the Client Services department shall be notified in order to contact the necessary clients regarding the contamination. Samples shall be reanalyzed if so desired by the client. If suspected contamination is not confirmed by storage blanks, no further action shall be pursued concerning said blanks. It is recommended that further action be taken to determine the possible cause of suspected contamination.

4.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. Whenever a highly concentrated sample is being encountered, it should be followed by an analysis of reagent water (instrument blank) to check for potential contamination. If carry-over is suspected, then numerous instrument blanks may be required; additionally, all affected samples are rerun for confirmation. In case of severe contamination, preventive maintenance of the entire system may be required.

5. Health and Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of safety data sheets (SDS) is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

5.1 Lab coats, safety glasses, and gloves must be worn when handling samples, standards, or solvents.

5.2 All stock solution standard preparation must be performed in the volatiles hood. Initial calibration, continuing calibration, laboratory control sample and client sample dilutions do not need to be performed in the hood.

5.3 All expired standards must be placed into the waste bucket in the lab for future disposal. The container must be labeled properly with hazard warning labels indicating the container contents.

5.4 Bottles containing Methanol must be stored in the flammables cabinet.

6. Sample Collection, Preservation, Storage, Shipping and Handling

6.1 Sample Collection and Preservation

6.1.1 Aqueous Samples

Grab samples are collected in standard 40mL glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two or more VOA vials should be filled per sample location. EPA Method 8260 requires that samples be acidified to eliminate the possibility of biological degradation. Unless otherwise directed for project-specific reasons, all VOA vials are delivered to the client with approximately 2 – 4 drops of 1:1 HCl added to the vial, which is sufficient to adjust the pH of the sample to < 2. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Fill the sample vial to the point of overflowing so that no headspace is contained within. Samples must be introduced into the vials gently to reduce agitation, which might drive off volatile compounds or cause loss of the HCl preservative.

Seal the bottle so that no air bubbles are in the VOA vial. If preservative has been added, shake vigorously for one minute. Invert the bottle and tap to check for air bubbles. Recollect the samples if any air bubbles are present.

Maintain the hermetic seal on the VOA vial until time of analysis.

6.1.2 Soil Samples

The recommended sampling method for soil samples is EPA 5035A. Method 5035A provides for two distinct sampling procedures, depending on the required reporting limits and suspected or known concentration levels of target analytes. These methods are referred to as the High Level and Low Level methods. Both are listed below but depending on the samples only one of the methods may be required. If concentration levels are unknown, it is recommended that samples be collected using both procedures.

The Lab will analyze the high level sample first, followed by the low level sample if the results from the high level analysis show that the sample is clean or contains analytes at low levels. The typical reporting levels of the two methods are listed in Table 1.

6.1.2.1 High Level Soil Samples

Collect sample in a standard 40mL glass screw-cap vial with Teflon lined silicon septa (VOA vial). The vial is provided containing 15mL of Purge and Trap Grade methanol and is labeled and weighed prior to addition of sample. Record the weight of the vial with methanol on the vial label. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Approximately 15g of soil is added to the vial in the field, making sure that the sample is completely covered by the methanol.

Maintain the hermetic seal on the VOA vial until the time of analysis.

An additional sample of the soil must also be obtained (without methanol) to be used for the determination of soil moisture content to allow for the calculation of the dry weight results, and to calculate the methanol dilution effect. (See Sections 11.2.2.2 and 11.2.2.2.1)

6.1.2.2 Low Level Soil Samples

Collect sample in a standard 40mL glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two samples should be taken per sample location. Vials are provided containing a magnetic stirring bar and 5 mL of either 200g/L sodium bisulfate solution or water, prepared by a certified vendor. These vials are labeled and weighed prior to addition of sample. Record the weight of the vial with the stirring bar and preservative on the vial label.

Approximately 5g of soil is added to the vial in the field, making sure that the sample is completely covered by the sodium bisulfate solution or water.

Maintain the hermetic seal on the VOA until the time of analysis.

6.2 Sample Handling and Storage

Document client specific sample handling, preservation and collection criteria in the project file. The laboratory Log-in staff documents sample temperature at the time of receipt.

Record deviations from this SOP or client specific criteria on the chain of custody form.

Record holding time exceedance, improper preservation and observed sample headspace on the nonconformance report form.

6.2.1 Aqueous Samples

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 1 and 4 °C. Sample receiving personnel must note on the sample delivery group form when samples received at the laboratory are not within the temperature criteria. If more than one vial is received for a sample, the vials are stored in separate refrigerators. Storing the vials apart provides a useful check if laboratory contamination of a sample is suspected. Samples must be analyzed within 14 days of collection. Unpreserved samples must be analyzed within 7 days of collection.

6.2.2 High Level Soil Samples

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 2 and 6 °C. Sample receiving personnel note on the

nonconformance report form when samples received at the laboratory are not within the temperature criteria. Samples must be analyzed within 14 days of collection.

6.2.3 Low Level Soil Samples

Ice or refrigerate samples preserved with water or sodium bisulfate from the time of collection until analysis, maintaining the sample temperature between 2 and 6 °C. Samples preserved with water are to be immediately frozen after sampling. Sample receiving personnel note on the nonconformance report form when samples received at the laboratory are not within the temperature criteria. Samples must be analyzed within 14 days of collection.

6.3 Sample Shipping

Samples requiring shipment to the laboratory are shipped in ice-packed coolers via an overnight delivery service in accordance with applicable Department of Transportation regulations.

7. Equipment and Supplies

7.1 Purge and Trap System (For Aqueous samples): The purge-and-trap system consists of two separate pieces of equipment: a purging device (autosampler) (TekmarAtomxXYZ, EST Centurion or equivalents) coupled to the desorber (concentrator) (EST Encon or Encon EV, or equivalents).

7.1.1 Purge gas = Helium analytical grade (99.999%) or Nitrogen analytical grade (99.999%).

7.1.2 The purging device is configured with 25 mL sample purge tubes, and the purge gas is introduced at the bottom of the water column as finely divided bubbles.

7.1.3 The trap used in the desorber is typically a Supelco “K” trap. Different traps may be used if equivalent performance is demonstrated.

7.1.4 The desorber is capable of rapidly heating the trap to 260^{o}C. The trap is not heated above manufacturer’s specifications.

7.2. Purge and Trap System (For Low Level and High Level Soil Samples): The purge and trap system consists of two separate pieces of equipment: a purging device (autosampler) (Tekmar AtomxXYZ, EST Centurion or equivalents) coupled to the desorber (concentrator) (Tekmar Velocity or Atomx, or EST Encon or Encon EV, or equivalents).

7.2.1 Purge gas = Helium analytical grade (99.999%) Nitrogen analytical grade (99.999%).

7.2.2 The autosampler purging device is a closed system, designed to accept the 40mL VOA vials. The VOA vial, containing the soil sample, water (or sodium bisulfate), and stirring bar is placed into the autosampler tray. The instrument automatically adds reagent water, internal standards, and surrogates to the unopened VOA vial. The vial is heated to 40 °C, and the purge gas is introduced into the aqueous portion to purge the volatile components onto the trap.

7.2.3 The trap used in the desorber is typically a Supelco “K” trap. Different traps may be used if equivalent performance is demonstrated.The desorber is capable of rapidly heating the trap to 260 °C. The trap is not heated above manufacturer specifications.

7.3 Gas Chromatography/Mass Spectrometer/Data System:

7.3.1 Gas Chromatograph, Agilent 6890/7890 or equivalent: An analytical system complete with a temperature-programmable gas chromatograph with appropriate

interface for sample introduction device. The system includes all required accessories, including syringes, analytical columns, and gases. The capillary column is directly coupled to the source of the GC/MS system.

7.3.2 Typical Gas Chromatographic Columns:

7.3.2.1 Column 1: Restek 502.2, 40 meter, 0.18mm ID, 1.0um, or equivalent.

7.3.2.2 Column 2: Restek RTX-VMS, 30 meter, 0.25mm ID, 1.4um, or equivalent.

7.3.2.3 Column 3: Restek RTX-VMS, 20 meter, 0.18mm ID, 1.5um, or equivalent.

7.3.3 Mass Spectrometer, Agilent 5973/5975/5978 or equivalent: Capable of acquiring mass spectra from mass/charge (m/z) 35 to 270 at a rate fast enough to acquire at least five (but preferably 10 or more) mass spectra across each chromatographic peak of interest, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for 4-Bromofluorobenzene (BFB) which meets all of the criteria in Table 3, when 50ng of the GC/MS tuning standard (BFB) are injected through the GC. For all SIM analysis, the mass spectrometer must also be able to acquire data in a dual acquisition mode (SIM and full scan).

7.3.4 Data System: Hewlett-Packard EnviroQuant software is used for data acquisition and allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program.

EnviroQuant E.02.02 (or equivalent) is used for data processing and allows searching of any GC/MS data file for ions of a specified m/z, and plotting such ion abundances versus time or scan-number.

The most recent version of the EPA/NIST Mass Spectral Library is loaded onto the Target / EnviroQuant data system.

7.4 Wiretrol or Micro syringes: 10µL - 1,000µL.

7.5 Syringes: 5mL, 10mL, or 25mL, glass with Luerlock tip.

7.6 Balances: Top-loading, capable of weighing 0.01g.

7.7 Vials: 2mL, 4mL.

7.8 Disposable Pipets.

7.9 Volumetric Flasks: Class A, appropriate sizes, with ground-glass stoppers.

7.10 Eppendorf pipets.

7.11 Ottawa Sand: SiO_2

8. Reagents and Standards

Reagent grade organic chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all organic reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

Great care must be taken to maintain the integrity of all standard solutions. Standards in methanol are stored at –10ºC or less, in amber vials with PTFE-lined screw-caps.

8.1 Organic-free Reagent Water:

All references to water in this method refer to organic-free reagent water, which is tap water passed through activated carbon and air bubbled through.

8.2 Methanol:

Purge and Trap Grade or equivalent. Store in flammables cabinet.

8.3 Stock Solutions:

All stock standards are purchased from commercial vendors as certified ampule solutions. When an ampule of stock solution is opened, it is transferred to a labeled amber screw-cap vial with minimal headspace. The expiration date of the stock solution is either the vendor specified expiration date or 6 months from the date the ampule was opened, whichever is sooner. Typical stock standard concentrations are listed in Table 4.

8.4 Intermediate Standards: Intermediate standards are prepared volumetrically by diluting the appropriate stock standard(s) with methanol. Initial Calibration solutions expire 2 months from the date of preparation, or sooner if daily continuing calibration checks do not achieve the method acceptance criteria. If the Intermediate Standards are used as a second source to verify a valid Initial Calibration solution, there is no expiration date.

8.4.1 Internal Standard Solutions:

The internal standards are Fluorobenzene, Chlorobenzene-d_5, and 1,4-Dichlorobenzene-d_4. The intermediate IS solution is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of IS solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample or standard. Internal standard is added at the same concentration to all standards, samples, and QC samples.

8.4.2 Surrogate Standard Solutions:

The surrogate standards are Dibromofluoromethane, 1,2-Dichloroethane-d_4, Toluene-d_8, and 4-Bromofluorobenzene. The intermediate surrogate solution is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of surrogate solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample.

8.4.3 Target Compound Solutions:

The target analytes routinely reported by this method are listed in Table 1 and 4. The intermediate target compound solutions are prepared by diluting the stock solution(s) with methanol. This set of solutions, at concentrations of 200 µg/mL, is used for preparation of the calibration standards.

8.4.4 4-Bromofluorobenzene (BFB) Tune solution:

8.4.4.1 A solution containing BFB at a concentration of 50 µg/mL is prepared by volumetrically diluting the BFB stock solution. 1 µL of this solution is direct-injected or purged into the GC/MS system to verify system performance prior to any standard or sample analysis.

8.4.4.2 BFB may be analyzed in full scan mode while standards, samples, and QC are analyzed in SIM

8.5 Calibration Standards:

There are two types of calibration standards used for this method – initial calibration standards and calibration verification standards.

8.5.1 Initial Calibration Standards:

Initial calibration standards can be prepared at the levels listed in Table 4 (other/different levels are allowed). The Initial Calibration needs to have a minimum of 5 standards, 6 if a quadratic curve fit is used. Prepare these solutions in organic-free reagent water. The standards correspond to the range of concentrations found in typical samples and do not exceed the working range of the GC/MS system. Initial calibration should be mixed from fresh stock standards and dilution standards when generating an initial calibration curve.

8.5.2 Initial Calibration Verification Standard (ICV):

The initial calibration verification standard is at the same concentration as the level 3 for liquids and level 4 for soils initial calibration standard. This standard is prepared from source materials from a second manufacturer or from a manufacturer's batch prepared independently from the batch used for calibration. A second lot# from the same manufacturer may be adequate to meet this requirement. The standard must contain all calibrated target analytes that will be reported for the project, if readily available.

8.5.3 Continuing Calibration Verification Standard:

The continuing calibration verification standard, or calibration check standard, should be analyzed near the action level of the project. Since most projects are focused on achieving low reporting limits, the continuing calibration verification standard is at the same concentrations as the level 3 for liquids and level 4 for soils initial calibration standard. This standard is run at the beginning of each analytical sequence, following the BFB tune standard, to verify system performance.

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 Blank(s)

9.1.1 Before processing any samples, the analyst must demonstrate through the analysis of a method blank (MB) or instrument blank that equipment and reagents are free from contaminants and interferences. The blank must contain the internal standards and surrogates and must be from the same source of water used for preparing the standards, QC samples and sample dilutions.

9.1.2 Analyze a matrix-specific blank, i.e. methanol samples need to have methanol in the blank; sodium bisulfate samples need to have a sodium bisulfate blank analyzed;

TCLP samples need a TCLP blank, after each ICAL and CCV, and prior to any sample analysis to demonstrate that interferences from the analytical system are under control.

9.1.3 Low level soil blanks must include 5g of Ottawa sand and be vortexed.

9.1.4 Blanks are considered to be acceptable if target analyte concentrations are less than one half the LOQ or are less than project-specific requirements. Blanks may contain analyte concentrations greater than acceptance limits if the associated samples in the batch are unaffected (i.e., target analytes are not present in samples or sample concentrations/responses are >10X the blank).

9.1.5 If an analyte of interest is found in a sample in the batch near a concentration detected in the blank, the presence and/or concentration of that analyte should be considered suspect and may require qualification. Reanalysis is not necessary if the analyte concentration falls well below the action or regulatory limit or if the analyte is deemed not important for the project.

9.1.6 The laboratory must not subtract the results of the MB (or any blank) from those of any associated samples.

9.2 Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD)

An LCS/LCSD pair is analyzed at the beginning of each analytical sequence. Since the LCS contains the same compounds at the same concentrations as the continuing calibration check standard, the same analysis is used to satisfy both QC elements. The LCS/LCSD acceptance criteria are based on in-house control limits, unless specified by project/regulation. Less than 10% of total compounds may be outside of control limits if recoveries are >10%. (Note: this does not apply to difficult analytes listed in Table 7 which may be accepted at recoveries <10.) If >10% of analytes are recovered above control limits, this is deemed acceptable as long as the analytes in question are not detected in associated samples. If these criteria are not met, the entire batch is re-extracted. If re-extraction is not possible, due to insufficient sample or holding time exceedance, the analyst must write up the failure on a narrative sheet for inclusion in the client report.

9.3 Initial Calibration Verification (ICV)

Refer to 12

9.4 Continuing Calibration Verification (CCV)

Refer to Section 11.2.

9.5 Matrix Spike/ Matrix Spike Duplicate

Upon Client Request or state mandate, a matrix spike/matrix spike duplicate pair may be analyzed with each batch of 20 or less samples. The MS/MSD are sample aliquots spiked with the target compounds at the same concentration as the continuing calibration standard for water analysis and level 6 for soils. The MS/MSD acceptance criteria are based on in-house control limits. If the MS/MSD does not meet the criteria, but the LCSD does, the failure may be attributed to sample matrix. Report the MS/MSD, including a narrative sheet for inclusion with the client report.

9.6 Laboratory Duplicate

Not applicable.

9.7 Method-specific Quality Control Samples

9.7.1 Internal Standards

Area counts of the internal standard peaks in all samples and QC samples must be between 50-200% of the areas of the internal standards in the QC check standard.

If any individual percent recovery falls outside the range, that parameter has failed the acceptance criteria. For calibration standards, CCVs, LCS/LCSD or blanks the internal standard must be within the range for data to be reported to the clients. For samples, matrix spikes and duplicates: if the data is not within the range, the sample is rerun to confirm that the failure is due to sample matrix. A nonconformance report form is completed to ensure client notification and reporting if matrix effect is confirmed.

9.7.2 Surrogates

Surrogates are added to each field sample and QC sample. The laboratory must evaluate surrogate recovery data from individual samples versus the surrogate control limits developed by the laboratory. The surrogate acceptance criteria are listed in Table 2. Since the SIM analysis is acquired in dual mode, the surrogates from the full scan are used to evaluate the entire sample (SIM and full scan).

9.8 Method Sequence

In a 12-hour period, the typical analytical sequence is as follows:

- BFB
- QC Check Standard/Laboratory Control Sample/LCSD
- Method Blank
- Samples
- MS/MSD (upon Client request, may be run any time after the Method Blank)

10. Procedure

10.1 Equipment Set-up

Typical instrument operating conditions are listed below. Alternate conditions are allowed if method performance criteria can be met.

10.1.1 GC Conditions:

Temperature 1:	35°C	Carrier gas:	Helium 99.999% or Nitrogen 99.999%
Hold Time 1:	4 minutes	Carrier mode:	Constant flow
Ramp 1:	6°C/minute	Carrier flow:	1 mL/minute
Temperature 2:	150°C		
Hold Time 2:	0 minutes		
Ramp 2:	8°C/minute		
Temperature 3:	220°C		
Final Time:	1 minute		

10.1.2 MS Conditions:

Mass range:	m/z of 35 – 270 amu
Scan time:	0.5 minutes/scan
Source temperature:	230°C or according to manufacturer's specifications.

10.1.3 Velocity Concentrator Purge and Trap Conditions:

Purge time:	11 minutes
Dry purge:	2 minutes
Desorb preheat:	250°C
Desorb temp:	255°C
Desorb time:	2 minutes
Bake temp:	290°C
Bake time:	10 minutes

10.1.4 Encon Concentrator Purge and Trap Conditions:

Purge time:	11 minutes
Dry purge:	1 minute
Desorb preheat:	245°C
Desorb temp:	255°C
Desorb time:	1 minute
Bake temp:	270°C
Bake time:	10 minutes

10.2 Initial Calibration

10.2.1 The initial calibration is performed at a minimum of five (5) concentration levels listed in Table 4, the low level either at or below the reporting limit. The calibration is performed using instrument conditions listed in 10.1.

BFB must be analyzed prior to analysis of the initial calibration standards and must pass the criteria listed in Table 3. The mass spectrum of BFB should be acquired in the following manner:

(1) Three scans (the peak apex scan, the scan immediately preceding the apex and the scan immediately following the apex) are acquired and averaged.
(2) Background subtraction is performed using a single scan of no more than 20 scans prior to the elution of BFB.

This is done automatically with the EnviroQuant software.

10.2.1.1 Low Level/High Level Soil Curve on Centurion: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 50mL volumetric flask using a micro syringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, then gently fill a 5mL syringe with standard and transfer to a 40mL VOA vial containing a magnetic stir bar. Load the vial onto autosampler.

10.2.1.2 Aqueous/High Level Soil Curve on Solatek or Centurion: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 100mL volumetric flask using a micro syringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, and then gently fill a 40mL VOA vial to the top. Load the vial onto the autosampler.

10.2.2 Establish the GC operating conditions by loading the appropriate GC method. Typical instrument conditions are listed in Section 10.1. The same operating conditions are used for calibration and sample analyses. Create the analytical sequence using the HP EnviroQuant data acquisition software.

Relative Response Factors: The internal standard calibration technique is used. In each calibration standard, calculate the relative response factor for each analyte and the relative standard deviation (RSD) of the response factors using the EnviroQuant data processing software. The response factors are calculated using the areas of the characteristic (quantitation) ion for each target analyte and internal standard. The calculations are performed automatically using the EnviroQuant software, using the formulae listed in Alpha's Quality Manual.

10.2.3 Initial Calibration Criteria: The following sections outline the method acceptance criteria for an initial calibration curve. All criteria must be met for the calibration to be deemed acceptable, and for sample analysis to proceed. For MCP and CT projects see the related project specific addenda for modifications.

10.2.3.1 Relative Standard Deviation Criteria: If the RSD for each target analyte is less than or equal to 20%, then the response for this compound is considered linear over the calibration range and the mean calibration factor can be used to quantitate sample results. If the 20% RSD criterion is not met for an analyte linear regression may be used if $\mathbf{r^2} \geq 0.990$, weighted linear with a weighting factor of 1/SD2 and r > 0.995, or quadratic fit if $\mathbf{r^2} \geq 0.990$. A minimum of five points are required for linear fit and six points is required for quadratic fit. The calibration must be repeated for any compounds that fail. If more than 10% of the compounds exceed the 20% RSD limit and do not achieve the minimum correlation coefficient for alternative curve fits, sample analysis cannot proceed.

10.2.3.1.1 Percent Relative Error (%RE): For linear and quadratic fit compounds the %RE relative error must be calculated for the standard at or near the midpoint of the initial calibration and at the lowest level. The %RE between the calculated and expected amounts of an analyte should be ≤ 30% for all standards, otherwise recalibration is necessary.

10.2.4 Evaluation of Retention Times: The relative retention times used for identification of target analytes are +/- 0.06 RRT (Relative Retention Time) units, based on the most recent standard run. It has been determined that these limits work well, being wide enough to eliminate false-negative results while being tight enough to eliminate false positive results. Due to the selectivity of the mass spectrometer, compound identification is more definitive than when using a less selective detector.

10.2.5 Initial Calibration Verification: After each calibration and before the analysis of samples, an ICV must be analyzed at or near the midpoint of the curve. The ICV must be prepared using a different source than the Initial Calibration and must contain all target analytes. The percent recoveries must be between 70% and 130% for target analytes

except for “difficult” analytes (Table 7), which must exhibit percent recoveries between 40% and 160%. Corrective action is required if greater than 10% of all analytes are outside the prescribed criteria.

10.2.5.1 The ICV used for the initial calibration can be used as the continuing calibration verification. See Section 10.4 for criteria.

10.2.6 Additional considerations for SIM analysis

10.2.6.1 SIM may be useful for applications requiring quantitation limits below the normal range of electron impact quadrupole mass spectrometry, and both are allowable options for this method. Using the primary m/z for quantitation and at least one secondary m/z (or product ion) for confirmation, set up the descriptor windows based on their retention times. The selected m/z values should include any mass defect noted in the target analyte mass spectra acquired on the instrument, usually less than 0.2 amu. The dwell time for each ion may be automatically calculated by the instrument software or may be calculated based on the peak widths of the analytes of interest, the number of spectra needed to be acquired across each peak, and the number of concurrent ions that need to be acquired in each segment. When fewer m/z values are monitored in each segment, the acquisition time for each m/z can be increased, thereby increasing the sensitivity of the system. The total cycle time for the MS should be short enough that at least five, but preferably ten or more, spectra are acquired per chromatographic peak.

10.2.6.2 When compounds are analyzed in SIM mode, the following best practices are recommended:

10.2.6.2.1 Monitor at least two ions for each target analyte and use the mid-point of the calibration curve to establish proper ion ratios for each compound. The ratios of primary and secondary ions are the only qualitative tools available in SIM runs (other than RT), which increases their importance in proper identification. When interferences are expected or observed in a given matrix, acquiring multiple secondary ions may aid in qualitative identification.

10.2.6.2.2 Verify that all monitored ions are correctly integrated in order to achieve proper ion ratios. Update the primary/secondary ion ratios and reference mass spectra after each ICAL using a mid-range ICAL standard.

10.3 Equipment Operation and Sample Processing

The same GC, MS, and Purge and Trap conditions used for the initial calibration must be employed for sample analysis. After verification of system performance by analysis of BFB, the continuing calibration standard and method blank, samples are analyzed and processed as described below.

10.3.1 All samples are initially screened using Tekmar 7000 Headspace Autosamplers.

10.3.2 Retrieve sample VOA vials from the sample refrigerator just prior to loading onto the purge and trap system.

10.3.3 Aqueous samples:
Load the VOA vial directly on the sampling rack. Dilutions may be prepared volumetrically and poured into VOA vials ensuring there is no headspace left in the vial. The autosampler will then sample 10mL from the VOA vial.

10.3.4 Low level soil samples:

Low level soil sample should be shaken briefly to ensure that the stir bar is loose, and will spin on the autosampler unit. Take the low level VOA vial and place directly into the rack of the autosampler unit. Surrogate and internal standards are added automatically by the autosampler prior to sample purging.

10.3.5 High level soil samples:

Shake or vortex the sample for 15 seconds, ensuring the methanol has completely penetrated the soil in the vial. Let sample settle prior to taking methanol aliquot.

10.3.5.1 Through liquid path

Load a maximum of 860µL or appropriate dilution of the methanol into a half-full VOA vial. Fill the VOA vial up to the top with water and cap with no headspace. Allow the auto-sampler to sample 10mL out of the VOA vial which would be equivalent to injecting 100µL of the methanol extract. Prepare dilutions accordingly.

10.3.5.2 Through soil path

Into a VOA vial with a stir bar added, load 4.9mL of water plus a maximum of 100 µL of methanol or appropriate dilution of methanol extract from a 5mL luerlock syringe. Cap the vial and load onto the auto-sampler.

10.3.6 Qualitative Analysis:

10.3.6.1 The qualitative identification of each compound is based on retention time and on comparison of the sample mass spectrum with the reference mass spectrum. The reference mass spectrum must be generated by the laboratory on the same GC/MS system. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds are identified as present when the following criteria are met:

10.3.6.1.1 The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. The EnviroQuant data system is configured to make this check.

10.3.6.1.2 The relative retention time (RRT) of the sample component is within ±0.06 RRT units of the RRT of the standard component.

10.3.6.1.3 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%.)

10.3.6.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is ≤ 50% of the average of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs (i.e., m and p-xylene).

10.3.6.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra is important.

10.3.6.1.6 Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes coelute (i.e., only one chromatographic peak is apparent), the identification criteria may be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

10.3.6.2 For samples containing non-target analytes, a library search will be performed at client request. Compound identification will be classified as “tentative”, and the concentration will be reported as an estimate as no quantitative standards are run for these compounds.

10.3.6.2.1 Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) are present in the sample spectrum.

10.3.6.2.2 The relative intensities of the major ions should agree within ±20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%.)

10.3.6.2.3 Molecular ions present in the reference spectrum are present in the sample spectrum. If the molecular ion is not present, carefully review library matches in order to avoid misidentification.

10.3.6.2.4 Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

10.3.6.2.5 Ions present in the reference spectrum but not in the sample spectrum are reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks.

10.3.6.2.6 Mass spectral library search algorithms typically assign a match factor to the peak identity based on comparison of an unknown mass spectrum to library spectra. For spectra meeting the above conditions, match factors greater than 0.85 (85%) may be considered confirming evidence. Where a known limitation in data collection is identified (e.g., the presence of an incompletely resolved spectral interference), a lower match factor may be considered confirmatory. For multiple library spectra with similar match factors (e.g., for hydrocarbons with low abundance molecular ions, or structural isomers), the tentative identification assigned to the unknown may be better represented as a more generic structure (e.g., unknown hydrocarbon, C4 benzene structural isomer).

10.3.7 Quantitative Analysis:

10.3.7.1 Quantitation of a target compound detected in a sample is performed automatically by the EnviroQuant data processing software, using the formulae found in Alpha’s Quality Manual. Either the average response factor or calibration curve will be used for sample quantitation, depending on how the particular analyte was processed in the initial calibration curve. If non-target

compounds are to be reported, the quantitation is performed automatically by the EnviroQuant software using the total area of the compound and the nearest internal standard, and assuming a relative response factor of 1.0.

10.4 Continuing Calibration

Calibration verification consists of three steps that are performed at the beginning of each 12-hour analytical shift. For MCP and CT projects see the related project specific addenda for modifications.

10.4.1 Prior to the analysis of samples or calibration standards, inject or purge 1 µL (50 ng) of the 4-Bromofluorobenzene standard (Section 8.4.4) into the GC/MS system. The resultant mass spectra for the BFB must meet the criteria given in Table 3 before sample analysis begins.

10.4.2 The initial calibration curve for each compound of interest must be verified once every 12 hours prior to sample analysis. This is accomplished by analyzing the continuing calibration check standard (Section 8.5.3).

10.4.3 A method blank must be analyzed prior to any samples, typically immediately following the continuing calibration check standard, to ensure that the analytical system is free of contaminants. The method blank must not contain any target analytes at or above the required compound reporting limits.

10.4.4 The percent difference or drift for each target analyte must be less than or equal to 20% (30% for all SIM compounds). If greater than 20% of target analytes exceed the %D criteria corrective action must be taken prior to the analysis of samples. If less than or equal to 20% of compounds exceed the criteria, corrective action is not required.

10.4.5 Internal Standard Retention Time:

The absolute retention times of the internal standards in the calibration verification standard are evaluated after data acquisition. If the absolute retention time for any internal standard changes by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

10.4.6 Internal Standard Response:

If the area for any of the internal standards in the calibration verification standard changes by a factor of two (50% to 200%) from that in the mid-point standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, re-analysis of samples analyzed while the system was malfunctioning is required.

10.5 Preventive Maintenance

Routine preventive maintenance should be performed on the analytical system. This includes replacement of GC septa and periodic rinsing or replacement of purge and trap tubes and sparge needles. The trap should be replaced every six months or sooner if performance criteria

cannot be met. Periodic cleaning (typically twice per year) of the mass spectrometer ion source is required. More frequent source cleaning may be needed, especially if dirty samples are analyzed.

If system performance deteriorates, additional maintenance may be required. This includes replacement of injector ports and seals, clipping several inches off of the front end of the GC column, or in extreme cases the replacement of the GC column. Flushing or replacement of purge and trap lines may be necessary if they become contaminated or develop active sites.

Perform routine preventative maintenance as described throughout this SOP. Record all maintenance in the instrument logbook.

11. Data Evaluation, Calculations and Reporting

11.1 LIMS Data Corrections

Please note that the Laboratory Information Management System (LIMS) automatically adjusts soil sample results to account for the % Total Solids of the sample (as determined per Alpha SOP/07-38) and the methanol preservation dilution effect.

11.2 Data Calculations

11.2.1 Results of Aqueous Sample Analysis:

$$Concentration\ (ug/L) = \frac{(Conc.)\ (Vp)\ (DF)}{(Vs)}$$

where:

Conc. = On-column concentration obtained from the quantitation report.
Vp = Volume purged, 10 mL is standard
Vs = Volume of sample purged
DF = Dilution factor, for manually prepared dilutions, not instrumental "dilutions".

11.2.2 Results of Sediment/Soil, Sludge, and Waste Analysis:

All solids including soils, sediments, and sludges must be reported on a dry-weight basis.

11.2.2.1 Low-Level Samples:

$$Concentration\ (ug/Kg) = \frac{(Conc.)\ (Vp)\ (DF)}{(W)\ (\%S)}$$

11.2.2.2 High-Level Samples:

$$\text{Concentration (ug/Kg)} = \frac{\text{(Conc.) (Vp) (5000) (DF)}}{\text{(W) (Ve) (\%S)}}$$

where:

Conc. = On-column concentration obtained from the quantitation report.
DF = Dilution factor, for manually prepared dilutions, not instrumental "dilutions".
Ve = Extract volume, mL
Vp = Volume purged, 5 mL is standard
W = Aliquot of sample (wet), g
%S = Sample % solid
5000 = Constant representing the final volume of the methanol extraction.

11.2.2.2.1 High-Level Samples Corrected for Total Water/Solvent Mixture (V_t):

Samples that are extracted prior to analysis in a water miscible solvent such as methanol are diluted by the total volume of the water/solvent mixture. The total mixture volume can only be calculated based on the sample moisture present as determined by the % moisture calculation.

$$\text{\% moisture} = \frac{\text{g of sample – g of dry sample}}{\text{g of sample}} \times 100$$

$$V_t = \frac{\text{[mL of solvent + (\%moisture x g of sample)]}}{100} \times 1000\text{mL/mL}$$

The calculated V_t value is now added to the volume of methanol in the sample (typically 5000µL), and the corrected concentration is calculated using the equation below:

$$\text{Corrected concentration (mg/Kg)} = \frac{\text{(Conc.) } (V_t \text{ + methanol vol.) (Vp) (DF)}}{\text{(W) (Ve) (\%S)}}$$

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

All batch and sample specific QC criteria outlined in section 10 are evaluated by the analyst prior to approval of the data. When any QC criteria fail, the cause for the failure must be identified and corrected. This may include instrument recalibration followed by sample reanalysis, sample cleanup, or sample re-extraction. If it is determined that the failure is due to sample matrix effects, a project narrative report is written by the analyst for inclusion in the data report. If there is insufficient sample volume to perform the re-analysis for confirmation, this is also noted in the narrative and included in the client report.

13. Method Performance

13.1 Detection Limit Study (DL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

The laboratory follows the procedure to determine the DL, LOD, and/or LOQ as outlined in Alpha SOP/1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

Refer to Alpha SOP/1739 for further information regarding IDC/DOC Generation.

13.2.1 Initial (IDC)

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method, prior to the processing of any samples.

13.2.2 Continuing (DOC)

The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

Refer to Alpha's Chemical Hygiene Plan and Waste Management and Disposal SOP for further pollution prevention and waste management information.

15. Referenced Documents

Chemical Hygiene Plan

SOP/1732 DL/LOD/LOQ Generation

SOP/1739 IDC/DOC Generation

SOP/1728 Waste Management and Disposal SOP

16. Attachments

Table 1: 8260 REPORTING LIMITS

Table 2: 8260 QC ACCEPTANCE CRITERIA

Table 3: BFB TUNING CRITERIA

Table 4: STANDARD SOLUTIONS and ICAL Levels

Table 5: 8260D Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Table 6: 8260D Quantitation Ions

Table 7: Difficult Analytes

Table 8: ICAL Low Point re-quantitation ranges

Table 1

Standard Reported Detection Limits

US EPA METHOD 8260D and 5035A/8260D

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
Acetone (3,4,5)	0.01	5.0	25	1250
Acrolein (5)		5.0	25	1250
Acrylonitrile (3,4)		5.0	4	200
Allyl Chloride (7)		N/A	5	250
Benzene (3,4,5)	0.2	0.5	0.5	25
Bromobenzene (3,4)		2.5	2	100
Bromochloromethane (3,4,5)	0.1	2.5	2	100
Bromodichloromethane (3,4,5)	0.300	0.5	0.5	25
Bromoform (3,4,5)	0.100	2.0	4	200
Bromomethane (3,4,5)	0.01	1.0	2	100
2-Butanone (3,4,5)	0.01	5.0	10	500
Butyl acetate (7)		N/A	5	50
n-Butylbenzene (3,4)		0.5	1	50
sec-Butylbenzene (3,4)		0.5	1	50
tert-Butylbenzene (3,4)		2.5	2	100
Carbon disulfide (3,4,5)	0.100	5.0	10	500
Carbon tetrachloride (3,4,5)	0.100	0.5	1	50
Chlorobenzene (3,4,5)	0.400	0.5	0.5	25
Chlorodifluoromethane (7)		N/A	5	250
Chloroethane (3,4,5)	0.01	1.0	2	100
2-Chloroethylvinyl ether (3)		10.0	20	1000
Chloroform (3,4,5)	0.300	0.75	1.5	75
Chloromethane (3,4,5)	0.01	2.5	4	200
o-Chlorotoluene (3,4)		2.5	2	100
Cyclohexane (5)	0.01	10	10	500
Cyclohexanone		10	20	1000
p-Chlorotoluene (3,4)		2.5	2	100
cis-Decahydronaphthalene (7)		N/A	5	250
trans-Decahydronaphthalene (7)		N/A	5	250
n-Decane (7)		N/A	5	250
Dibromochloromethane (3,4,5)	0.200	0.5	1	50
1,2-Dibromo-3-chloropropane (3,4,5)	0.01	2.5	3	150
1,2-Dibromoethane (3,4,5)	0.200	2.0	1	50
Dibromomethane (3,4)		5.0	2	100
1,2-Dichlorobenzene (3,4,5)	0.600	2.5	2	100
1,3-Dichlorobenzene (3,4,5)	0.500	2.5	2	100
1,4-Dichlorobenzene (3,4,5)	0.600	2.5	2	100
1,4-Dichlorobutane (3,4)		5.0	10	500

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
trans-1,4-Dichloro-2-butene (3,4)		2.5	5	250
Dichlorodifluoromethane (3,4,5)	0.01	5.0	10	500
1,1-Dichloroethane (3,4,5)	0.300	0.75	1	50
1,2-Dichloroethane (3,4,5)	0.07	0.5	1	50
1,1-Dichloroethene (3,4,5)	0.06	0.5	1	50
cis-1,2-Dichloroethene (3,4,5)	0.200	0.5	1	50
trans-1,2-Dichloroethene (3,4,5)	0.100	0.75	1.5	75
1,2-Dichloropropane (3,4,5)	0.200	1.75	1	50
1,3-Dichloropropane (3,4)		2.5	2	100
2,2-Dichloropropane (3,4)		2.5	2	100
1,1-Dichloropropene (3,4)		2.5	0.5	25
cis-1,3-Dichloropropene (3,4,5)	0.300	0.5	0.5	25
p-Diethylbenzene (4)		2.0	2	100
Diisopropyl Ether (6)		2.0	2	100
1,4-Dioxane (5) (non-SIM)		250.0	80	4000
trans-1,3-Dichloropropene (3,4,5)	0.300	0.5	1	50
Ethanol (7)		250.0	1000	50000
Ethyl acetate		10.0	10	500
Ethylbenzene (3,4,5)	0.400	0.5	1	50
Ethyl ether (3,4)		2.5	2	100
4-Ethyltoluene (4)		2.0	2	100
Ethyl methacrylate (3,4)		5.0	10	500
Ethyl-Tert-Butyl-Ether (6)		2.0	2	100
Freon-113 (5)	0.05	10.0	4	200
n-Heptane (7)		N/A	5	250
Hexachlorobutadiene (3,4)		0.5	4	200
Hexachloroethane (7)		N/A	5	250
Hexane		1.0	5	250
2-Hexanone (3,4,5)	0.01	5.0	10	500
Iodomethane		5.0	10	500
Isopropyl Alcohol (IPA)		100.0	100	5000
Isopropylbenzene (3,4,5)	0.400	0.5	1	50
p-Isopropyltoluene (3,4)			1	50
Limonene (7)		N/A	5	250
Methyl Acetate (5)	0.01	10.0	4	200
Methylene chloride (3,4,5)	0.01	3.0	5	250
Methyl Cyclohexane (5)	0.05	10.0	4	200
Methyl isothiocyanate (7)		N/A	5	250
Methyl Methacrylate		2.5	5	250
4-Methyl-2-pentanone (3,4,5)	0.03	5.0	10	500
Methyl-tert-butyl-ether (3,4,5)	0.100	1.0	2	100

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
Naphthalene (3,4)		2.5	4	200
Nitrobenzene (7)		N/A	5	250
2-Nitropropane (7)		N/A	5	250
n-Nonane (7)		N/A	5	250
n-Octane (7)		N/A	5	250
n-Butanol (5)		100.0	300	15000
n-Propylbenzene (3,4)		0.5	1	50
n-Propyl bromide		5.0	N/A	N/A
Pentachloroethane		2.0	N/A	N/A
Styrene (3,4,5)	0.200	1.0	1	50
Tert-Butyl Alcohol (5)		10.0	20	1000
Tertiary-Amyl Methyl Ether (6)		2.0	2	100
1,1,1,2-Tetrachloroethane (3,4)		0.5	0.5	25
1,2,4,5-Tetramethylbenzene (4)		2.0	2	100
1,1,2,2-Tetrachloroethane (3,4,5)	0.200	0.5	0.5	25
Tetrachloroethene (3,4,5)	0.100	0.5	0.5	25
Tetrahydrofuran (3)		5.0	4	200
Toluene (3,4,5)			1	50
1,2,3-Trichlorobenzene (3,4,5)	0.400	2.5	2	100
1,2,4-Trichlorobenzene (3,4,5)	0.400	2.5	2	100
1,3,5-Trichlorobenzene (6)		2.0	2	100
1,1,1-Trichloroethane (3,4,5)	0.05	0.5	0.5	25
1,1,2-Trichloroethane (3,4,5)	0.200	0.75	1	50
Trichloroethene (3,4,5)	0.200	0.5	0.5	25
Trichlorofluoromethane (3,4,5)	0.01	2.5	4	200
1,2,3-Trichloropropane (3,4)		5.0	10	500
1,2,4-Trimethylbenzene (3,4)		2.5	2	100
1,3,5-Trimethylbenzene (3,4)		2.5	2	100
n-Undecane (7)		N/A	5	250
Vinyl acetate (3,4)		5.0	10	500
Vinyl chloride (3,4,5) (non-SIM)	0.01	1.0	1	50
m/p-Xylenes (3,4,5)	0.200	1.0	2	100
o-Xylene (3,4,5)	0.200	1.0	1	50
Isobutyl Alcohol		10.0	N/A	N/A
2-Butanol		25.0	N/A	N/A
4-penten-2-ol		100.0	N/A	N/A
2-methyl-2-butanol		25.0	N/A	N/A
4-methyl-2-pentanol		25.0	N/A	N/A

Analyte	Recommended Minimum Response Factor	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG) (2)
Chloropicrin		20.0	100	5000
Halothane		2.5	10	500
1,4-Dioxane (5) SIM		3.0	N/A	N/A
1,1,2,2-Tetrachloroethane SIM		0.1	N/A	N/A
Vinyl Chloride (9) SIM		0.035	N/A	N/A

(1) Detection Limits are for Low-level Aqueous preserved samples.
(2) Detection Limits are for High-level Methanol preserved samples.
(3) Analyte reported by standard 8260 reporting list.
(4) Analyte reported by New York TCL reporting list.
(5) Analyte reported by New Jersey TCL reporting list.
(6) Analyte reported for New Hampshire in addition to standard 8260 reporting list.
(7) Analyte only reported for New York TCL report upon client request.
(8) Note: Reporting Limits are based on standard 8260 reporting list, RL's may vary for NY and NJ reporting lists.
(9) Analyte only reported for New Jersey TCL report upon client request.

Table 2

QUALITY CONTROL ACCEPTANCE CRITERIA

Surrogate Spike Percent Recovery	Aqueous Limits		Soil Limits	
	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit
1,2-Dichloroethane-d_4	70%	130%	70%	130%
4-Bromofluorobenzene	70%	130%	70%	130%
Toluene-d_8	70%	130%	70%	130%
Dibromofluoromethane	70%	130%	70%	130%

Table 3

BFB (4-BROMOFLUOROBENZENE) MASS INTENSITY CRITERIA

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95 (not required)
75	30 to 60% of m/z 95 (not required)
95	50 to 200% of m/z 174
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	50 to 200% of m/z 95
175	5 to 9% of m/z 174
176	95% to 105% of m/z 174
177	5 to 10% of m/z 176

Table 4

Stock Standard Concentrations and Suggested Calibration Concentration Levels - Soil

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Fluorobenzene	2500	20	20	20	20	20	20	20	20	20	20
Dichlorodifluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorodifluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Vinyl chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Bromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Trichlorofluoromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Ethanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
1,1-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
Carbon disulfide	2000	0.5	1	2	4	20	40	60	100	200	300
Freon-113	2000	0.5	1	2	4	20	40	60	100	200	300
Iodomethane	2000	0.5	1	2	4	20	40	60	100	200	300
Acrolein	2000	0.5	1	2	4	20	40	60	100	200	300
Allyl chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Methylene chloride	2000	0.5	1	2	4	20	40	60	100	200	300
Isopropyl alcohol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Acetone	2000	0.5	1	2	4	20	40	60	100	200	300
trans-1,2-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
Hexane	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl tert-butyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
tert-Butyl alcohol	2000	2.5	5	10	20	100	200	300	500	1000	1500
Diisopropyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
1,1-Dichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Halothane	2000	0.5	1	2	4	20	40	60	100	200	300
Acrylonitrile	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl tert-butyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Vinyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
cis-1,2-Dichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
2,2-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
Bromochloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Cyclohexane	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Chloroform	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl acetate	2000	0.5	1	2	4	20	40	60	100	200	300
Carbon tetrachloride	2000	0.5	1	2	4	20	40	60	100	200	300
Tetrahydrofuran	2000	0.5	1	2	4	20	40	60	100	200	300
Dibromofluoromethane	2500	20	20	20	20	20	20	20	20	20	20
1,1,1-Trichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
2-Butanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
2-Butanone	2000	0.5	1	2	4	20	40	60	100	200	300
1,1-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Heptane	2000	0.5	1	2	4	20	40	60	100	200	300
Benzene	2000	0.5	1	2	4	20	40	60	100	200	300
tert-Amyl methyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichloroethane-d4	2500	20	20	20	20	20	20	20	20	20	20
1,2-Dichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Isobutyl alcohol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
2-Methyl-2-butanol	2000	2.5	5	10	20	100	200	300	500	1000	1500
Methyl cyclohexane	2000	0.5	1	2	4	20	40	60	100	200	300
Trichloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Dibromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
4-penten-2-ol	2000	2.5	5	10	20	100	200	300	500	1000	1500
2-Chloroethyl vinyl ether	2000	0.5	1	2	4	20	40	60	100	200	300
Bromodichloromethane	2000	0.5	1	2	4	20	40	60	100	200	300
Ethyl acrylate	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dioxane	2000	N/A	40	80	200	1000	2000	3000	5000	10000	15000
cis-1,3-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorobenzene-d5	2500	20	20	20	20	20	20	20	20	20	20
Octane	2000	0.5	1	2	4	20	40	60	100	200	300
Toluene-d8	2500	20	20	20	20	20	20	20	20	20	20
Toluene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Methyl-2-pentanone	2000	0.5	1	2	4	20	40	60	100	200	300
Tetrachloroethene	2000	0.5	1	2	4	20	40	60	100	200	300
2-Nitropropane	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
Chloropicrin	2000	N/A	50	N/A	100	200	300	400	500	600	700
trans-1,3-Dichloropropene	2000	0.5	1	2	4	20	40	60	100	200	300
Methyl isothiocyanate	2000	0.5	1	2	4	20	40	60	100	200	300
4-Methyl-2-pentanol	2000	N/A	20	N/A	80	200	400	600	1000	3000	4000
Ethyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,2-Trichloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorodibromomethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dibromoethane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butyl Acetate	2000	0.5	1	2	4	20	40	60	100	200	300
2-Hexanone	2000	0.5	1	2	4	20	40	60	100	200	300
Nonane	2000	0.5	1	2	4	20	40	60	100	200	300
Chlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Ethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,1,2-Tetrachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
p/m Xylene	2000	1	2	4	8	40	80	120	200	400	600
o Xylene	2000	1	2	4	8	40	80	120	200	400	600
Styrene	2000	1	2	4	8	40	80	120	200	400	600
1,4-Dichlorobenzene-d4	2500	20	20	20	20	20	20	20	20	20	20
Bromoform	2000	0.5	1	2	4	20	40	60	100	200	300
Butyl acrylate	2000	0.5	1	2	4	20	40	60	100	200	300
Isopropylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Bromofluorobenzene	2500	20	20	20	20	20	20	20	20	20	20
Bromobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Decane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Propylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dichlorobutane	2000	0.5	1	2	4	20	40	60	100	200	300
1,1,2,2-Tetrachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
4-Ethyltoluene	2000	0.5	1	2	4	20	40	60	100	200	300
2-Chlorotoluene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3,5-Trimethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,3-Trichloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
trans-1,4-Dichloro-2-butene	2000	0.5	1	2	4	20	40	60	100	200	300
4-Chlorotoluene	2000	0.5	1	2	4	20	40	60	100	200	300

Soil	Stock (µg/mL)	Level 0 (ug/kg)	Level 1 (ug/kg)	Level 1.5 (ug/kg)	Level 2 (ug/kg)	Level 3 (ug/kg)	Level 4 (ug/kg)	Level 5 (ug/kg)	Level 6 (ug/kg)	Level 7 (ug/kg)	Level 8 (ug/kg)
tert-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Pentachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butyl methacrylate	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4-Trimethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Limonene	2000	0.5	1	2	4	20	40	60	100	200	300
sec-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
p-Isopropyltoluene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,4-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
trans-Decahydronaphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
Undecane	2000	0.5	1	2	4	20	40	60	100	200	300
p-Diethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
n-Butylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Hexachloroethane	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
cis-Decahydronaphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4,5-Tetramethylbenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2-Dibromo-3-chloropropane	2000	0.5	1	2	4	20	40	60	100	200	300
1,3,5-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Nitrobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Hexachlorobutadiene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,4-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
Naphthalene	2000	0.5	1	2	4	20	40	60	100	200	300
1,2,3-Trichlorobenzene	2000	0.5	1	2	4	20	40	60	100	200	300
1,3-Dioxolane	2000	N/A	25	N/A	50	100	250	500	1000	1500	2000

- For Low Level Soil analysis, the calibration levels are the same in µg/Kg units.
- For High Level Soil analysis, the calibration levels are at 50x the levels listed due to sample preparation requirements.

Stock Standard Concentrations and Suggested Calibration Concentration Levels – Water

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L) Optional	Level 6 (ug/L)	Level 7 (ug/L) Optional	Level 8 (ug/L)	Level 9 (ug/L) Optional	Level 10 (ug/L)
Fluorobenzene	2500	10	10	10	10	10	10	10	10	10	10	10
Dichlorodifluoromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Vinyl chloride	2000	0.19	0.5	2	10	30	50	80	100	120	160	200
Bromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Trichlorofluoromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Ethanol	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Carbon disulfide	2000		0.5	2	10	30	50	80	100	120	160	200
Freon-113	2000		0.5	2	10	30	50	80	100	120	160	200
Iodomethane	2000		0.5	2	10	30	50	80	100	120	160	200
Acrolein	2000		0.5	2	10	30	50	80	100	120	160	200
Methylene chloride	2000		0.5	2	10	30	50	80	100	120	160	200
Isopropyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
Acetone	2000		0.5	2	10	30	50	80	100	120	160	200
trans-1,2-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Methyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200
Methyl tert-butyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
tert-Butyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
Diisopropyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Halothane	2000		0.5	2	10	30	50	80	100	120	160	200
Acrylonitrile	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl tert-butyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Vinyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200
cis-1,2-Dichloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
2,2-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
Bromochloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Cyclohexane	2000		0.5	2	10	30	50	80	100	120	160	200
Chloroform	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl acetate	2000		0.5	2	10	30	50	80	100	120	160	200
Carbon tetrachloride	2000	0.19	0.5	2	10	30	50	80	100	120	160	200

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L) Optional	Level 6 (ug/L)	Level 7 (ug/L) Optional	Level 8 (ug/L)	Level 9 (ug/L) Optional	Level 10 (ug/L)
Tetrahydrofuran	2000		0.5	2	10	30	50	80	100	120	160	200
Dibromofluoromethane	2500	10	10	10	10	10	10	10	10	10	10	10
1,1,1-Trichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
2-Butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Butanone	2000		0.5	2	10	30	50	80	100	120	160	200
1,1-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
Benzene	2000	0.19	0.5	2	10	30	50	80	100	120	160	200
tert-Amyl methyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichloroethane-d4	2500	10	10	10	10	10	10	10	10	10	10	10
1,2-Dichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
Isobutyl alcohol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Methyl-2-butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
Methyl cyclohexane	2000		0.5	2	10	30	50	80	100	120	160	200
Trichloroethene	2000	0.19	0.5	2	10	30	50	80	100	120	160	200
n-Butanol	2000		2.5	10	50	150	250	400	500	600	800	1000
Dibromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
4-penten-2-ol	2000		2.5	10	50	150	250	400	500	600	800	1000
2-Chloroethyl vinyl ether	2000		0.5	2	10	30	50	80	100	120	160	200
Bromodichloromethane	2000		0.5	2	10	30	50	80	100	120	160	200
Ethyl acrylate	2000		0.25	1	5	15	25	40	50	60	80	100
Methyl methacrylate	2000		0.25	1	5	15	25	40	50	60	80	100
1,4-Dioxane	2000		100	400	500	600	1000	800	1000	1200	1600	2000
cis-1,3-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
Chlorobenzene-d5	2500	10	10	10	10	10	10	10	10	10	10	10
Toluene-d8	2500	10	10	10	10	10	10	10	10	10	10	10
Toluene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Methyl-2-pentanone	2000		0.5	2	10	30	50	80	100	120	160	200
Tetrachloroethene	2000		0.5	2	10	30	50	80	100	120	160	200
Chloropicrin	2000		30	50	80	120	200	160	400	200	320	400
trans-1,3-Dichloropropene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Methyl-2-pentanol	2000		2.5	10	50	150	250	400	500	600	800	1000
Ethyl methacrylate	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,2-Trichloroethane	2000		0.5	2	10	30	50	80	100	120	160	200

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L) Optional	Level 6 (ug/L)	Level 7 (ug/L) Optional	Level 8 (ug/L)	Level 9 (ug/L) Optional	Level 10 (ug/L)
Chlorodibromomethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dibromoethane	2000		0.5	2	10	30	50	80	100	120	160	200
2-Hexanone	2000		0.5	2	10	30	50	80	100	120	160	200
Chlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Ethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,1,2-Tetrachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
p/m Xylene	2000		1	4	20	60	100	160	200	240	320	400
o Xylene	2000		1	4	20	60	100	160	200	240	320	400
Styrene	2000		1	4	20	60	100	160	200	240	320	400
1,4-Dichlorobenzene-d4	2500	10	10	10	10	10	10	10	10	10	10	10
Bromoform	2000		0.5	2	10	30	50	80	100	120	160	200
Butyl acrylate	2000		0.25	1	5	15	25	40	50	60	80	100
Isopropylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Bromofluorobenzene	2500	10	10	10	10	10	10	10	10	10	10	10
Bromobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
n-Propylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dichlorobutane	2000		0.5	2	10	30	50	80	100	120	160	200
1,1,2,2-Tetrachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
4-Ethyltoluene	2000		0.5	2	10	30	50	80	100	120	160	200
2-Chlorotoluene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3,5-Trimethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,3-Trichloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
trans-1,4-Dichloro-2-butene	2000		0.5	2	10	30	50	80	100	120	160	200
4-Chlorotoluene	2000		0.5	2	10	30	50	80	100	120	160	200
tert-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Pentachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
n-Butyl methacrylate	2000		0.25	1	5	15	25	40	50	60	80	100
1,2,4-Trimethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
sec-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
p-Isopropyltoluene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200

Water	Stock (µg/mL)	Level 11 (ug/L)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L) Optional	Level 6 (ug/L)	Level 7 (ug/L) Optional	Level 8 (ug/L)	Level 9 (ug/L) Optional	Level 10 (ug/L)
p-Diethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
n-Butylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,4,5-Tetramethylbenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2-Dibromo-3-chloropropane	2000		0.5	2	10	30	50	80	100	120	160	200
1,3,5-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Hexachlorobutadiene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,4-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
Naphthalene	2000		0.5	2	10	30	50	80	100	120	160	200
1,2,3-Trichlorobenzene	2000		0.5	2	10	30	50	80	100	120	160	200
1,3-Dioxolane	2000		10	40	100	250	N/A	500	N/A	750	N/A	1000
Pentachloroethane	2000		0.5	2	10	30	50	80	100	120	160	200
1,4-Dioxane (SIM)	100		0.5	2	10	20	30	50	100	200	N/A	N/A
1,1,2,2-Tetrachloroethane (SIM)	100		0.05	0.1	0.2	0.5	1	2	5	10	N/A	N/A
Vinyl Chloride (SIM)	200		0.02	0.05	0.1	0.2	0.5	1.0	2.0			

- For Low Level Soil analysis, the calibration levels are the same in µg/Kg units.
- For High Level Soil analysis, the calibration levels are at 50x the levels listed due to sample preparation requirements.

Table 5

8260D Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Fluorobenzene	Chlorobenzene-d5	1,4-Dichlorobenzene-d4
Dichlorodifluoromethane	Toluene-d8 (surr)	Isopropylbenzene
Chloromethane	Toluene	Bromoform
Vinyl Chloride	Ethyl Methacrylate	1,4-dichloro-2-butane
Bromomethane	Trans-1,3-dichloropropene	1,1,2,2,-tetrachloroethane
Chloroethane	1,1,2-trichloroethane	4-bromofluorobenzene (surr)
Trichlorofluoromethane	2-hexanone	1,2,3-trichloropropane
Ethyl Ether	1,3-dichloropropane	trans-1,4-dichloro-2-butene
Freon 113	Tetrachloroethene	n-propylbenzene
Acrolein	Chlorodibromomethane	Bromobenzene
Acetone	1,2-dibromoethane	4-ethyltoluene
Ethanol	Chlorobenzene	1,3,5-trimethybenzene
1,1,-dichloroethene	1,1,1,2-tetrachloroethane	2-chlorotoluene
Tert-Butyl Alcohol	Ethylbenzene	4-chorotoluene
Methyl Acetate	p/m xylene	tert-butylbenzene
Carbon Disulfide	o xylene	1,2,4-trimethylbenzene
Methylene Chloride	Styrene	sec-butylbenzene
Acrylonitrile	Octane	p-isopropyltoluene
Methyl Tert Butyl Ether	2-Nitropropane	1,3-dichlorobenzene
Halothane	Methyl isothiocyanate	1,4-dichlorobenzene
Trans-1,2-dichloroethene	n-Butyl acetate	n-butylbenzene
Diisopropyl Ether	Nonane	p-diethylbenzene
Vinyl Acetate		1,2-dichlorobenzene
1,1-dichloroethane		1,2,4,5-tetramethylbenzene
Ethyl-Tert-Butyl-Ether		1,2-dibromo-3-chloropropane
2-butanone		1,3,5-trichlorobenzene
2,2-dichloropropane		1,2,4-trichlorobenzene
Cis-1,2-dichloroethene		Hexachlorobutadiene
Chloroform		Naphthalene
Bromochloromethane		1,2,3-trichlorobenzene
Tetrahydrofuran		Cyclohexanone
Dibromofluoromethane (surr)		Nitrobenzene

Fluorobenzene	Chlorobenzene-d5	1,4-Dichlorobenzene-d4
1,1,1-trichloroethane		Pentachloroethane
Cyclohexane		Decane
1,1-dichloropropene		Limonene
carbon Tetrachloride		trans-Decahydronaphthalene
Tertiary-Amyl Methyl Ether		Undecane
1,2-dichloroethane-d4 (surr)		Hexachloroethane
1,2-dichloroethane		cis-Decahydronaphthalene
Benzene		
Trichloroethene		
Methyl cyclohexane		
1,2-Dichloropropane		
Bromodichloromethane		
1,4-Dioxane		
Dibromomethane		
2-Chloroethylvinyl Ether		
4-methyl-2-pentanone		
cis-1,3-Dichloropropene		
Iodomethane		
Methyl methacrylate		
n-Butanol		
Ethyl acetate		
Isopropyl alcohol (IPA)		
Hexane		
n-Propyl bromide		
Chlorodifluoromethane		
Allyl chloride		
Heptane		

Table 6

8260D Quantitation Ions

Analyte	Quantitation Ion	Analyte	Quantitation Ion
Dichlorodifluoromethane	85	Ethyl Methacrylate	69
Chloromethane	50	Trans-1,3-dichloropropene	75
Vinyl Chloride	62	1,1,2-trichloroethane	83
Bromomethane	94	2-hexanone	43
Chloroethane	64	1,3-dichloropropane	76
Trichlorofluoromethane	101	Tetrachloroethene	166
Ethyl Ether	74	Chlorodibromomethane	129
Freon 113	101	1,2-dibromoethane	107
Acrolein	56	Chlorobenzene	112
Acetone	43	1,1,1,2-tetrachloroethane	131
1,1,-dichloroethene	96	Ethylbenzene	91
Tert-Butyl Alcohol	59	p/m xylene	106
Methyl Acetate	43	o xylene	106
Carbon Disulfide	84	Styrene	104
Methylene Chloride	76	Isopropylbenzene	105
Acrylonitrile	53	Bromoform	173
Methyl Tert Butyl Ether	73	1,4-dichloro-2-butane	55
Halothane	117	1,1,2,2,-tetrachloroethane	83
Trans-1,2-dichloroethene	96	1,2,3-trichloropropane	75
Diisopropyl Ether	45	Trans-1,4-dichloro-2-butene	53
Vinyl Acetate	43	n-propylbenzene	91
1,1-dichloroethane	63	Bromobenzene	156
Ethyl-Tert-Butyl-Ether	59	4-ethyltoluene	105
2-butanone	43	1,3,5-trimethybenzene	105
2,2-dichloropropane	77	2-chlorotoluene	91
Cis-1,2-dichloroethene	96	4-chlorotoluene	91
Chloroform	83	tert-butylbenzene	119
Bromochloromethane	128	1,2,4-trimethylbenzene	105
Tetrahydrofuran	42	sec-butylbenzene	105
1,1,1-trichloroethane	97	p-isopropyltoluene	119
Cyclohexane	56	1,3-dichlorobenzene	146
1,1-dichloropropene	75	1,4-dichlorobenzene	146
Carbon Tetrachloride	117	n-butylbenzene	91
Tertiary-Amyl Methyl Ether	73	p-diethylbenzene	119
1,2-dichloroethane	62	1,2-dichlorobenzene	146
Benzene	78	1,2,4,5-Tetramethylbenzene	119
Trichloroethene	95	1,2-Dibromo-3-chloropropane	75
Methyl Cyclohexane	83	1,3,5-Trichlorobenzene	180
1,2-Dichloropropane	63	1,2,4-Trichlorobenzene	180
Bromodichloromethane	83	Hexachlorobutadiene	225
1,4-dioxane	88	Naphthalene	128
Dibromomethane	93	1,2,3-trichlorobenzene	180
2-Chloroethylvinyl Ether	63	Ethanol	45
4-methyl-2-pentanone	58	Cyclohexanone	55
Cis-1,3-dichloropropene	75	Ethyl acetate	43
Toluene	92	Iodomethane	142
Methyl methacrylate	69	n-Butanol	56
Pentachloroethane	167	Isopropyl Alcohol (IPA)	45

Analyte	Quantitation Ion	Analyte	Quantitation Ion
Hexane	57	n-Propyl bromide	43
Chlorodifluoromethane	51	Iodomethane	142
Allyl chloride	76	Heptane	71
Octane	85	2-Nitropropane	41
Methyl isothiocyanate	73	n-Butyl Acetate	43
Nonane	57	Decane	57
Limonene	68	Undecane	57
trans-Decahydronaphthalene	138	cis-Decahydronaphthalene	138
Hexachloroethane	117	Nitrobenzene	77

Table 7

List of 8260 Difficult Analytes:

1,1,2,2-Tetrachloroethane
1,2-Dibromo-3-chloropropane (DBCP)
1,4-Dioxane
2-Butanone
2-chloroethylvinyl ether
2-Hexanone
2,2-dichloropropane
4-Methyl-2-pentanone
Acetone
Bromoform
Bromomethane
Carbon disulfide
Chloroethane
Chloromethane
cis-1,3-Dichloropropene
Dichlorodifluoromethane (Freon 12)
Ethanol
Iodomethane
Isobutyl Alcohol
Naphthalene
Nitrobenzene
n-butanol
Styrene
Tert-Butyl Alcohol
Trichlorofluoromethane (Freon 11)
Isopropyl Alcohol (IPA)

Table 8

ICAL Low Point re-quantitation ranges - Water

Water	Level 11 (ug/L)	L11 (70% - 130%)	Level 1 (ug/L)	L1 (70% - 130%)	Level 2 (ug/L)	L2 (70% - 130%)	Level 3 (ug/L)	L3 (70% - 130%)
Dichlorodifluoromethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chloromethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Vinyl chloride	0.19	0.133 - 0.247	0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Bromomethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Trichlorofluoromethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethanol			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1-Dichloroethene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Carbon disulfide			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Freon-113			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Iodomethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Acrolein			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0

Water	Level 11 (ug/L)	L11 (70% - 130%)	Level 1 (ug/L)	L1 (70% - 130%)	Level 2 (ug/L)	L2 (70% - 130%)	Level 3 (ug/L)	L3 (70% - 130%)
Methylene chloride			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Isopropyl alcohol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
Acetone			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
trans-1,2-Dichloroethene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Methyl acetate			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Methyl tert-butyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
tert-Butyl alcohol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
Diisopropyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1-Dichloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Halothane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Acrylonitrile			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethyl tert-butyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Vinyl acetate			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
cis-1,2-Dichloroethene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
2,2-Dichloropropane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Bromochloromethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Cyclohexane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chloroform			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethyl acetate			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Carbon tetrachloride	0.19	0.133 - 0.247	0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Tetrahydrofuran			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1,1-Trichloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
2-Butanol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
2-Butanone			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1-Dichloropropene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Benzene	0.19	0.133 - 0.247	0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
tert-Amyl methyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2-Dichloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Isobutyl alcohol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
2-Methyl-2-butanol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
Methyl cyclohexane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Trichloroethene	0.19	0.133 - 0.247	0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
n-Butanol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
Dibromomethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2-Dichloropropane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
4-penten-2-ol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
2-Chloroethyl vinyl ether			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Bromodichloromethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethyl acrylate			0.25	0.175 - 0.325	1	0.7 - 1.3	5	3.5 - 6.5
Methyl methacrylate			0.25	0.175 - 0.325	1	0.7 - 1.3	5	3.5 - 6.5
1,4-Dioxane			100	70 - 130	400	280 - 520	500	350 - 650
cis-1,3-Dichloropropene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Toluene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0

Water	Level 11 (ug/L)	L11 (70% - 130%)	Level 1 (ug/L)	L1 (70% - 130%)	Level 2 (ug/L)	L2 (70% - 130%)	Level 3 (ug/L)	L3 (70% - 130%)
4-Methyl-2-pentanone			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Tetrachloroethene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chloropicrin			30	21 - 39	50	35 - 65	80	56 - 104
trans-1,3-Dichloropropene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
4-Methyl-2-pentanol			2.5	1.75 - 3.25	10	7 - 13.0	50	35 - 65
Ethyl methacrylate			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1,2-Trichloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chlorodibromomethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,3-Dichloropropane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2-Dibromoethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
2-Hexanone			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Chlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Ethylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1,1,2-Tetrachloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
p/m Xylene			1	0.7 - 1.3	4	2.8 - 5.2	20	14 - 26
o Xylene			1	0.7 - 1.3	4	2.8 - 5.2	20	14 - 26
Styrene			1	0.7 - 1.3	4	2.8 - 5.2	20	14 - 26
Bromoform			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Butyl acrylate			0.25	0.175 - 0.325	1	0.7 - 1.3	5	3.5 - 6.5
Isopropylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Bromobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
n-Propylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,4-Dichlorobutane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1,2,2-Tetrachloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
4-Ethyltoluene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
2-Chlorotoluene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,3,5-Trimethylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2,3-Trichloropropane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
trans-1,4-Dichloro-2-butene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
4-Chlorotoluene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
tert-Butylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Pentachloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
n-Butyl methacrylate			0.25	0.175 - 0.325	1	0.7 - 1.3	5	3.5 - 6.5
1,2,4-Trimethylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
sec-Butylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
p-Isopropyltoluene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,3-Dichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,4-Dichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
p-Diethylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
n-Butylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2-Dichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2,4,5-Tetramethylbenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2-Dibromo-3-chloropropane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,3,5-Trichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0

Water	Level 11 (ug/L)	L11 (70% - 130%)	Level 1 (ug/L)	L1 (70% - 130%)	Level 2 (ug/L)	L2 (70% - 130%)	Level 3 (ug/L)	L3 (70% - 130%)
Hexachlorobutadiene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2,4-Trichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
Naphthalene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,2,3-Trichlorobenzene			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,3-Dioxolane			10	7 - 13.0	40	28 - 52	100	70 - 130
Pentachloroethane			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,4-Dioxane (SIM)			0.5	0.35 - 0.65	2	1.4 - 2.6	10	7 - 13.0
1,1,2,2-Tetrachloroethane (SIM)			0.05	0.035 - 0.065	0.1	0.07 - 0.13	0.2	0.14 - 0.26

ICAL Low Point re-quantitation ranges – Soil

Soil	Level 0 (ug/kg)	L0 (70% - 130%)	Level 1 (ug/kg)	L1 (70% - 130%)	Level 1.5 (ug/kg)	L1.5 (70% - 130%)	Level 2 (ug/kg)	L2 (70% - 130%)	Level 3 (ug/kg)	L3 (70% - 130%)
Dichlorodifluoromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chlorodifluoromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chloromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Vinyl chloride	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Bromomethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Trichlorofluoromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethanol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 -104	200	140 - 260
1,1-Dichloroethene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Carbon disulfide	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Freon-113	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Iodomethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Acrolein	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Allyl chloride	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Methylene chloride	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Isopropyl alcohol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 -104	200	140 - 260
Acetone	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
trans-1,2-Dichloroethene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Methyl acetate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Hexane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Methyl tert-butyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
tert-Butyl alcohol	2.5	1.75 - 3.25	5	3.5 - 6.5	10	7.0 - 13.	20	14 - 26	100	70 - 130
Diisopropyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,1-Dichloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Halothane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Acrylonitrile	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethyl tert-butyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26

Soil	Level 0 (ug/kg)	L0 (70% - 130%)	Level 1 (ug/kg)	L1 (70% - 130%)	Level 1.5 (ug/kg)	L1.5 (70% - 130%)	Level 2 (ug/kg)	L2 (70% - 130%)	Level 3 (ug/kg)	L3 (70% - 130%)
Vinyl acetate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
cis-1,2-Dichloroethene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
2,2-Dichloropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Bromochloromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Cyclohexane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chloroform	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethyl acetate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Carbon tetrachloride	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Tetrahydrofuran	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,1,1-Trichloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
2-Butanol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 - 104	200	140 - 260
2-Butanone	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,1-Dichloropropene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Heptane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Benzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
tert-Amyl methyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2-Dichloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Isobutyl alcohol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 - 104	200	140 - 260
2-Methyl-2-butanol	2.5	1.75 - 3.25	5	3.5 - 6.5	10	7	20	14 - 26	100	70 - 130
Methyl cyclohexane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Trichloroethene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
n-Butanol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 - 104	200	140 - 260
Dibromomethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2-Dichloropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
4-penten-2-ol	2.5	1.75 - 3.25	5	3.5 - 6.5	10	7	20	14 - 26	100	70 - 130
2-Chloroethyl vinyl ether	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Bromodichloromethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethyl acrylate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Methyl methacrylate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,4-Dioxane	N/A	N/A	40	28 - 52	80	56 – 104	200	140 - 260	1000	700 - 1300
cis-1,3-Dichloropropene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Octane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Toluene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
4-Methyl-2-pentanone	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Tetrachloroethene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
2-Nitropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chloropicrin	N/A	N/A	50	35 - 65	N/A	N/A	100	70 - 130	200	140 - 260
trans-1,3-Dichloropropene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Methyl isothiocyanate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
4-Methyl-2-pentanol	N/A	N/A	20	14 - 26	N/A	N/A	80	56 - 104	200	140 - 260
Ethyl methacrylate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26

Soil	Level 0 (ug/kg)	L0 (70% - 130%)	Level 1 (ug/kg)	L1 (70% - 130%)	Level 1.5 (ug/kg)	L1.5 (70% - 130%)	Level 2 (ug/kg)	L2 (70% - 130%)	Level 3 (ug/kg)	L3 (70% - 130%)
1,1,2-Trichloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chlorodibromomethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,3-Dichloropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2-Dibromoethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
n-Butyl Acetate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
2-Hexanone	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Nonane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Chlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Ethylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,1,1,2-Tetrachloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
p/m Xylene	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	8	5.6 - 10.4	40	28 - 52
o Xylene	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	8	5.6 - 10.4	40	28 - 52
Styrene	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	8	5.6 - 10.4	40	28 - 52
Bromoform	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Butyl acrylate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Isopropylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Bromobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Decane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
n-Propylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,4-Dichlorobutane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,1,2,2-Tetrachloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
4-Ethyltoluene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
2-Chlorotoluene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,3,5-Trimethylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2,3-Trichloropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
trans-1,4-Dichloro-2-butene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
4-Chlorotoluene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
tert-Butylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Pentachloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
n-Butyl methacrylate	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2,4-Trimethylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Limonene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
sec-Butylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
p-Isopropyltoluene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,3-Dichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,4-Dichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
trans-Decahydronaphthalene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Undecane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
p-Diethylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26

Soil	Level 0 (ug/kg)	L0 (70% - 130%)	Level 1 (ug/kg)	L1 (70% - 130%)	Level 1.5 (ug/kg)	L1.5 (70% - 130%)	Level 2 (ug/kg)	L2 (70% - 130%)	Level 3 (ug/kg)	L3 (70% - 130%)
n-Butylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Hexachloroethane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2-Dichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
cis-Decahydronaphthalene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2,4,5-Tetramethylbenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2-Dibromo-3-chloropropane	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,3,5-Trichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Nitrobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Hexachlorobutadiene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2,4-Trichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
Naphthalene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,2,3-Trichlorobenzene	0.5	0.35 - 0.65	1	0.7 - 1.3	2	1.4 - 2.6	4	2.8 - 5.2	20	14 - 26
1,3-Dioxolane	N/A	N/A	25	17.5 - 32.5	N/A	N/A	50	35 - 65	100	70 - 130

ATTACHMENT B

Field Audit Checklist

Field Audit Checklist

Instructions: Review this checklist to ensure field work is conducted as proposed.

Site:	
Field Personnel and Organization:	
Date:	

☐ Have daily safety meetings been conducted?

☐ Have daily emails to project team been sent to help track project status and to keep key team members up to date with the field program?

☐ Does the on-site field lead have contact information for all subcontractors on site?

☐ Has the laboratory courier been contacted (if needed) to pick up samples at the end of the day? If courier is not being used, has time been allocated to deliver samples to shipping center?

☐ Has the Health and Safety Plan (HASP) been reviewed and signed by all field personnel and has the work been performed in accordance with the HASP (including proof of certification for all personnel)?

☐ Do any Job Safety Analyses need to be updated?

☐ Have the project Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and HASP been reviewed by each field team member? Is there a hardcopy of each on site?

☐ Have sampling procedures such as acceptance criteria, sample description homogenization, and decontamination of equipment been conducted as described in the FSP and QAPP?

☐ Have the duplicate, matrix spike, and matrix spike duplicate samples been collected for sediment and surface water analyses?

☐ Has a rinsate blank been collected for each sampling method?

☐ Have there been any substantial changes from the FSP, QAPP, or HASP?

- ☐ If yes, have the PM, NYSDEC, and EPA been notified?

☐ Is investigation-derived waste being stored, labeled, and tracked properly? Have samples been collected for waste characterization? Are additional drums needed for future sampling?

APPENDIX F

Project Documentation Forms

ROUX

DAILY LOG	DATE			
	NO.			
	SHEET		OF	

FIELD ACTIVITY DAILY LOG

PROJECT NAME:	PROJECT NO.
PROJECT LOCATION:	CLIENT:
FIELD ACTIVITY:	

DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:

TIME	DESCRIPTION

VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:

WEATHER CONDITIONS: A.M.:	IMPORTANT TELEPHONE CALLS:
P.M.:	

PERSONNEL ON SITE:

SIGNATURE DATE:

Sediment Core Collection Log

Job: | **Station ID:**

Job No: | **Attempt No.**

Field Staff: | **Date:**

Contractor: | **Logged By:**

Vertical Datum: | **Horizontal Datum:**

Field Collection Coordinates:

Lat/Northing: | Long/Easting:

A. Water Depth

DTM Depth Sounder:

DTM Lead Line:

B. Water Level Measurements

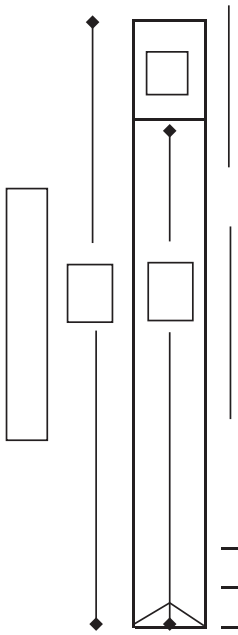
Time:

Tide Height:

Source:

C. Mudline Elevation

Recovery Measurements (prior to cuts)



Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length:

Drive Penetration:

Headspace Measurement:

Recovery Measurement:

Recovery Percentage:

Total Length of Core To Process:

Drive Notes:

Sections To Process:

A:

B:

C:

D:

Core Field Observations and Description:

Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Notes:

Sediment/Soil Core Processing Log

Job:	Station ID:
Job No.	Date/Time:
No. of Sections:	Core Logged By:
Drive Length:	Attempt #:
Recovery:	Type of Core | Direct Push | Vibracore | Diver Core
% Recovery:	Diameter of Core (inches)
Notes:	Core Quality | Good | Fair | Poor | Disturbed

Recovered Length (cm)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (cm)	PID	Sample	Summary Sketch

SOIL/SEDIMENT CLASSIFICATION FIELD GUIDE

SOIL/SEDIMENT DESCRIPTION COMPONENTS: USCS name (USCS symbol): density/consistency, moisture, color, list gravel/silt/sand by %; additional remarks

Density of Coarse-grained (Cohesionless) Soils

Density	*Standard Penetration (N; blows/foot)*
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	More than 50

Consistency of Fine-grained (Cohesive) Soils

Consistency	*Standard Penetration (N; blows/foot)*	*Unconfined Compressive Strength (tsf)*	*Manual Penetration Test*
Very Soft	0 to 2	<0.25	Thumb will penetrate soil more than 1 inch
Soft	2 to 4	0.25 to 0.5	Thumb will penetrate soil about 1 inch
Medium Stiff	4 to 8	0.5 to 1	Molded by moderate to firm finger pressure
Stiff	8 to 15	1 to 2	Readily indented by thumb, difficult to penetrate
Very Stiff	15 to 30	2 to 4	Readily indented by thumbnail
Hard	More than 30	>4	Indented with difficulty by thumbnail

Gray

Gray-brown

Olive-brown

Olive

Olive-gray

Dark brown

Red-gray

Red-brown

Brown

Red

Light brown

Tan

Yellow-brown

Red-yellow

Yellow

Moisture Content

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible, free water

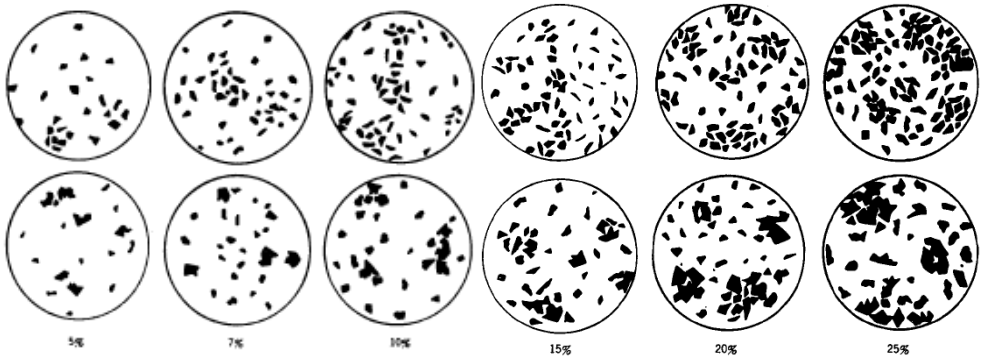
Particle Shape/Angularity

Description	*Criteria*
Rounded	Near-spherical or oval
Sub-rounded	Primarily rounded corners and edges
Sub-angular	Slightly rounded corners and edges
Angular	Sharp corners and edges

Grain Size

Soil Component		*Anthropogenic Component*	*Size Range (U.S. Standard Sieve)*	*Approximate Size*
Boulders		Blocks	>12 inches	larger than basketball
Cobbles		Pieces	3 to 12 inches	fist to basketball
Gravel	Coarse	Fragments	3/4 to 3 inches	thumb to fist
	Fine		#4 to 3/4 inches	pea to thumb
Sand	Coarse	Particles	#10 to #4	rock salt to pea
	Medium		#40 to #10	sugar to rock salt
	Fine		#200 to #40	flour to sugar
Fine Grained	Silt	Specks	Pass #200	finer than flour
	Clay			

Charts for Estimating Percentages (After Compton, 1962)



Index of Plasticity

Description	*Criteria*
Non-plastic	A 1/8 inch (3 mm) thread cannot be rolled at any water content. Has definite structure but can easily be separated or crumbled. Is readily rinsed off sampling equipment. Breaks easily when pieces are dried.
Low Plasticity	A thread can barely be rolled.
Medium Plasticity	A thread is easily rolled. Stays together relatively well when molded (i.e., behaves like Play-Doh). Can be washed off sampling equipment easily. Requires some effort to break when pieces are dried.
High Plasticity	A threat is easily rolled, and can be rerolled several times. Can be easily molded and stays together very well, but takes effort to rinse off of sampling equipment. Difficult to break when pieces are dried.

Criteria for Describing Soil Structure

Decomposed	Visible signs of breakdown, applicable to organic matter and rock.
Homogeneous	Same color and appearance throughout.
Interbedded	Alternating soil layers of different composition.
Lens	A very thin cohesive layer, less than .5-inch thick.
Layer	A general term for material lying essentially parallel to the surfaces against which it was formed (.5-inch to 12-inch thick).
Varved	A cyclic sedimentary couplet consisting of a coarser and a finer layer, representing variation in depositional energy.
Washed	Material missing in core tube due to loss through the bottom of sampler due to improper closing.

APPENDIX G

Permits

From:	Lori Riker
To:	"sydney.snyder@parks.ny.gov"
Cc:	Winter, Courtney; Thomas Forbes; "jessica.schreyer@parks.ny.gov"
Subject:	SHPO Environmental Review - Smokes Creek, Lackawanna, NY
Date:	Tuesday, September 30, 2025 12:44:00 PM
Attachments:	image003.png image004.png image005.png image006.png Section 106 Determination.pdf Figure 1; Site Location and Vicinity Map.pdf Figure 2; Site Plan.pdf image002.png

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Good afternoon Sydney,

Roux is assisting Tecumseh Redevelopment with a USEPA Great Lakes Legacy Act (GLLA) project on the Former Bethlehem Steel Site in Lackawanna, NY that includes Smokes Creek and adjacent source areas. We prepared a draft Pre-Design Investigation (PDI) Work Plan for Smokes Creek to conduct a bathymetric survey and perform sediment coring/sampling for chemical analysis. We also have several projects considered "source control" including an upcoming remedial project involving soil excavation on a NYSDEC Brownfield Cleanup Program (BCP) site adjacent to Smokes Creek.

As the Non-Federal Sponsor (NFS), Tecumseh Redevelopment is responsible for SHPO coordination.

The Former Bethlehem Steel Site is within the City of Lackawanna First Ward Brownfield Opportunity Area (BOA) and a Final Implementation Plan was issued December 2018. According to this document:

ARCHEOLOGICAL SENSITIVE AREAS AND HISTORIC PRESERVATION

There are no listings within the First Ward BOA on the National Register of Historic Places (NHRP). The Buffalo Harbor South Entrance Light is listed on the NHRP but lies outside of the northern border of the First Ward BOA. According to the New York State Historic Preservation Office (SHPO), the Cazenovia Park-South Park System is registered under the National Register of Historic Places; however, this lies outside (northeast) of the First Ward BOA and the City of Lackawanna. In addition, the archeological significant areas map indicates that the entire eastern portion of the BOA is categorized as an archeological significant area (See Figure 4.12). However, much, if not all, of the First Ward BOA has previously been altered by late 19th century and early 20th century construction and development activities, making it unlikely that archeological or cultural resources would be present in this area. Further investigation to determine whether this district could be designated by SHPO is required to obtain sufficient information.

During this project, a Phase IA Archeological Survey was conducted for the entire First Ward BOA, which can be located in the Appendix A. The purpose of this Phase IA investigation was to identify cultural resources that may be impacted by any proposed development activities within the First Ward BOA, assess the likelihood that unrecorded resources may be present, and identify the presence of historic properties. This investigation provides an in-depth settlement and history of the First Ward BOA and City of Lackawanna. Additionally, five archeological sites were identified within or immediately adjacent to the First Ward BOA. None of these sites have been determined eligible for listing on the NHRP, due to previous disturbance of the area. Additionally, the potential Kane Street Historic District is comprised of a cluster of five early 20th century commercial buildings that, collectively, retain sufficient integrity to convey their association and use as former support for the large Bethlehem Steel Plant workforce.

We prepared the attached Section 106 determination for SHPO's review and are requesting a determination from SHPO as to whether or not the project site falls within an area of archaeological sensitivity.

Thank you in advance for your time,
Lori

Lori Riker, P.E. – NY | Principal Engineer
2558 Hamburg Turnpike, Suite 300, Buffalo, NY 14218
Main: (716) 856-0599 | Direct: (716) 725-6963 | Mobile: (716) 474-7510
Email: lriker@rouxinc.com | Website: www.rouxinc.com

ROUX

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NEW YORK STATE | Department of Environmental Conservation | Office of General Services | Department of State

US Army Corps of Engineers

JOINT APPLICATION FORM

For Permits for activities activities affecting streams, waterways, waterbodies, wetlands, coastal areas, sources of water, and endangered and threatened species.

You must separately apply for and obtain Permits from each involved agency before starting work. Please read all instructions.

1. **Applications To:**

>NYS Department of Environmental Conservation ☑ Check here to confirm you sent this form to NYSDEC.

Check all permits that apply:

- ☑ Stream Disturbance
- ☐ Excavation and Fill in Navigable Waters
- ☐ Docks, Moorings or Platforms
- ☐ Dams and Impoundment Structures
- ☐ 401 Water Quality Certification *
- ☐ Freshwater Wetlands
- ☐ Tidal Wetlands
- ☐ Wild, Scenic and Recreational Rivers
- ☐ Coastal Erosion Management
- ☐ Water Withdrawal
- ☐ Long Island Well
- ☐ Incidental Take of Endangered / Threatened Species

* See Instructions Page 3

>US Army Corps of Engineers ☑ Check here to confirm you sent this form to USACE.

Check all permits that apply: ☑ Section 404 Clean Water Act ☐ Section 10 Rivers and Harbors Act

Is the project Federally funded? ☐ Yes ☑ No

If yes, name of Federal Agency:

General Permit Type(s), if known: NWP No. 6 (Survey Activities)

Preconstruction Notification: ☐ Yes ☑ No

>NYS Office of General Services ☐ Check here to confirm you sent this form to NYSOGS.

Check all permits that apply:

- ☐ State Owned Lands Under Water
- ☐ Utility Easement (pipelines, conduits, cables, etc.)
- ☐ Docks, Moorings or Platforms

>NYS Department of State ☐ Check here to confirm you sent this form to NYSDOS.

Check if this applies: ☐ Coastal Consistency Concurrence

2. **Name of Applicant**

Tecumseh Redevelopment Inc. c/o Cleveland-Cliffs

Taxpayer ID (if applicant is NOT an individual): 01-0649791

Mailing Address	Post Office / City	State	Zip
200 Public Square, Suite 3400	Cleveland	OH	44114-2315

Telephone: 216-694-5700 Email: Keith.Nagel1@ClevelandCliffs.com

Applicant Must be (check all that apply): ☑ Owner ☐ Operator ☐ Lessee

3. **Name of Property Owner (if different than Applicant)**

Mailing Address	Post Office / City	State	Zip

Telephone: Email:

For Agency Use Only	Agency Application Number:

4. **Name of Contact / Agent**

Thomas H. Forbes, P.E.

Mailing Address	Post Office / City	State	Zip
2558 Hamburg Turnpike, Suite 300	Buffalo	NY	14218

Telephone 716-856-0599 Email tforbes@rouxinc.com

5. **Project / Facility Name**

Smokes Creek Bathymetric Survey & Core Sampling

Property Tax Map Section / Block / Lot Number: 141.11-1-1.111

Project Street Address, if applicable	Post Office / City	State	Zip
2303 Hamburg Turnpike	Lackawanna	NY	14218

Provide directions and distances to roads, intersections, bridges and bodies of water

The project involves the portion of Smokes Creek on the Tecumseh property and extends to Lake Erie

☐ Town ☐ Village ☑ City

Lackawanna	Erie	Smokes Creek

Project Location Coordinates: Enter Latitude and Longitude in degrees, minutes, seconds:

Latitude: N42 ° 81 ' 00 " Longitude: W78 ° 86 ' 40 "

6. **Project Description:** Provide the following information about your project. Continue each response and provide any additional information on other pages. **Attach plans on separate pages.**

a. Purpose of the proposed project:

To determine the thickness of fine-grained sediment above the 1965 USACE design elevation of Smokes Creek. Collect core samples from hard sediment along transects for chemical analysis.

b. Description of current site conditions:

c. Proposed site changes:

None

d. Type of structures and fill materials to be installed, and quantity of materials to be used (e.g., square feet of coverage, cubic yards of fill material, structures below ordinary/mean high water, etc.):

Not applicable

e. Area of excavation or dredging, volume of material to be removed, location of dredged material placement:

Only core samples will be collected.

f. Is tree cutting or clearing proposed? ☐ Yes If Yes, explain below. ☑ No

Timing of the proposed cutting or clearing (month/year):

Number of trees to be cut: Acreage of trees to be cleared:

g. Work methods and type of equipment to be used:

Boat with echosounder and vibracore for sampling

h. Describe the planned sequence of activities:

Mark out transects, perform bathymetric survey, determine thickness of fine-grained sediment, and collect core samples from hard sediment.

i. Pollution control methods and other actions proposed to mitigate environmental impacts:

None

j. Erosion and silt control methods that will be used to prevent water quality impacts:

k. Alternatives considered to avoid regulated areas. If no feasible alternatives exist, explain how the project will minimize impacts:

l. Proposed use: ☐ Private ☐ Public ☑ Commercial

m. Proposed Start Date: 9/1/2025 Estimated Completion Date: 9/15/2025

n. Has work begun on project? ☐ Yes If Yes, explain below. ☑ No

o. Will project occupy Federal, State, or Municipal Land? ☐ Yes If Yes, explain below. ☑ No

p. List any previous DEC, USACE, OGS or DOS Permit / Application numbers for activities at this location:

q. Will this project require additional Federal, State, or Local authorizations, including zoning changes?

☐ Yes If Yes, list below. ☑ No

7. **Signatures.**

Applicant and Owner (If different) must sign the application. If the applicant is the landowner, the **landowner attestation form** can be used as an electronic signature as an alternative to the signature below, if necessary. Append additional pages of this Signature section if there are multiple Applicants, Owners or Contact/Agents.

I hereby affirm that information provided on this form and all attachments submitted herewith is true to the best of my knowledge and belief.

Permission to Inspect - I hereby consent to Agency inspection of the project site and adjacent property areas. Agency staff may enter the property without notice between 7:00 am and 7:00 pm, Monday - Friday. Inspection may occur without the owner, applicant or agent present. If the property is posted with "keep out" signs or fenced with an unlocked gate, Agency staff may still enter the property. Agency staff may take measurements, analyze site physical characteristics, take soil and vegetation samples, sketch and photograph the site. I understand that failure to give this consent may result in denial of the permit(s) sought by this application.

False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the NYS Penal Law. Further, the applicant accepts full responsibility for all damage, direct or indirect, of whatever nature, and by whomever suffered, arising out of the project described herein and agrees to indemnify and save harmless the State from suits, actions, damages and costs of every name and description resulting from said project. In addition, Federal Law, 18 U.S.C., Section 1001 provides for a fine of not more than $10,000 or imprisonment for not more than 5 years, or both where an applicant knowingly and willingly falsifies, conceals, or covers up a material fact; or knowingly makes or uses a false, fictitious or fraudulent statement.

Signature of Applicant | Date

Applicant Must be (check all that apply): ☑ Owner ☐ Operator ☐ Lessee

Printed Name: Keith A. Nagel | Title: Director Environment Land & Remediation

Signature of Owner (if different than Applicant) | Date

Printed Name | Title

Signature of Contact / Agent | Date

Printed Name: Thomas H. Forbes | Title: Site Manager

For Agency Use Only **DETERMINATION OF NO PERMIT REQUIRED**

Agency Application Number

(Agency Name) has determined that No Permit is required from this Agency for the project described in this application.

Agency Representative:

Printed Name | Title

Signature | Date

New York State
Parks, Recreation and
Historic Preservation

KATHY HOCHUL
Governor

KATHY MOSER
Acting Commissioner

November 07, 2025

Lori Riker
Principal Engineer
Roux Environmental Engineering and Geology, D.P.C.
2558 Hamburg Turnpike
Suite 300
Buffalo, NY 14218

Re: EPA
Pre-Design Investigation and Remedial Design of Smokes Creek
City of Lackawanna, NY
25PR09218
NWP-6

Dear Lori Riker:

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the project in accordance with Section 106 of the National Historic Preservation Act of 1966. These comments are those of the SHPO and relate only to Historic/Cultural resources. They do not include potential environmental impacts to New York State Parkland that may be involved in or near your project.

Based upon this review, it is the opinion of the New York SHPO that no historic properties, including archaeological and/or historic resources, will be affected by this undertaking.

If further correspondence is required regarding this project, please be sure to refer to the OPRHP Project Review (PR) number noted above. If you have any questions, please contact Jessica Vavrasek at the following email address:

Jessica.Vavrasek@parks.ny.gov

Sincerely,

R. Daniel Mackay

Deputy State Historic Preservation Officer
Division for Historic Preservation

Environmental Reviews

- Section 7 of the Endangered Species Act, 16 U.S.C. 1531: The Applicant consulted the US Fish & Wildlife Service's map of Threatened and Endangered Species with Critical Habitat; none were identified for the project area. However, the U.S. Fish & Wildlife Service Information for Planning and Construction (IPaC)[1] revealed the following species as endangered, proposed threatened, or protected for the project site:
    - Northern Long-eared Bat (mammal): These bats roost in cavities, or crevices of both live and dead trees. Males and non-reproductive females may also roost in cooler places, like caves or mines. The proposed activities will not impact trees and there are no mines or caves on the project site.
    - Monarch Butterfly (insect): This species is shown as a candidate; however, the Monarch will not be impacted as milkweed and flowering plants, if present, will not be disturbed.
    - Bald and Golden Eagles (birds): Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald eagles generally nest near coastlines, rivers, and large lakes where there is an adequate food supply. Nests are built on trees (with a preference for mature or old-growth trees), snags (dead trees), cliffs, and rock promontories, usually with a dominant view of the surrounding landscape. Any potential nesting sites in the project area would not be disturbed nor is this a Bird of Conservation Concern (BCC) in this area.

  This resource list is for informational purposes only and does not constitute an analysis of project level impact.

  A full environmental assessment form (FEAF) was generated using the NYSDEC EAF Mapper[2]. The FEAF indicates the following species listed by New York State (NYS) as endangered or threatened:

    - Lake Sturgeon (freshwater fish): The NYS conservation status of the Lake Sturgeon is threatened. The American Fisheries Society has listed the Lake Sturgeon as threatened in all states where it occurs. According to the NYSDEC website, although it is difficult to determine the specific causes of Lake Sturgeon population declines, several factors have been blamed, including over exploitation of stocks due to high demand for their eggs (caviar) and smoked flesh; construction of dams that cut off spawning and nursery areas; and possibly byproducts of urban and rural development such as pollution and channelization that caused degradation of habitat. The stormwater discharges to the Union Ship Canal will not contain pollutants and will be monitored and inspected to ensure no impact to the Lake Sturgeon.

  The FEAF indicates no species of plant or animal that is listed by NYS as rare, or as a species of special concern; no significant natural communities; and no unique geological features. The project site does not contain, nor is it substantially contiguous to, a National Natural Landmark or a NYS listed Critical Environmental Area.

[1] https://ipac.ecosphere.fws.gov/
[2] https://gisservices.dec.ny.gov/eafmapper/

- Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. 306108: According to the NYSDEC EAF Mapper, the project site is in or adjacent to an area designated as sensitive for archaeological sites on the NY State Historic Preservation Office (SHPO) archaeological site inventory.
    - The proposed action does not occur wholly or partially within, or substantially contiguous to, any buildings, archaeological sites, or districts that are listed on or been nominated by the NYS Board of Historic Preservation for inclusion on the State or National Register of Historic Places.
    - There are no known sites that have been identified as significant according to the 1989 City of Lackawanna Local Waterfront Revitalization Program (LWRP). Specifically, the following excerpts from the LWRP address archeological resources proximate to the Project Area:
        - *The former Bethlehem Steel employment office near the Buffalo-Lackawanna city line is an early twentieth century structure which is both architecturally and historically significant. The structure's historic significance comes from its association with the Bethlehem Steel Corporation, while the architectural importance stems from its classical, revival style of grey brick on a rusticated ashlar basement. It is topped with a hipped roof. The building, however, is not presently listed on the National or state Registers of Historic places*." This building was demolished in 2013.
    - A Phase IA Cultural Resources Investigation[3] was conducted for the entire First Ward BOA. The purpose of this Phase IA was to identify previously recorded cultural resources that may be impacted by any proposed development activities within the First Ward BOA, assess the likelihood that unrecorded resources may be present, and identify the presence of historic properties. This investigation provides an in-depth settlement and history of the First Ward BOA and City of Lackawanna. The methodology for this investigation involved background data as well as a field survey. A significant in-depth cultural background is provided in this investigation report. The entirety of the First Ward BOA was previously disturbed and significant land area, now considered a portion of the former Bethlehem Steel Site, is man-made land. Five archeological sites were identified within or immediately adjacent to the First Ward BOA. None of these sites are on or adjacent to the Project Site nor have they been determined eligible for listing on the National Register of Historic Places (NHRP) due to previous disturbance of the area.

  Based on these determinations and the long history of industrial activity on the Site; the creation of man-made lands that the project site will occupy (through steel slag deposition); and significant prior disturbances to the project site through historic demolition and environmental investigations, it unlikely that archeological or cultural resources would be present in the project area. Therefore, there are no historic or cultural resources to be adversely affected or potentially adversely affected by the project.

[3] Phase IA Cultural Resources Investigation in Support of the City of Lackawanna First Ward Brownfields Opportunity Area, City of Lackawanna, Erie County, New York prepared by Panamerican Consultants, Inc. July 2017.

Nationwide Permit 6 - Survey Activities

Effective Date: February 25, 2022; Expiration Date: March 14, 2026
(NWP Final Notice, 86 FR 73522)

Nationwide Permit 6 - Survey Activities. Survey activities, such as core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, exploratory trenching, soil surveys, sampling, sample plots or transects for wetland delineations, and historic resources surveys. For the purposes of this NWP, the term “exploratory trenching” means mechanical land clearing of the upper soil profile to expose bedrock or substrate, for the purpose of mapping or sampling the exposed material. The area in which the exploratory trench is dug must be restored to its pre-construction elevation upon completion of the work and must not drain a water of the United States. In wetlands, the top 6 to 12 inches of the trench should normally be backfilled with topsoil from the trench. This NWP authorizes the construction of temporary pads, provided the discharge of dredged or fill material does not exceed 1/10-acre in waters of the U.S. Discharges of dredged or fill material and structures associated with the recovery of historic resources are not authorized by this NWP. Drilling and the discharge of excavated material from test wells for oil and gas exploration are not authorized by this NWP; the plugging of such wells is authorized. Fill placed for roads and other similar activities is not authorized by this NWP. The NWP does not authorize any permanent structures. The discharge of drilling mud and cuttings may require a permit under Section 402 of the Clean Water Act. (Authorities: Sections 10 and 404)

2021 Nationwide Permit General Conditions

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP. Every person who may wish to obtain permit authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

1. **Navigation.** (a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his or her authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. **Aquatic Life Movements.** No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless culvert cannot be used, then the crossing should be designed and constructed to minimize adverse effects to aquatic life movements.

3. **Spawning Areas.** Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. **Migratory Bird Breeding Areas.** Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. **Shellfish Beds.** No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. **Suitable Material.** No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see section 307 of the Clean Water Act).

7. **Water Supply Intakes.** No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. **Adverse Effects From Impoundments.** If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. **Management of Water Flows.** To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be

maintained for each activity, including stream channelization, storm water management activities, and temporary and permanent road crossings, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. **Fills Within 100-Year Floodplains.** The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. **Equipment.** Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. **Soil Erosion and Sediment Controls.** Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow, or during low tides.

13. **Removal of Temporary Structures and Fills.** Temporary structures must be removed, to the maximum extent practicable, after their use has been discontinued. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. **Proper Maintenance.** Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. **Single and Complete Project.** The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. **Wild and Scenic Rivers.** (a) No NWP activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a “study river” for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status.

(b) If a proposed NWP activity will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a “study river” for possible inclusion in the system while the river is in an official study status, the permittee must submit a pre-construction notification (see general condition 32). The

district engineer will coordinate the PCN with the Federal agency with direct management responsibility for that river. Permittees shall not begin the NWP activity until notified by the district engineer that the Federal agency with direct management responsibility for that river has determined in writing that the proposed NWP activity will not adversely affect the Wild and Scenic River designation or study status.

(c) Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service). Information on these rivers is also available at: http://www.rivers.gov/.

17. **Tribal Rights.** No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

18. **Endangered Species.** (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify designated critical habitat or critical habitat proposed for such designation. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless ESA section 7 consultation addressing the consequences of the proposed activity on listed species or critical habitat has been completed. See 50 CFR 402.02 for the definition of "effects of the action" for the purposes of ESA section 7 consultation, as well as 50 CFR 402.17, which provides further explanation under ESA section 7 regarding "activities that are reasonably certain to occur" and "consequences caused by the proposed action."

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA (see 33 CFR 330.4(f)(1)). If pre-construction notification is required for the proposed activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation has not been submitted, additional ESA section 7 consultation may be necessary for the activity and the respective federal agency would be responsible for fulfilling its obligation under section 7 of the ESA.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species (or species proposed for listing) or designated critical habitat (or critical habitat proposed such designation) might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat or critical habitat proposed for such designation, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species (or species proposed for listing) or designated critical habitat (or critical habitat proposed for such designation), the pre-construction

notification must include the name(s) of the endangered or threatened species (or species proposed for listing) that might be affected by the proposed activity or that utilize the designated critical habitat (or critical habitat proposed for such designation) that might be affected by the proposed activity. The district engineer will determine whether the proposed activity “may affect” or will have “no effect” to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps’ determination within 45 days of receipt of a complete pre-construction notification. For activities where the non-Federal applicant has identified listed species (or species proposed for listing) or designated critical habitat (or critical habitat proposed for such designation) that might be affected or is in the vicinity of the activity, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification that the proposed activity will have “no effect” on listed species (or species proposed for listing or designated critical habitat (or critical habitat proposed for such designation), or until ESA section 7 consultation or conference has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation or conference with the FWS or NMFS the district engineer may add species-specific permit conditions to the NWPs.

(e) Authorization of an activity by an NWP does not authorize the “take” of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with “incidental take” provisions, etc.) from the FWS or the NMFS, the Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word “harm” in the definition of “take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) If the non-federal permittee has a valid ESA section 10(a)(1)(B) incidental take permit with an approved Habitat Conservation Plan for a project or a group of projects that includes the proposed NWP activity, the non-federal applicant should provide a copy of that ESA section 10(a)(1)(B) permit with the PCN required by paragraph (c) of this general condition. The district engineer will coordinate with the agency that issued the ESA section 10(a)(1)(B) permit to determine whether the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation conducted for the ESA section 10(a)(1)(B) permit. If that coordination results in concurrence from the agency that the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation for the ESA section 10(a)(1)(B) permit, the district engineer does not need to conduct a separate ESA section 7 consultation for the proposed NWP activity. The district engineer will notify the non-federal applicant within 45 days of receipt of a complete pre-

construction notification whether the ESA section 10(a)(1)(B) permit covers the proposed NWP activity or whether additional ESA section 7 consultation is required.

(g) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.nmfs.noaa.gov/pr/species/esa/ respectively.

19. **Migratory Birds and Bald and Golden Eagles.** The permittee is responsible for ensuring that an action authorized by an NWP complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The permittee is responsible for contacting the appropriate local office of the U.S. Fish and Wildlife Service to determine what measures, if any, are necessary or appropriate to reduce adverse effects to migratory birds or eagles, including whether "incidental take" permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity.

20. **Historic Properties.** (a) No activity is authorized under any NWP which may have the potential to cause effects to properties listed, or eligible for listing, in the National Register of Historic Places until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of section 106 of the National Historic Preservation Act (see 33 CFR 330.4(g)(1)). If pre-construction notification is required for the proposed NWP activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation is not submitted, then additional consultation under section 106 may be necessary. The respective federal agency is responsible for fulfilling its obligation to comply with section 106.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the NWP activity might have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties might have the potential to be affected by the proposed NWP activity or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of, or potential for, the presence of historic properties can be sought from the State Historic Preservation Officer, Tribal Historic Preservation Officer, or designated tribal representative, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable

and good faith effort to carry out appropriate identification efforts commensurate with potential impacts, which may include background research, consultation, oral history interviews, sample field investigation, and/or field survey. Based on the information submitted in the PCN and these identification efforts, the district engineer shall determine whether the proposed NWP activity has the potential to cause effects on the historic properties. Section 106 consultation is not required when the district engineer determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR 800.3(a)). Section 106 consultation is required when the district engineer determines that the activity has the potential to cause effects on historic properties. The district engineer will conduct consultation with consulting parties identified under 36 CFR 800.2(c) when he or she makes any of the following effect determinations for the purposes of section 106 of the NHPA: no historic properties affected, no adverse effect, or adverse effect.

(d) Where the non-Federal applicant has identified historic properties on which the proposed NWP activity might have the potential to cause effects and has so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects to historic properties or that NHPA section 106 consultation has been completed. For non-federal permittees, the district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA section 106 consultation is required. If NHPA section 106 consultation is required, the district engineer will notify the non-Federal applicant that he or she cannot begin the activity until section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (54 U.S.C. 306113) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. **Discovery of Previously Unknown Remains and Artifacts.** Permittees that discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by an NWP, they must immediately notify the district engineer of what they have found, and to the maximum extent practicable,

avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal, and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. **Designated Critical Resource Waters.** Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, 52, 57 and 58 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, 38, and 54, notification is required in accordance with general condition 32, for any activity proposed by permittees in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after she or he determines that the impacts to the critical resource waters will be no more than minimal.

23. **Mitigation.** The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse environmental effects of the proposed activity are no more than minimal, and provides an activity-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in only minimal adverse environmental effects.

(d) Compensatory mitigation at a minimum one-for-one ratio will be required for all losses of stream bed that exceed 3/100-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse environmental effects of the proposed activity are no more than minimal, and provides an activity-specific waiver of this requirement. This compensatory mitigation requirement may be satisfied through the restoration or enhancement of riparian areas next to streams in accordance with paragraph (e) of this general condition. For losses of stream bed of 3/100-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in only minimal adverse environmental effects. Compensatory mitigation for losses of streams should be provided, if practicable, through stream rehabilitation, enhancement, or preservation, since streams are difficult-to-replace resources (see 33 CFR 332.3(e)(3)).

(e) Compensatory mitigation plans for NWP activities in or near streams or other open waters will normally include a requirement for the restoration or enhancement, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, the restoration or maintenance/protection of riparian areas may be the only compensatory mitigation required. If restoring riparian areas involves planting vegetation, only native species should be planted. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to restore or maintain/protect a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or maintaining/protecting a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of minimization or compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(f) Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in no more than minimal adverse environmental effects. For the NWPs, the preferred mechanism for providing compensatory mitigation is mitigation bank credits or in-lieu fee program credits (see 33 CFR 332.3(b)(2) and (3)). However, if an appropriate number and type of mitigation bank or in-lieu credits are not available at the time the

PCN is submitted to the district engineer, the district engineer may approve the use of permittee-responsible mitigation.

(2) The amount of compensatory mitigation required by the district engineer must be sufficient to ensure that the authorized activity results in no more than minimal individual and cumulative adverse environmental effects (see 33 CFR 330.1(e)(3)). (See also 33 CFR 332.3(f).)

(3) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, aquatic resource restoration should be the first compensatory mitigation option considered for permittee-responsible mitigation.

(4) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) through (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)). If permittee-responsible mitigation is the proposed option, and the proposed compensatory mitigation site is located on land in which another federal agency holds an easement, the district engineer will coordinate with that federal agency to determine if proposed compensatory mitigation project is compatible with the terms of the easement.

(5) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan needs to address only the baseline conditions at the impact site and the number of credits to be provided (see 33 CFR 332.4(c)(1)(ii)).

(6) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan (see 33 CFR 332.4(c)(1)(ii)).

(g) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any NWP activity resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that an NWP activity already meeting the established acreage limits also satisfies the no more than minimal impact requirement for the NWPs.

(h) Permittees may propose the use of mitigation banks, in-lieu fee programs, or permittee-responsible mitigation. When developing a compensatory mitigation proposal, the permittee must consider appropriate and practicable options consistent with the framework at 33 CFR 332.3(b). For activities resulting in the loss of marine or estuarine resources, permittee-responsible mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(i) Where certain functions and services of waters of the United States are permanently adversely affected by a regulated activity, such as discharges of dredged or fill material into waters of the United States that will convert a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse environmental effects of the activity to the no more than minimal level.

24. **Safety of Impoundment Structures.** To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state or federal, dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. **Water Quality.** (a) Where the certifying authority (state, authorized tribe, or EPA, as appropriate) has not previously certified compliance of an NWP with CWA section 401, a CWA section 401 water quality certification for the proposed discharge must be obtained or waived (see 33 CFR 330.4(c)). If the permittee cannot comply with all of the conditions of a water quality certification previously issued by certifying authority for the issuance of the NWP, then the permittee must obtain a water quality certification or waiver for the proposed discharge in order for the activity to be authorized by an NWP.

(b) If the NWP activity requires pre-construction notification and the certifying authority has not previously certified compliance of an NWP with CWA section 401, the proposed discharge is not authorized by an NWP until water quality certification is obtained or waived. If the certifying authority issues a water quality certification for the proposed discharge, the permittee must submit a copy of the certification to the district engineer. The discharge is not authorized by an NWP until the district engineer has notified the permittee that the water quality certification requirement has been satisfied by the issuance of a water quality certification or a waiver.

(c) The district engineer or certifying authority may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. **Coastal Zone Management.** In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). If the permittee cannot comply with all of the conditions of a coastal zone management consistency concurrence previously issued by the state, then the permittee must obtain an individual coastal zone management consistency concurrence or presumption of concurrence in order for the activity to be authorized by an NWP. The district engineer or a state may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. **Regional and Case-By-Case Conditions.** The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its CWA section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. **Use of Multiple Nationwide Permits.** The use of more than one NWP for a single and complete project is authorized, subject to the following restrictions:

(a) If only one of the NWPs used to authorize the single and complete project has a specified acreage limit, the acreage loss of waters of the United States cannot exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1⁄3-acre.

(b) If one or more of the NWPs used to authorize the single and complete project has specified acreage limits, the acreage loss of waters of the United States authorized by those NWPs cannot exceed their respective specified acreage limits. For example, if a commercial development is constructed under NWP 39, and the single and complete project includes the filling of an upland ditch authorized by NWP 46, the maximum acreage loss of waters of the United States for the commercial development under NWP 39 cannot exceed 1/2-acre, and the total acreage loss of waters of United States due to the NWP 39 and 46 activities cannot exceed 1 acre.

29. **Transfer of Nationwide Permit Verifications.** If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s)

of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

_____
(Transferee)

_____
(Date)

30. **Compliance Certification.** Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and implementation of any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized activity was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the activity and mitigation.

The completed certification document must be submitted to the district engineer within 30 days of completion of the authorized activity or the implementation of any required compensatory mitigation, whichever occurs later.

31. **Activities Affecting Structures or Works Built by the United States.** If an NWP activity also requires review by, or permission from, the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers (USACE) federally authorized Civil Works project (a "USACE project"), the prospective permittee must submit a pre-construction notification. See paragraph (b)(10) of general condition 32. An activity that requires section 408 permission and/or review is not authorized by an NWP until the appropriate Corps office issues the section 408 permission or completes its review to alter, occupy, or use the USACE project, and the district engineer issues a written NWP verification.

32. **Pre-Construction Notification.** (a) *Timing*. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or are in the vicinity of the activity, or to notify the Corps pursuant to general condition 20 that the activity might have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or section 106 of the National Historic Preservation Act (see 33 CFR 330.4(g)) has been completed. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) *Contents of Pre-Construction Notification*: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed activity;

(3) Identify the specific NWP or NWP(s) the prospective permittee wants to use to authorize the proposed activity;

(4) (i) A description of the proposed activity; the activity's purpose; direct and indirect adverse environmental effects the activity would cause, including the anticipated amount of loss of wetlands, other special aquatic sites, and other waters expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; a description of any proposed mitigation measures intended to reduce the adverse environmental effects caused by the proposed activity; and any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity, including other separate and distant crossings for linear projects that require Department of the Army authorization but do not require pre-construction notification. The description of the proposed activity and any proposed mitigation measures should be sufficiently detailed to allow the district engineer to determine that the adverse environmental effects of the activity will be no more than minimal and to determine the need for compensatory mitigation or other mitigation measures.

(ii) For linear projects where one or more single and complete crossings require pre-construction notification, the PCN must include the quantity of anticipated losses of wetlands, other special aquatic sites, and other waters for each single and complete crossing of those wetlands, other special aquatic sites, and other waters (including those single and complete crossings authorized by an NWP but do not require PCNs). This information will be used by the district engineer to evaluate the cumulative adverse environmental effects of the proposed linear project, and does not change those non-PCN NWP activities into NWP PCNs.

(iii) Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the activity and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(5) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial and intermittent streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many wetlands, other special aquatic sites, and other waters. Furthermore, the 45-day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(6) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands or 3/100-acre of stream bed and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse environmental effects are no more than minimal and why

compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(7) For non-federal permittees, if any listed species (or species proposed for listing) or designated critical habitat (or critical habitat proposed for such designation) might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat (or critical habitat proposed for such designation), the PCN must include the name(s) of those endangered or threatened species (or species proposed for listing) that might be affected by the proposed activity or utilize the designated critical habitat (or critical habitat proposed for such designation) that might be affected by the proposed activity. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with the Endangered Species Act;

(8) For non-federal permittees, if the NWP activity might have the potential to cause effects to a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, the PCN must state which historic property might have the potential to be affected by the proposed activity or include a vicinity map indicating the location of the historic property. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with section 106 of the National Historic Preservation Act;

(9) For an activity that will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a “study river” for possible inclusion in the system while the river is in an official study status, the PCN must identify the Wild and Scenic River or the “study river” (see general condition 16); and

(10) For an NWP activity that requires permission from, or review by, the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers federally authorized civil works project, the pre-construction notification must include a statement confirming that the project proponent has submitted a written request for section 408 permission from, or review by, the Corps office having jurisdiction over that USACE project.

(c) *Form of Pre-Construction Notification*: The nationwide permit pre-construction notification form (Form ENG 6082) should be used for NWP PCNs. A letter containing the required information may also be used. Applicants may provide electronic files of PCNs and supporting materials if the district engineer has established tools and procedures for electronic submittals.

(d) *Agency Coordination*: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity’s compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the activity’s adverse environmental effects so that they are no more than minimal.

(2) Agency coordination is required for: (i) all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States; (ii) NWP 13 activities in excess of 500 linear feet, fills greater than one cubic yard per running foot, or involve discharges of dredged or fill material into special aquatic sites; and (iii) NWP 54 activities in excess of 500 linear feet, or that extend into the waterbody more than 30 feet from the mean low water line in tidal waters or the ordinary high water mark in the Great Lakes.

(3) When agency coordination is required, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (FWS, state natural resource or water quality agency, EPA, and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to notify the district engineer via telephone, facsimile transmission, or e-mail that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse environmental effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure that the net adverse environmental effects of the proposed activity are no more than minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(4) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.

(5) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

2021 District Engineer's Decision

1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. If a project proponent requests authorization by a specific NWP, the district engineer should

issue the NWP verification for that activity if it meets the terms and conditions of that NWP, unless he or she determines, after considering mitigation, that the proposed activity will result in more than minimal individual and cumulative adverse effects on the aquatic environment and other aspects of the public interest and exercises discretionary authority to require an individual permit for the proposed activity. For a linear project, this determination will include an evaluation of the single and complete crossings of waters of the United States that require PCNs to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings of waters of the United States authorized by an NWP. If an applicant requests a waiver of an applicable limit, as provided for in NWPs 13, 36, or 54, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in only minimal individual and cumulative adverse environmental effects.

2. When making minimal adverse environmental effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. He or she will also consider the cumulative adverse environmental effects caused by activities authorized by an NWP and whether those cumulative adverse environmental effects are no more than minimal. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional or condition assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse environmental effects determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.

3. If the proposed activity requires a PCN and will result in a loss of greater than 1/10-acre of wetlands or 3/100-acre of stream bed, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for NWP activities with smaller impacts, or for impacts to other types of waters. The district engineer will consider any proposed compensatory mitigation or other mitigation measures the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed activity are no more than minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse environmental effects are no more than minimal, after considering mitigation, the district engineer will notify the permittee and include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the

permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure that the NWP activity results in no more than minimal adverse environmental effects. If the net adverse environmental effects of the NWP activity (after consideration of the mitigation proposal) are determined by the district engineer to be no more than minimal, the district engineer will provide a timely written response to the applicant. The response will state that the NWP activity can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

4. If the district engineer determines that the adverse environmental effects of the proposed activity are more than minimal, then the district engineer will notify the applicant either: (a) that the activity does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (b) that the activity is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse environmental effects so that they are no more than minimal; or (c) that the activity is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse environmental effects, the activity will be authorized within the 45-day PCN period (unless additional time is required to comply with general conditions 18, 20, and/or 31), with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation plan or a requirement that the applicant submit a mitigation plan that would reduce the adverse environmental effects so that they are no more than minimal. When compensatory mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

2021 Further Information

1. District engineers have authority to determine if an activity complies with the terms and conditions of an NWP.

2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.

3. NWPs do not grant any property rights or exclusive privileges.

4. NWPs do not authorize any injury to the property or rights of others.

5. NWPs do not authorize interference with any existing or proposed Federal project (see general condition 31).

2021 Nationwide Permit Definitions

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate the adverse environmental effects on surface water quality resulting from development. BMPs are categorized as structural or non-structural.

Compensatory mitigation: The restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved.

Currently serviceable: Useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.

Direct effects: Effects that are caused by the activity and occur at the same time and place.

Discharge: The term "discharge" means any discharge of dredged or fill material into waters of the United States.

Ecological reference: A model used to plan and design an aquatic habitat and riparian area restoration, enhancement, or establishment activity under NWP 27. An ecological reference may be based on the structure, functions, and dynamics of an aquatic habitat type or a riparian area type that currently exists in the region where the proposed NWP 27 activity is located. Alternatively, an ecological reference may be based on a conceptual model for the aquatic habitat type or riparian area type to be restored, enhanced, or established as a result of the proposed NWP 27 activity. An ecological reference takes into account the range of variation of the aquatic habitat type or riparian area type in the region.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve a specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource function(s), but may also lead to a decline in other aquatic resource function(s). Enhancement does not result in a gain in aquatic resource area.

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area.

High Tide Line: The line of intersection of the land with the water's surface at the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by a line of oil or scum along shore objects, a more or less continuous deposit of fine shell or debris on the foreshore or berm, other physical markings or characteristics, vegetation lines, tidal gages, or other suitable means that delineate the general height reached by a rising tide. The line encompasses spring high tides and other high tides that occur with periodic frequency but does not include storm surges in which there is a departure from the normal or predicted reach of the tide due to the piling up of water against a coast by strong winds such as those accompanying a hurricane or other intense storm.

Historic Property: Any prehistoric or historic district, site (including archaeological site), building, structure, or other object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria (36 CFR part 60).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps Regulatory Program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Indirect effects: Effects that are caused by the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.

Loss of waters of the United States: Waters of the United States that are permanently adversely affected by filling, flooding, excavation, or drainage because of the regulated activity. The loss of stream bed includes the acres of stream bed that are permanently adversely affected by filling or excavation because of the regulated activity. Permanent adverse effects include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody. The acreage of loss of waters of the United States is a threshold measurement of the impact to jurisdictional waters or wetlands for determining whether a project may qualify for an NWP; it is not a net threshold that is calculated after considering compensatory mitigation that may be used to offset losses of aquatic functions and services. Waters of the United States temporarily filled, flooded, excavated, or drained, but restored to pre-construction contours and elevations after construction, are not included in the measurement of loss of waters of the United States. Impacts resulting from activities that do not require Department of the Army authorization, such as activities eligible for exemptions under section 404(f) of the Clean Water Act, are not considered when calculating the loss of waters of the United States.

Navigable waters: Waters subject to section 10 of the Rivers and Harbors Act of 1899. These waters are defined at 33 CFR part 329.

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Open water: For purposes of the NWPs, an open water is any area that in a year with normal patterns of precipitation has water flowing or standing above ground to the extent that an ordinary high water mark can be determined. Aquatic vegetation within the area of flowing or standing water is either non-emergent, sparse, or absent. Vegetated shallows are considered to be open waters. Examples of "open waters" include rivers, streams, lakes, and ponds.

Ordinary High Water Mark: The term ordinary high water mark means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Perennial stream: A perennial stream has surface water flowing continuously year-round during a typical year.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Pre-construction notification: A request submitted by the project proponent to the Corps for confirmation that a particular activity is authorized by nationwide permit. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of a nationwide permit, or by regional conditions. A pre-construction notification may be voluntarily submitted in cases where pre-construction notification is not required and the project proponent wants confirmation that the activity is authorized by nationwide permit.

Preservation: The removal of a threat to, or preventing the decline of, aquatic resources by an action in or near those aquatic resources. This term includes activities commonly associated with the protection and maintenance of aquatic resources through the implementation of appropriate legal and physical mechanisms. Preservation does not result in a gain of aquatic resource area or functions.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complex: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a course substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Riparian areas: Riparian areas are lands next to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. (See general condition 23.)

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term “single and complete project” is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

Single and complete non-linear project: For non-linear projects, the term "single and complete project" is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. A single and complete non-linear project must have independent utility (see definition of "independent utility"). Single and complete non-linear projects may not be "piecemealed" to avoid the limits in an NWP authorization.

Stormwater management: Stormwater management is the mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Stormwater management facilities: Stormwater management facilities are those facilities, including but not limited to, stormwater retention and detention ponds and best management practices, which retain water for a period of time to control runoff and/or improve the quality (i.e., by reducing the concentration of nutrients, sediments, hazardous substances and other pollutants) of stormwater runoff.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream's course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized jurisdictional stream remains a water of the United States.

Structure: An object that is arranged in a definite pattern of organization. Examples of structures include, without limitation, any pier, boat dock, boat ramp, wharf, dolphin, weir, boom, breakwater, bulkhead, revetment, riprap, jetty, artificial island, artificial reef, permanent mooring structure, power transmission line, permanently moored floating vessel, piling, aid to navigation, or any other manmade obstacle or obstruction.

Tidal wetland: A tidal wetland is a jurisdictional wetland that is inundated by tidal waters. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tide line.

Tribal lands: Any lands title to which is either: 1) held in trust by the United States for the benefit of any Indian tribe or individual; or 2) held by any Indian tribe or individual subject to restrictions by the United States against alienation.

Tribal rights: Those rights legally accruing to a tribe or tribes by virtue of inherent sovereign authority, unextinguished aboriginal title, treaty, statute, judicial decisions, executive order or agreement, and that give rise to legally enforceable remedies.

Vegetated shallows: Vegetated shallows are special aquatic sites under the 404(b)(1) Guidelines. They are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as seagrasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems.

Waterbody: For purposes of the NWPs, a waterbody is a "water of the United States." If a wetland is adjacent to a waterbody determined to be a water of the United States, that waterbody and any adjacent wetlands are considered together as a single aquatic unit (see 33 CFR 328.4(c)(2)).

ADDITIONAL INFORMATION

Information about the U.S. Army Corps of Engineers Regulatory Program, including nationwide permits, may also be accessed at http://www.swt.usace.army.mil/Missions/Regulatory.aspx or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx

From: Winter, Courtney
To: Lori Riker; Thomas Forbes
Subject: Smoke Creek THPO consultation for Section 106
Date: Wednesday, November 26, 2025 9:34:07 AM

This message originated outside your organization. Please use caution!

Hi Lori and Tom,

Neither of the Nations that were reached out to for consultation on the Smoke Creek GLLA Project responded. The 30-day response window ended on Monday, 11/24.

Hope you both enjoy your Thanksgivings!
Courtney

Courtney Winter
U.S. EPA - Great Lakes National Program Office
Chicago, IL
winter.courtney@epa.gov | (312) 353-5657

From:	Street, Jennifer (DOS)
To:	Lori Riker
Cc:	DeMers, Danielle (DOS); Bidell, Benjamin (DOS); dos.sm.Cstl.CR
Subject:	RE: Smokes Creek GLLA Project with EPA GLNPO
Date:	Monday, October 6, 2025 11:21:02 AM
Attachments:	image001.png image003.png image004.png

This message originated outside your organization. Please use caution!

Hi Lori,

Consistency Review would be required for sediment sampling/core samples under NWP #6 and is typically a pretty expedited review. Our last review of dredging at this location/facility was in 2022, so please identify is there is any proposed change in the dredge area (new or expansion).

A federal permit application or PCN notification form should be sent to us, as well as a federal consistency assessment form found at: https://dos.ny.gov/system/files/documents/2020/09/fcaf_fillable.pdf, maps outlining the survey areas and core locations, as well as a policy analysis using the City of Lackawanna Local Waterfront Revitalization Program policies at: https://dos.ny.gov/system/files/documents/2019/05/lackawannasiii.pdf.

This location is also either within, or adjacent to, the federally approved Smokes Creek Shoals Significant Coastal Fish and Wildlife Habitat at: https://dos.ny.gov/system/files/documents/2020/03/smoke_creek_shoals.pdf

An electronic submission of the materials identified above can be submitted to CR@dos.ny.gov. Please feel free to reach out if you have any additional questions.

Sincerely,

Jennifer L. Street
Coastal Resources Specialist 4
Director, Development Division
New York State Coastal Management Program

New York State Department of State
Office of Planning, Development & Community Infrastructure
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O: 518.474.7247 | C: 518.417.9235
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www.dos.ny.gov
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From: Bidell, Benjamin (DOS) <Benjamin.Bidell@dos.ny.gov>
Sent: Friday, September 26, 2025 9:51 AM
To: Street, Jennifer (DOS) <Jennifer.Street@dos.ny.gov>
Cc: lriker@rouxinc.com; DeMers, Danielle (DOS) <Danielle.DeMers@dos.ny.gov>
Subject: Fw: Smokes Creek GLLA Project with EPA GLNPO

Hi Jen,

I've worked with Lori Riker in the past on BOA conformance determinations. She has a question about whether a coastal consistency review is required for the attached project. See the exchange with USACE below.

According to Lori, the following statement is NOT true: "The NYSDOS concurs with the USACE's consistency determination where the activities to be authorized would be limited to sample plots or transects for wetland delineations and historic resource surveys. Therefore, she is looking for confirmation on whether an individual consistency determination is required for these activities to fall under NWP#6.

Please follow up with Lori directly and/or forward this email on, as appropriate.

Thanks!

-Ben

Benjamin J. Bidell
Office of Planning, Development & Community Infrastructure
New York State Department of State
295 Main Street, Suite 821
Buffalo, New York 14203
Office: 716-847-3150 | Cell: 716-638-7573
benjamin.bidell@dos.ny.gov
www.dos.ny.gov

From: Lori Riker <lriker@rouxinc.com>
Sent: Thursday, September 25, 2025 3:10 PM
To: Bidell, Benjamin (DOS) <Benjamin.Bidell@dos.ny.gov>
Subject: Smokes Creek GLLA Project with EPA GLNPO

ATTENTION: This email came from an external source. Do not open attachments or click on links from unknown senders or unexpected emails.

Hi Ben,

We are assisting Tecumseh Redevelopment with a Great Lakes Legacy Act (GLLA) project on the Former Bethlehem Steel Site in Lackawanna that includes Smokes Creek and adjacent source areas. We prepared a draft Pre-Design Investigation (PDI) Work Plan for Smokes Creek to conduct a bathymetric survey and perform sediment coring/sampling for chemical analysis. We also have several projects considered "source control" including an upcoming remedial project involving soil excavation on a BCP site adjacent to Smokes Creek.

We asked USACE for guidance on permitting and received the response below. From what I read about historic resource surveys, I don't believe our project falls within that scope. For the work adjacent to Smokes Creek, there will not be any discharges of dredge or fill material into Smokes Creek or a delineated wetland, and no structures be placed within Smokes Creek to do the work.

Also attached are the documents we sent to USACE for review. If it's easier to discuss over the phone, I'm generally available next week.

Thank you,
Lori

Lori Riker, P.E. - NY | Principal Engineer
2558 Hamburg Turnpike, Suite 300, Buffalo, NY 14218
Main: (716) 856-0599 | Direct: (716) 725-6963 | Mobile: (716) 474-7510
Email: lriker@rouxinc.com | Website: www.rouxinc.com

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From: Rowley, Joseph M CIV USARMY CELRB (USA) <Joseph.M.Rowley@usace.army.mil>

Sent: Wednesday, September 24, 2025 10:37 AM
To: Lori Riker <lriker@rouxinc.com>
Cc: Thomas Forbes <tforbes@rouxinc.com>
Subject: RE: Smokes Creek GLLA Project

Hi Lori,

Sorry for the delay response. Looks like the survey activities can be covered under non-reporting (no application needs to be submitted) NWP#6 and the Blanket Sec 401 WQC attached. However, an Individual Coastal Consistency is required (not sure if you can get to historic resource surveys????):

New York State Department of State Coastal Zone Management Consistency Determination:

Pursuant to 15 CFR Part 930.41 and 930.43, the New York State Department of State (NYSDOS) concurs with the USACE' consistency determination for this NWP with which all general and all Buffalo and New York District regional conditions are complied and with the additional condition(s), as follows:

• The NYSDOS concurs with the USACE' consistency determination where the activities to be authorized would be limited to sample plots or transects for wetland delineations and historic resource surveys.

For activities that do not comply with the above condition, the NYSDOS objects to the USACE' consistency determination and therefore, an individual consistency determination from NYSDOS is required for this NWP to be valid in the New York coastal area. Activities authorized pursuant to this Nationwide Permit shall be submitted to NYSDOS for review by the applicant. NYSDOS will review the proposed activities pursuant to 15 CFR Part 930 Subpart D. NYSDOS concurrence with an applicant's consistency certification shall not be presumed unless NYSDOS fails to concur with or object to an applicant's consistency certification within six (6) months of commencement of NYSDOS' review of an applicant's consistency certification and all necessary data and information in accordance with 15 CFR § 930.62 or § 930.63. See Section I below for further information.

I would reach out to NYSDOS and see what they say about the proposed survey activities. For the work adjacent to Smokes Creek, will there be a discharge of dredge or fill material into Smokes Creek, or a delineated wetland? Will any structures be placed within Smokes Creek to do the work?

Thank you
Joe

Joseph Rowley
USACE Buffalo District
Regulatory - NY Permit Evaluation Section
478 Main Street
Buffalo, New York 14202

(C) 716-345-6026
https://www.lrd.usace.army.mil/Wetlands-Permits/Article/3646979/regulatory-program-new-york/

From: Lori Riker
Sent: Friday, August 22, 2025 11:32 AM
To: joseph.m.rowley@usace.army.mil
Cc: Thomas Forbes <tforbes@rouxinc.com>
Subject: Smokes Creek GLLA Project

Good morning Joe,

We are assisting Tecumseh Redevelopment with a GLLA project on the Former Bethlehem Steel Site in Lackawanna that includes Smokes Creek and adjacent source areas. We would appreciate your input on required reviews and permits.

We are preparing a Pre-Design Investigation (PDI) Work Plan for Smokes Creek to conduct a bathymetric survey and perform sediment coring/sampling for chemical analysis. We also have several projects considered “source control” including an upcoming remedial project involving soil excavation on a BCP site adjacent to Smokes Creek.

The Smokes Creek PDI Work Plan includes the following section on permitting:

Sampling will be performed within navigable waters of the United States and, therefore, requires a USACE permit that will be covered under Nationwide Permit No. 6 Survey Activities. The proposed work also requires a NYSDEC Protection of Waters Permit. USACE and NYSDEC permits will be applied for using New York State’s joint permit application and will require consultation with the NYSDEC Division of Fish and Wildlife and the State Historic Preservation Office. The project is anticipated to be considered “Minor,” which streamlines the permitting process.

- Attached is the draft permit application. I don’t believe Coastal Consistency Concurrence from DOS would be required but please confirm.

EPA brought up the possible need for Endangered Species Act (ESA) and Section 106 documentation.

- We ran the NYSDEC EAF Mapper for Smokes Creek and surrounding areas. Please see the attached narrative to support the results.

If a Teams call would be more efficient, please provide your availability for next week.

Thanks in advance for your assistance,
Lori

Lori Riker, P.E. - NY | Principal Engineer
2558 Hamburg Turnpike, Suite 300, Buffalo, NY 14218
Main: (716) 856-0599 | Direct: (716) 725-6963 | Mobile: (716) 474-7510
Email: lriker@rouxinc.com | Website: www.rouxinc.com

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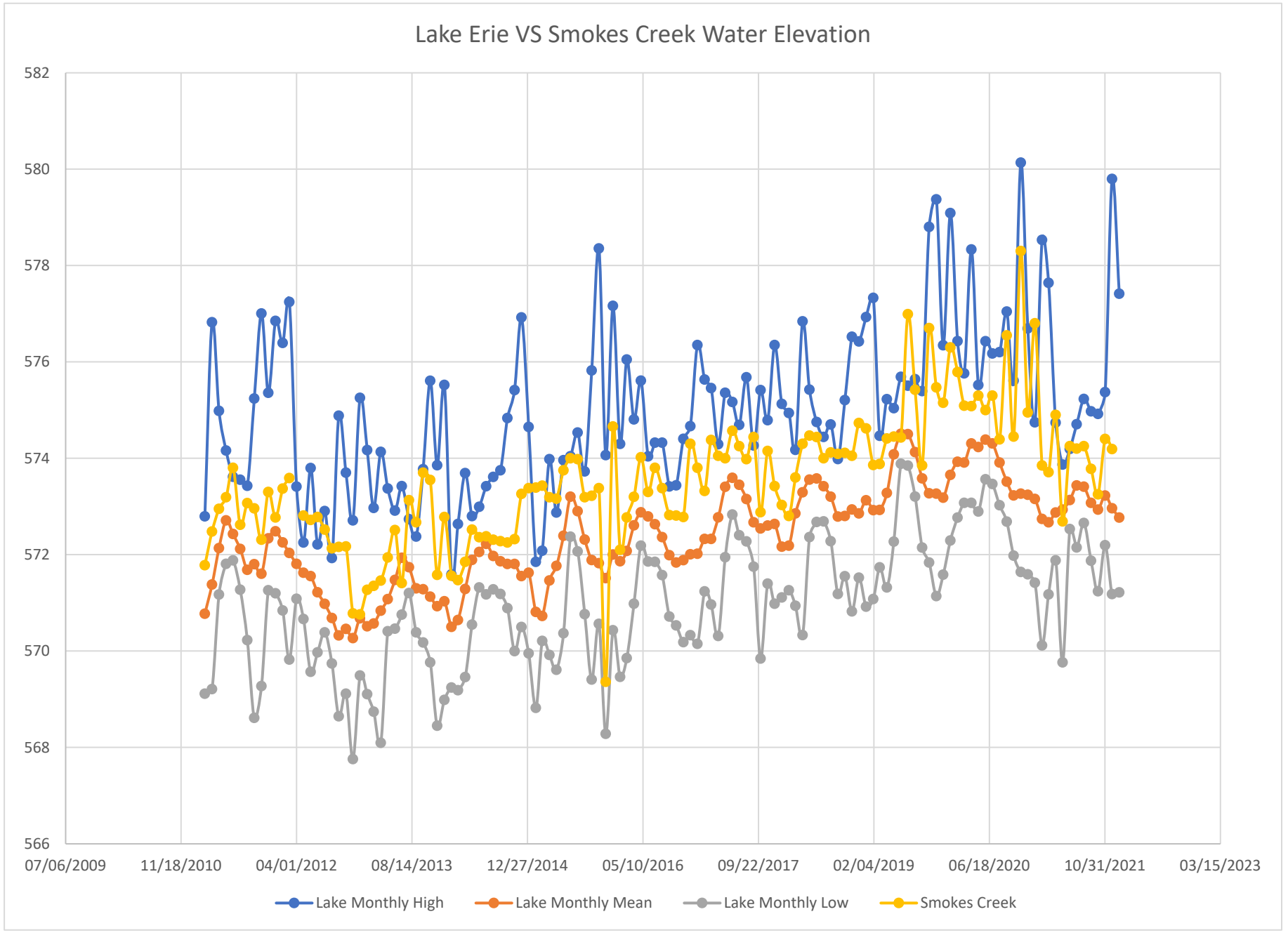
APPENDIX H

Mean-High Water Level Determination


Lake Erie VS Smokes Creek Water Elevation
582
580
578
576
574
572
570
568
566
07/06/2009
11/18/2010
04/01/2012
08/14/2013
12/27/2014
05/10/2016
09/22/2017
02/04/2019
06/18/2020
10/31/2021
03/15/2023
Lake Monthly High
Lake Monthly Mean
Lake Monthly Low
Smokes Creek

Date	Lake Erie Highest	Lake Erie MSL (ft)	Lake Erie Lowest (ft)	Smokes Creek
03/01/2011	572.795	570.774	569.114	571.78
04/01/2011	576.821	571.38	569.209	572.48
05/01/2011	574.984	572.135	571.171	572.95
06/01/2011	574.16	572.709	571.808	573.19
07/01/2011	573.615	572.429	571.88	573.80
08/01/2011	573.553	572.118	571.273	572.62
09/01/2011	573.428	571.684	570.226	573.07
10/01/2011	575.24	571.801	568.612	572.96
11/01/2011	577.005	571.603	569.272	572.31
12/01/2011	575.358	572.337	571.26	573.30
01/01/2012	576.85	572.484	571.198	572.77
02/01/2012	576.394	572.254	570.84	573.37
03/01/2012	577.244	572.034	569.823	573.59
04/01/2012	573.412	571.808	571.083	
05/01/2012	572.251	571.625	570.663	572.81
06/01/2012	573.796	571.555	569.567	572.72
07/01/2012	572.211	571.218	569.97	572.78
08/01/2012	572.904	570.977	570.387	572.52
09/01/2012	571.929	570.685	569.741	572.13
10/01/2012	574.882	570.323	568.645	572.16
11/01/2012	573.701	570.459	569.114	572.17
12/01/2012	572.71	570.268	567.756	570.78
01/01/2013	575.253	570.677	569.491	570.76
02/01/2013	574.17	570.512	569.104	571.27
03/01/2013	572.969	570.571	568.74	571.35
04/01/2013	574.131	570.835	568.094	571.46
05/01/2013	573.373	571.075	570.41	571.94
06/01/2013	572.913	571.475	570.463	572.51
07/01/2013	573.422	571.933	570.755	571.41
08/01/2013	572.736	571.739	571.201	573.13
09/01/2013	572.375	571.3	570.387	572.67
10/01/2013	573.773	571.281	570.177	573.70
11/01/2013	575.607	571.127	569.764	573.55
12/01/2013	573.855	570.929	568.448	571.58
01/01/2014	575.522	571.032	568.986	572.78
02/01/2014	571.588	570.5	569.242	571.56
03/01/2014	572.635	570.643	569.186	571.47
04/01/2014	573.691	571.286	569.459	571.85
05/01/2014	572.799	571.889	570.548	572.52
06/01/2014	572.992	572.056	571.319	572.36
07/01/2014	573.419	572.222	571.175	572.38
08/01/2014	573.612	571.972	571.28	572.31
09/01/2014	573.75	571.861	571.184	572.28
10/01/2014	574.833	571.805	570.889	572.25
11/01/2014	575.413	571.805	569.997	572.32
12/01/2014	576.923	571.553	570.499	573.26

Date	Lake Erie Highest	Lake Erie MSL (ft)	Lake Erie Lowest (ft)	Smokes Creek
01/01/2015	574.649	571.624	569.951	573.38
02/01/2015	571.85	570.81	568.819	573.39
03/01/2015	572.08	570.726	570.21	573.43
04/01/2015	573.98	571.462	569.918	573.19
05/01/2015	572.874	571.765	569.61	573.16
06/01/2015	573.96	572.39	570.367	573.75
07/01/2015	574.042	573.203	572.372	574.00
08/01/2015	574.534	572.901	572.067	573.98
09/01/2015	573.727	572.311	570.764	573.19
10/01/2015	575.823	571.887	569.406	573.22
11/01/2015	578.353	571.823	570.564	573.38
12/01/2015	574.065	571.511	568.281	569.36
01/01/2016	577.162	572.002	570.43	574.66
02/01/2016	574.298	571.861	569.462	572.10
03/01/2016	576.047	572.075	569.852	572.77
04/01/2016	574.806	572.608	570.981	573.20
05/01/2016	575.61	572.877	572.185	574.02
06/01/2016	574.039	572.792	571.857	573.30
07/01/2016	574.324	572.631	571.85	573.80
08/01/2016	574.324	572.362	571.575	573.38
09/01/2016	573.415	571.988	570.715	572.82
10/01/2016	573.438	571.837	570.531	572.81
11/01/2016	574.403	571.886	570.184	572.78
12/01/2016	574.665	572.005	570.328	574.30
01/01/2017	576.348	572.018	570.148	573.80
02/01/2017	575.633	572.326	571.237	573.32
03/01/2017	575.456	572.326	570.965	574.38
04/01/2017	574.291	572.772	570.312	574.05
05/01/2017	575.358	573.406	571.946	574.00
06/01/2017	575.167	573.593	572.831	574.57
07/01/2017	574.692	573.448	572.402	574.25
08/01/2017	575.679	573.153	572.274	573.98
09/01/2017	574.265	572.671	571.749	574.44
10/01/2017	575.413	572.543	569.843	572.88
11/01/2017	574.79	572.602	571.398	574.15
12/01/2017	576.348	572.635	570.981	573.42
01/01/2018	575.128	572.165	571.112	573.03
02/01/2018	574.938	572.185	571.26	572.80
03/01/2018	574.173	572.854	570.938	573.60
04/01/2018	576.841	573.294	570.331	574.30
05/01/2018	575.423	573.556	572.362	574.47
06/01/2018	574.751	573.579	572.677	574.44
07/01/2018	574.442	573.419	572.69	574.00
08/01/2018	574.701	573.202	572.28	574.12
09/01/2018	573.983	572.789	571.184	574.09
10/01/2018	575.207	572.802	571.552	574.11

Date	Lake Erie Highest	Lake Erie MSL (ft)	Lake Erie Lowest (ft)	Smokes Creek
11/01/2018	576.522	572.936	570.823	574.05
12/01/2018	576.424	572.854	571.522	574.73
01/01/2019	576.929	573.127	570.919	574.62
02/01/2019	577.329	572.923	571.079	573.86
03/01/2019	574.465	572.927	571.736	573.88
04/01/2019	575.226	573.278	571.319	574.41
05/01/2019	575.039	574.081	572.27	574.45
06/01/2019	575.689	574.508	573.885	574.43
07/01/2019	575.505	574.501	573.848	576.99
08/01/2019	575.64	574.127	573.205	575.42
09/01/2019	575.394	573.583	572.146	573.85
10/01/2019	578.802	573.271	571.837	576.70
11/01/2019	579.373	573.264	571.138	575.47
12/01/2019	576.345	573.182	571.585	575.15
01/01/2020	579.088	573.655	572.293	576.30
02/01/2020	576.43	573.927	572.769	575.79
03/01/2020	575.761	573.911	573.074	575.09
04/01/2020	578.333	574.308	573.074	575.08
05/01/2020	575.518	574.232	572.894	575.30
06/01/2020	576.427	574.386	573.563	575.00
07/01/2020	576.175	574.308	573.465	575.30
08/01/2020	576.201	573.911	573.025	574.39
09/01/2020	577.044	573.514	572.684	576.55
10/01/2020	575.61	573.228	571.978	574.45
11/01/2020	580.135	573.264	571.64	578.30
12/01/2020	576.693	573.241	571.591	574.95
01/01/2021	574.744	573.156	571.417	576.80
02/01/2021	578.53	572.74	570.115	573.85
03/01/2021	577.641	572.671	571.175	573.71
04/01/2021	574.738	572.874	571.88	574.90
05/01/2021	573.868	572.933	569.764	572.69
06/01/2021	574.193	573.133	572.53	574.25
07/01/2021	574.705	573.435	572.149	574.20
08/01/2021	575.23	573.409	572.657	574.25
09/01/2021	574.974	573.074	571.873	573.78
10/01/2021	574.921	572.933	571.24	573.25
11/01/2021	575.371	573.225	572.195	574.40
12/01/2021	579.797	572.963	571.181	574.19
01/01/2022	577.415	572.769	571.217	
AVERAGE	**575.0**	**572.4**	**571.0**	**573.5**

Smokes Creek Manual Peaks Only
SG-06
Average: 574.46

573.8
573.07
573.3
573.59
572.78
572.51
573.13
573.7
572.78
572.52
573.43
574
573.88
574.66
574.02
573.8
574.3
574.38
574.57
574.44
574.15
574.47
574.73
574.41
576.99
576.7
576.3
575.3
575.3
576.55
578.3
576.8
574.9
574.25
574.4

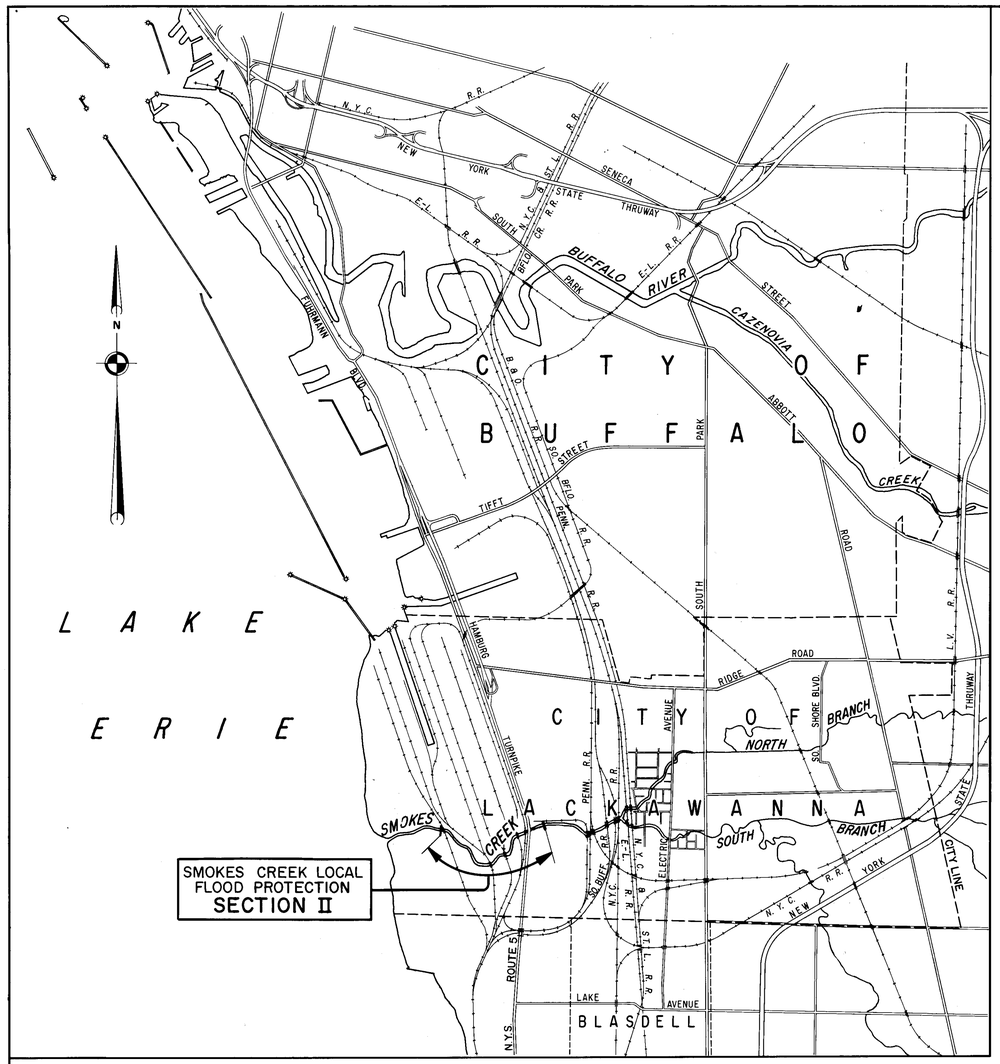
ATP Assessment Project)
Staff Gauge SG-02B

Monthly High Water Level	
May-23	573.27
June-23	574.04
July-23	574.52
August-23	575.14
September-23	575.37
Average (MHWL)	**574.47**

*Raw data available upon request

APPENDIX I

1965 USACE Plan and Profile Drawings



LOCATION MAP
SCALE OF MILES
1½ 0 1

INDEX

TITLE	DRAWING NO.	SHEET NO.
GENERAL DRAWINGS		
VICINITY MAP, LOCATION MAP AND INDEX	182-A-5/1	1
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LAKE LEVELS FOR LAKE ERIE	182-A-5/4	4
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PLAN AND PROFILE - STA. 30+20M TO STA. 40+50M	182-A-5/6	6
PLAN AND PROFILE - STA. 40+50M TO STA. 59+00M	182-A-5/7	7
PLAN AND PROFILE - STA. 59+00M TO STA. 76+50M	182-A-5/8	8
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BRIDGES 1, 2 AND 3 - PLAN AND SECTIONS	182-A-5/9	9
BRIDGES 1 AND 2 - UNDERPINNING AND CELLS	182-A-5/10	10
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BRIDGES 4 AND 5 - REINFORCEMENT	182-A-5/15	15
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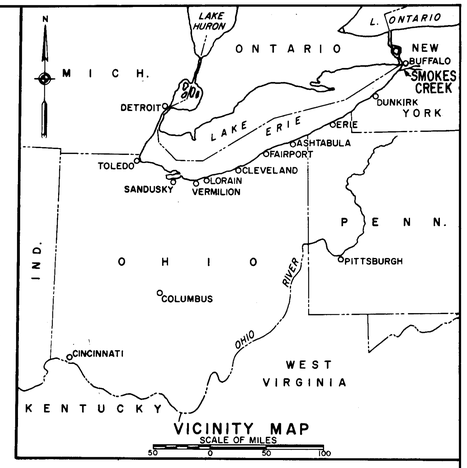
BRIDGE 13 - REINFORCEMENT	182-A-5/28	28
SPOIL AREAS		
SPOIL AREA II-C	182-A-5/29	29



DRAWINGS IN THIS FOLIO HAVE BEEN REDUCED TO ONE-HALF THE ORIGINAL SCALE

REVISION	DATE	DESCRIPTION	BY	BY

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO 7, NEW YORK

DRAWN BY: CTB
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph D. Wemmer, CHIEF, DESIGN BRANCH
APPROVED: Sidney M. Hemingway, CHIEF, ENGINEERING DIVISION

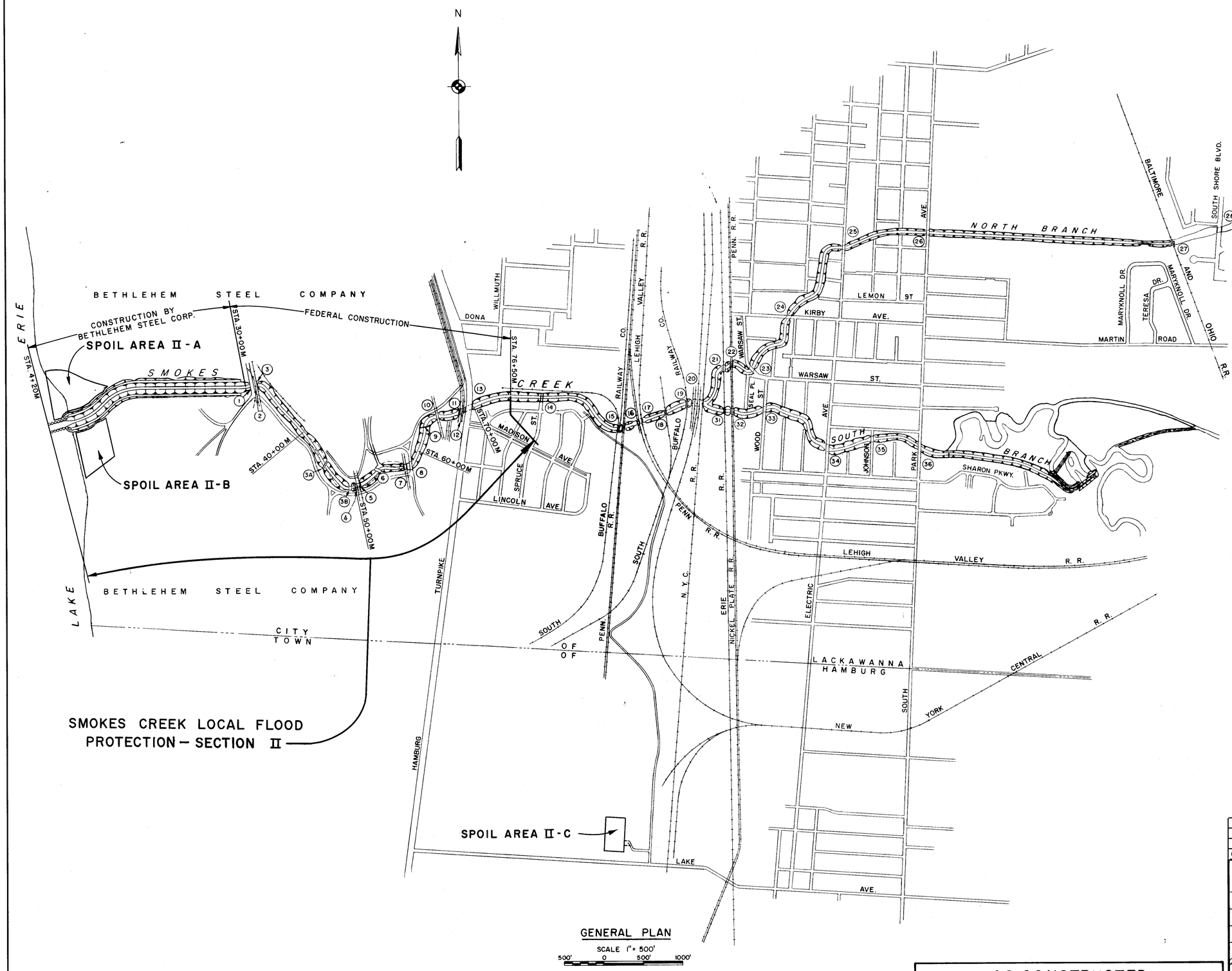
LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
VICINITY MAP, LOCATION MAP AND INDEX

APPROVED: R. Wilson Hoff, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED.
TO ACCOMPANY SPECIFICATIONS
SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER
182-A-5/1
SHEET 1 OF 29



GENERAL PLAN

SCALE 1" = 500'

500' 0 500' 1000'

GENERAL NOTES:

WORK DONE UNDER THIS CONTRACT IS DESIGNATED BY UPPER CASE LETTERING ON PLAN AND PROFILE, SHEETS 6 THRU 8.

THE TERMS "LEFT BANK" AND "RIGHT BANK" REFER TO THE LEFT AND RIGHT CHANNEL BANKS RESPECTIVELY AS VIEWED WHEN LOOKING DOWNSTREAM.

WELDING SYMBOLS USED ARE JOINT ARMY-NAVY STANDARD.

ELEVATIONS ARE IN FEET AND ARE REFERRED TO U.S.C.& G.S. DATUM. FOR REFERENCE BENCHMARKS, SEE SPECIFICATIONS.

EXCEPT FOR RIPRAP OUTLINES, LEFT BANK CONSTRUCTION IS NOT SHOWN ON PROFILES.

COORDINATES AND CURVE DATA FOR CHANNEL ℄ ARE SHOWN ON THE DRAWINGS. COORDINATES FOR SURVEY TRAVERSE POINTS ARE TABULATED IN THE SPECIFICATIONS.

WHERE TABULATIONS OF ADJUSTMENTS TO UTILITIES OR STRUCTURES BY LOCAL INTERESTS ARE SHOWN ON THE DRAWINGS, SUCH ADJUSTMENTS HAVE BEEN COMPLETED BEFORE THE START OF WORK UNDER THIS CONTRACT.

SPOIL LIMITS FOR SPOIL AREA II-C ARE SHOWN ON SHEET 29. FOR SPOIL LIMITS IN OTHER AREAS, SEE SPECIFICATIONS.

LOCATIONS OF BORINGS AS SHOWN ON THE DRAWINGS ARE APPROXIMATE, LOGS OF BORINGS ARE SHOWN ON SHEET 4.

THE FOLLOWING SYMBOLS HAVE BEEN USED ON THE DRAWINGS:

- INDICATES TRAVERSE POINT.
- INDICATES UTILITY POLE.
- (7) INDICATES BRIDGE NUMBER.
- INDICATES POINT OF INFLECTION FOR CHANNEL ℄.
- INDICATES LOCATION OF 1 1/2" I.D. SPLIT SPOON SAMPLER BORING.
- INDICATES LOCATION OF 1" I.D. PORTER SAMPLER BORING.
- INDICATES LOCATION OF 1 1/2" HAND AUGER BORING.
- INDICATES LOCATION OF 4" SHELBY TUBE SAMPLER BORING.
- 55-2 INDICATES PROFILE LOCATION OF SUBSURFACE EXPLORATION.
- INDICATES LOCATION OF PROBING.

AS CONSTRUCTED

SUBMITTED: CHIEF, OPERATIONS DIVISION

APPROVED: COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: CTB
DESIGNED BY:
CHECKED BY: KRH
SUBMITTED BY: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
GENERAL PLAN

APPROVED: COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

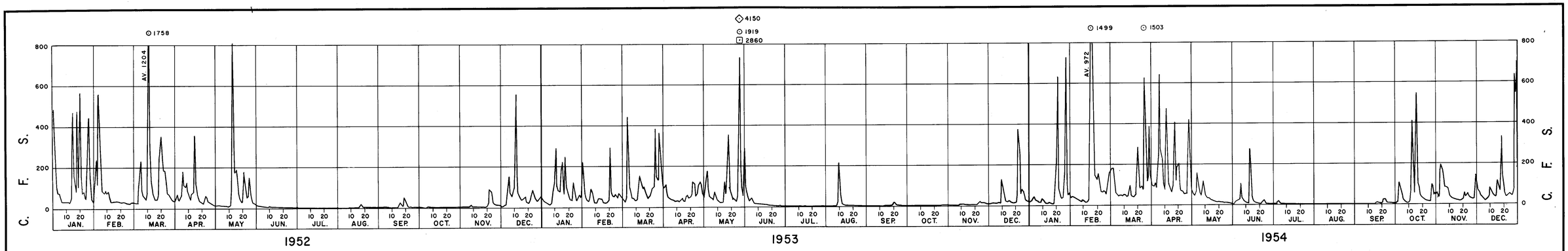
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

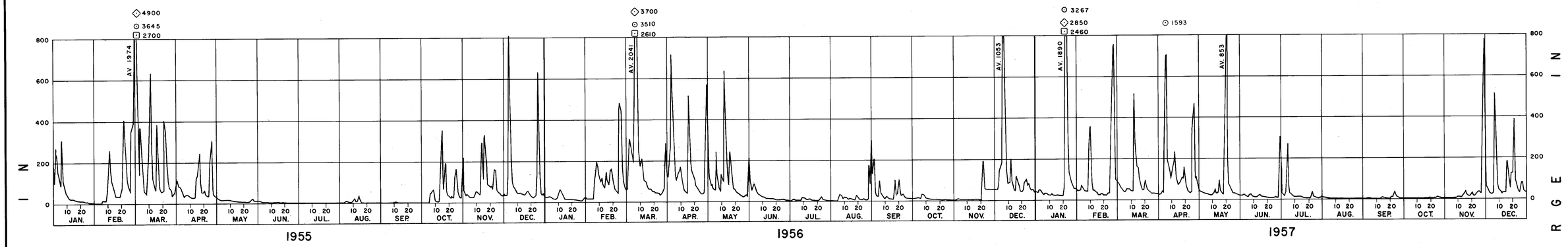
SCALE: AS SHOWN SPEC. NO.

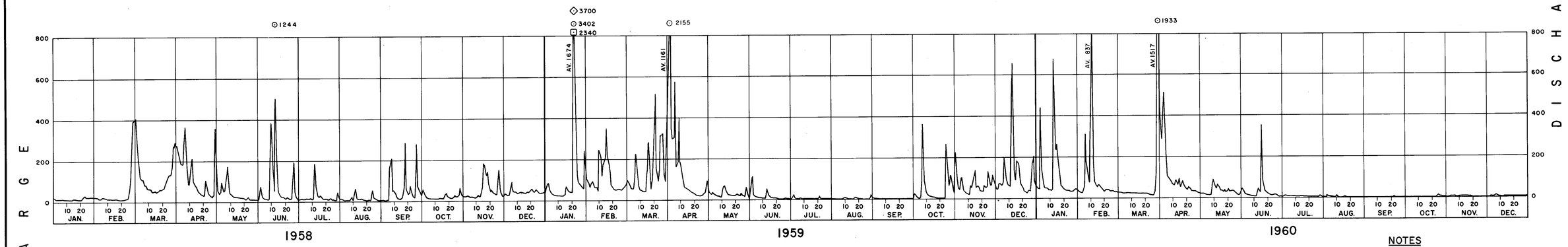
DRAWING NUMBER 182-A-5/2
SHEET 2 OF 29

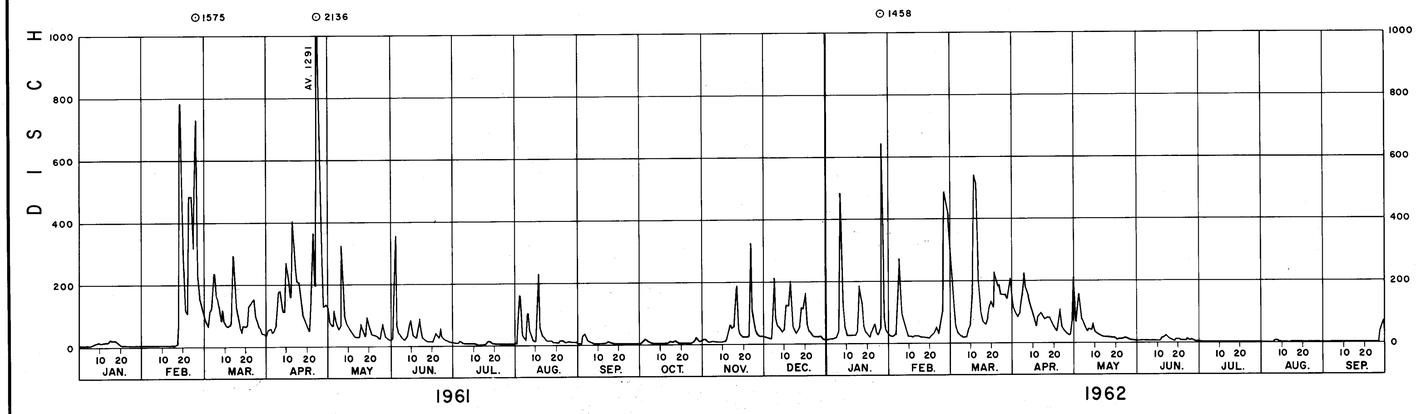
PLATE 3

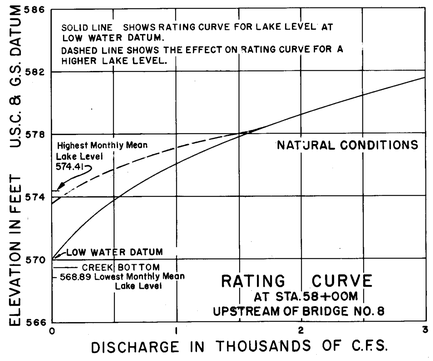
SEMCO BLUE PRINT CO. BUFFALO, N. Y.











NOTES

1. SINCE NO PERMANENT RECORDING GAGE IS LOCATED ON SMOKES CREEK, THESE HYDROGRAPHS ARE SYNTHETIC MEAN DAILY INFLOWS, DERIVED FROM THE RECORD OF THE U.S. GEOLOGICAL SURVEY RECORDING GAGE ON CAZENOVIA CREEK AT EBENEZER, NEW YORK. THE COMPUTATION OF THE SYNTHETIC VALUES HAS TAKEN INTO ACCOUNT THE REDUCTION OF DRAINAGE AREA AND DIFFERENCES IN WATERSHED CHARACTERISTICS OF THE TWO CREEKS.

2. INFLOW TO THE CONFLUENCE, LOCATED ON SHEET 2, EQUALS OUTFLOW FOR DISCHARGES UP TO ABOUT 1000 CFS ON EACH BRANCH. ABOVE THIS DISCHARGE, OUTFLOW IS LIMITED BY THE CAPACITIES OF BRIDGE OPENINGS AND STORAGE OF OVERBANK FLOODING.

3. THESE HYDROGRAPHS WERE DEVELOPED FROM INFLOWS TO THE MAIN STEM OF SMOKES CREEK FOR THE DRAINAGE AREA ABOVE BRIDGE NUMBER 8, STATION 58+00M.

4. ⊙ INDICATES A SYNTHETIC INSTANTANEOUS PEAK INFLOW DERIVED AS IN NOTE 1.

5. ◇ INDICATES A KNOWN INSTANTANEOUS PEAK INFLOW AT THE CONFLUENCE OF THE NORTH AND SOUTH BRANCHES OF SMOKES CREEK.

6. ⊡ INDICATES A KNOWN INSTANTANEOUS PEAK OUTFLOW AT THE CONFLUENCE OF THE NORTH AND SOUTH BRANCHES OF SMOKES CREEK.

7. APPROXIMATELY 200 CFS ARE DISCHARGED ALMOST CONTINUOUSLY INTO SMOKES CREEK BY VARIOUS BETHLEHEM STEEL COMPANY PLANT OUTFLOWS BETWEEN BRIDGE NUMBER 3, STATION 32+00M AND BRIDGE NUMBER 8, STATION 58+00M.

8. THE RATING CURVE HAS BEEN DEVELOPED FROM DATA OF THE CORPS OF ENGINEERS AND DERIVED BY STANDARD PROCEDURES.

9. ALL DATA SHOWN ON THIS SHEET ARE FOR THE CONTRACTOR'S GENERAL INFORMATION ONLY.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO 7, NEW YORK

DRAWN BY: R.L.J.
TRACED BY: T.P.L.
CHECKED BY: R.B.B.
SUBMITTED BY: David M. Lewis, CHIEF, HYDRAULICS BRANCH
APPROVED: Frank N. Wallace, CHIEF, ENGINEERING DIVISION
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION

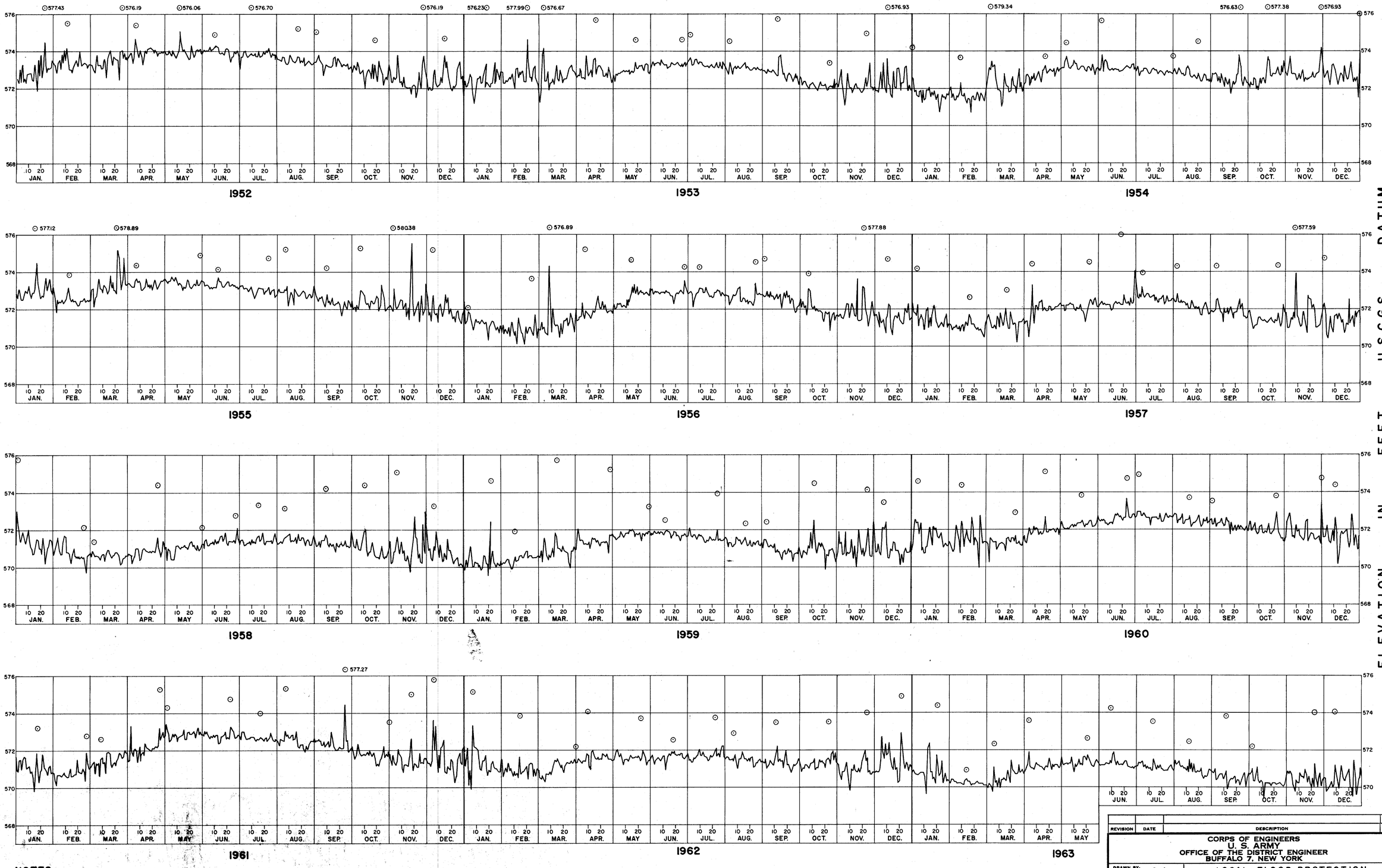
SMOKES CREEK AT LACKAWANNA, NEW YORK

SECTION II

HYDROGRAPHS AND RATING CURVES

APPROVED: W. Glenn Toffle, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER
182-A-5/3
SHEET 3 OF 29



NOTES:

1. THESE STAGE-HYDROGRAPHS ARE MEAN DAILY ELEVATIONS RECORDED AT THE U.S. LAKE SURVEY RECORDING GAGE ON LAKE ERIE AT THE HEAD OF THE NIAGARA RIVER AT BUFFALO, NEW YORK.
2. ⊙ - INDICATES RECORDED INSTANTANEOUS MONTHLY PEAK ELEVATIONS.
3. RECORDS AVAILABLE SINCE 1860.
4. THE ELEVATIONS OF LAKE ERIE AT BUFFALO ARE RECORDED ON I.G.L.D. DATUM OF 1955 FOR THE PERIOD AFTER 1961. PRIOR TO THIS, THEY WERE RECORDED ON THE U.S.L.S. DATUM. THE FOLLOWING EQUALITY EXISTS: I.G.L.D. DATUM + 1.85' = U.S.L.S. DATUM; U.S.L.S. DATUM -0.58 = U.S.C. AND G.S. DATUM.
5. ALL DATA SHOWN ON THIS SHEET ARE FOR CONTRACTOR'S GENERAL INFORMATION ONLY.

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS
U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
BUFFALO 7, NEW YORK

DRAWN BY: RJJ
TRACED BY: W.A.F.
CHECKED BY: A.S.S.
SUBMITTED BY: Arnold M. Sidwell, CHIEF, HYDRAULICS BRANCH
APPROVED: Joseph H. Hartman, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

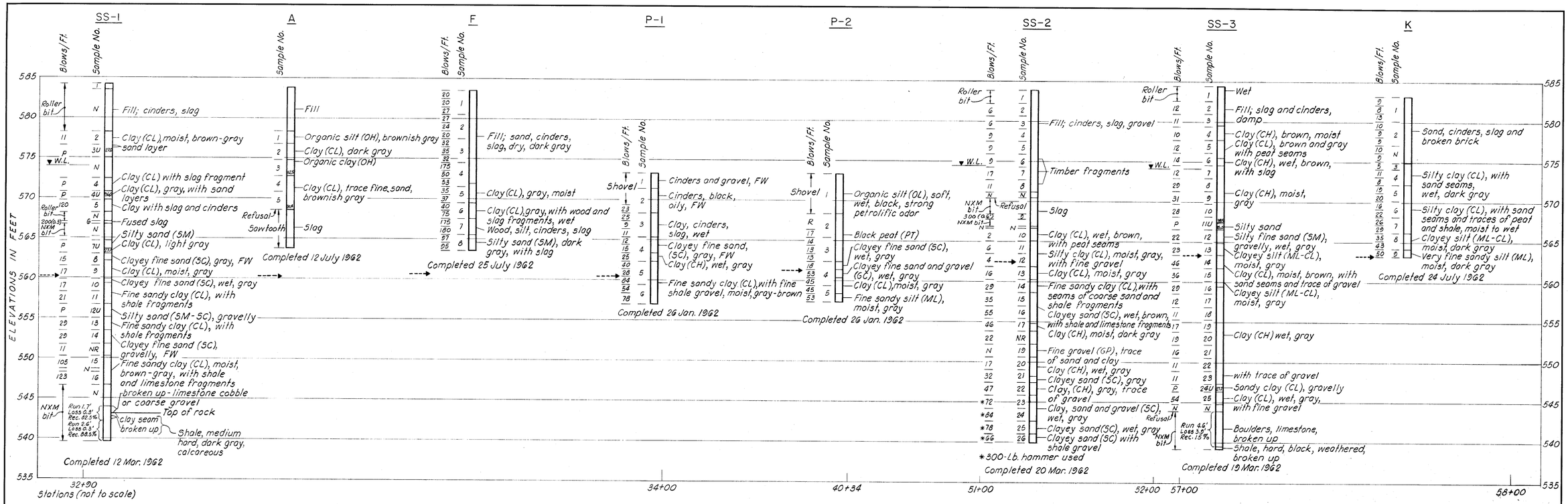
LAKE LEVELS FOR LAKE ERIE

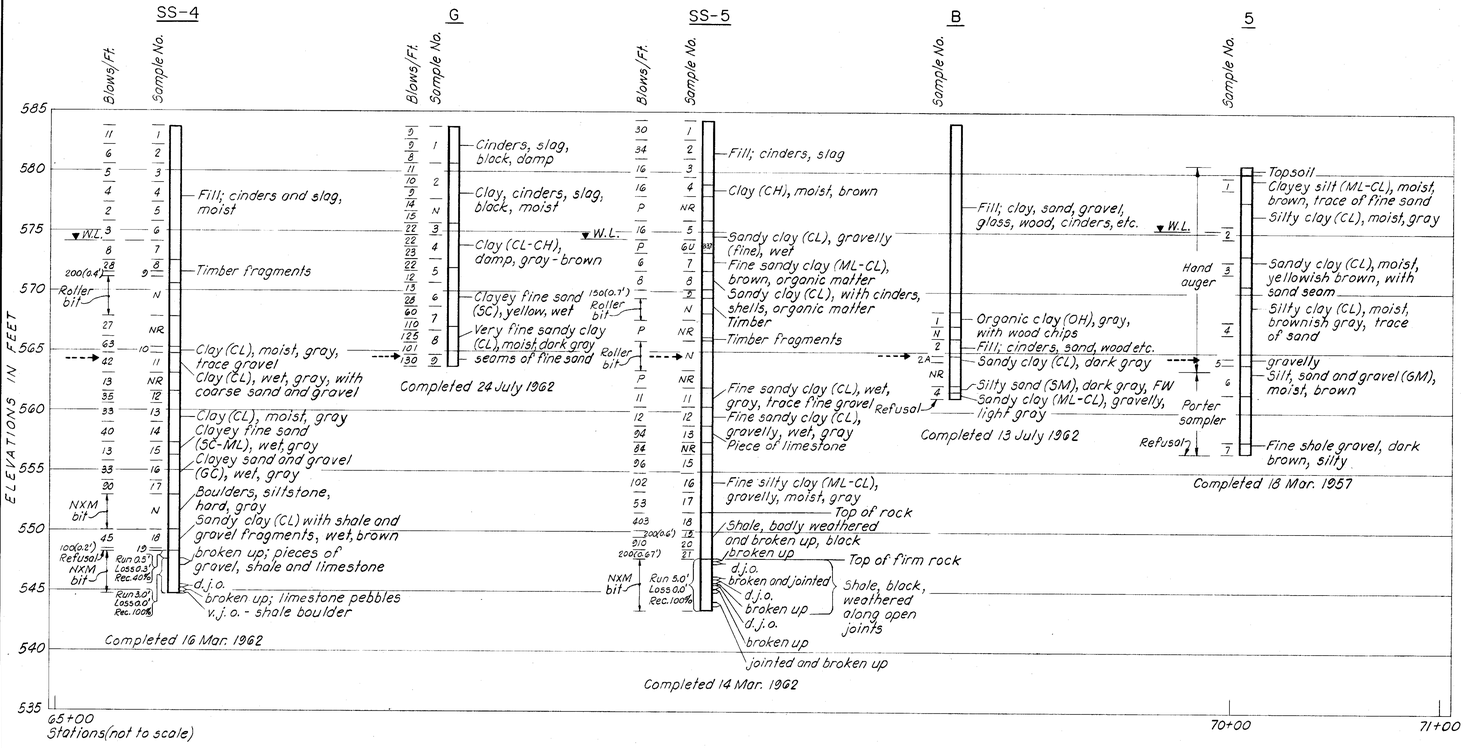
APPROVED: O. O'Brien Noyes, COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER
182-A-5/4
SHEET 4 OF 29





LEGEND - RELATIVE TO BORINGS

SC	CLAYEY SAND
SM	SILTY SAND
CL	LEAN CLAY, LOW TO MEDIUM PLASTICITY
CH	FAT CLAY, HIGH PLASTICITY
ML	SILT, LOW TO NO PLASTICITY
OL	ORGANIC SILT OR CLAY, LOW PLASTICITY
OH	ORGANIC SILT OR CLAY, HIGH PLASTICITY
GC	CLAYEY GRAVEL
GM	SILTY GRAVEL
GP	GRAVEL, POORLY GRADED
PT	PEAT
CL - CH	BORDERLINE BETWEEN LEAN AND FAT CLAY
ML - CL	BORDERLINE BETWEEN SILT AND CLAY
SC - ML	BORDERLINE BETWEEN CLAYEY SAND AND SILT
SM - SC	BORDERLINE BETWEEN CLAYEY AND SILTY SAND
FW	FREE WATER IN JAR SAMPLE
7U	UNDISTURBED SAMPLE
N	NO SAMPLE TAKEN
NR	NO RECOVERY
P	SAMPLER PUSHED HYDRAULICALLY
R	PUSHED BY HAND
d.j.o.	DIAGONAL JOINT, OPEN
v.j.o.	VERTICAL JOINT, OPEN
h.f.o.	HORIZONTAL FRACTURE, OPEN
23.5	MOISTURE CONTENT, PERCENT OF DRY WEIGHT
▼ W.L.	WATER LEVEL IN HOLE AT DATE OF BORING
----→	NEW THALWEG ELEVATION, APPROXIMATE

NOTES - RELATIVE TO BORINGS

LOCATIONS OF BORINGS ARE SHOWN ON SHEETS 6 THRU 8.

OVERBURDEN SAMPLES FROM HOLES SS-1 THRU SS-5, WERE OBTAINED WITH A 1 1/2 INCH I.D. STANDARD SPLIT SPOON SAMPLER, ADVANCED BY A 140 LB. HAMMER FALLING 30 INCHES, EXCEPT WHERE OTHERWISE NOTED.

ROCK CORES FROM HOLES SS-1, SS-3 THRU SS-5, WERE OBTAINED WITH A NXM DIAMOND BIT.

BORINGS P-1 AND P-2, F, G AND K WERE MADE WITH A 1 INCH I.D. PORTER SAMPLER ADVANCED BY A 15 LB. DROP WEIGHT MANUALLY OPERATED.

UNDISTURBED SAMPLES WERE OBTAINED FROM BORINGS A AND B, BY MEANS OF 4 INCH I.D. SHELBY TUBES PUSHED HYDRAULICALLY.

BORING 5 WAS MADE WITH A 1 1/2 INCH HAND AUGER, EXCEPT AS NOTED ON THE LOG.

MATERIAL DESCRIPTIONS ARE BASED ON VISUAL AND MANUAL EXAMINATION OF THE SAMPLES, EXCEPT WHERE LABORATORY TESTS WERE PERFORMED ON UNDISTURBED SOIL SAMPLES.

BLOW COUNTS SHOWN ON THE LOGS INDICATE THE RESISTANCE OF THE SOIL TO PENETRATION BY THE SAMPLER.

THE SHALE IN GENERAL, EXCEPT WHERE NOTED, IS BLACK, MEDIUM HARD, DENSE, CARBONACEOUS, CALCAREOUS, UNWEATHERED TO SLIGHTLY WEATHERED AND JOINTED.

IN HOLE SS-4, DUE TO THE PRESENCE OF ROUNDED LIMESTONE PEBBLES AND INVERTED BEDDING PLANES AT THE BOTTOM OF THE CORE, DOUBT EXISTS WHETHER DRILLING EXTENDED TO BED ROCK.

THE MEANINGS OF THE SOIL GROUP SYMBOLS SHOWN IN THE LEGEND ARE GIVEN IN MORE DETAIL IN THE CORPS OF ENGINEERS TECHNICAL MEMORANDUM NO. 3-357 "THE UNIFIED SOIL CLASSIFICATION SYSTEM", TABLES I AND 2, VOL. 1, MARCH 1953.

SOIL SAMPLES IN JARS AND ROCK CORES IN BOXES ARE AVAILABLE FOR INSPECTION AT THE OFFICE OF THE DISTRICT ENGINEER, BUFFALO, NEW YORK.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY: AK
CHECKED BY: JW
SUBMITTED BY: Joseph D. Weinmann, CHIEF, DESIGN BRANCH
APPROVED: Daniel H. Hoffman, CHIEF, ENGINEERING DIVISION
APPROVED: R. Nelson Neff, COL., C.E. DISTRICT ENGINEER — DATE: 4 JAN. 1965
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27 — DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
LOGS OF BORINGS

SCALE: AS SHOWN | SPEC. NO.
DRAWING NUMBER 182-A-5/5
SHEET 5 OF 29

SENECA BLUE PRINT CO. BUFFALO, N. Y.

UTILITY LINES AND STRUCTURES REQUIRING ADJUSTMENT				
DESCRIPTION	LOCATION STATION	BANK	ADJUSTMENT REQUIRED	ADJUSTING AGENCY
15" C.I. drain	28+14M	Rt.	Extend to new channel	Local interest
Gas storage facility	32+40M	Lt.	Relocation	Local interest
Parking area fence	29+96M 30+64M	Rt.	Relocation	Local interest
Power line	32+20M	Rt.	Temp. Reloc.	Local interest
Signal cable	32+10M	Rt.	Relocation	Local interest

FOR DETAIL AT BRIDGES 1, 2 AND 3, SEE SHEET 9

N

PLAN

SCALE: 1" = 50'

COORDINATES		
P.I. NO.	NORTH	EAST
4M	3653.00	109.00
5M	3716.00	368.00

CHANNEL CURVE DATA					
CURVE NO.	Δ	RADIUS	P.C. STATION	P.T. STATION	TANGENT
4M	7°37'17"	1000.00'	28+97.25M	30+30.26M	66.60'
5M	55°24'26"	80.00'	31+88.20M	32+65.56M	42.01'

PROFILE

SCALE: 1" = 5'

DETAIL OF THICKENED SECTION AT ALL UPSTREAM AND DOWNSTREAM RIPRAP LIMITS

SCALE: 1" = 5'

DETAIL OF TOE FOR RIPRAP PLACED ON BANK ONLY

SCALE: 1" = 5'

CHANNEL CROSS SECTION

SCALE: 1" = 20'

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR OTHER RIPRAP DETAILS, SEE SHEET 7.

AS CONSTRUCTED

SUBMITTED: CHIEF, OPERATIONS DIVISION

APPROVED: COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL., C. E. DISTRICT ENGINEER

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
PLAN AND PROFILE
STA. 30+20M TO STA. 40+50M

DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27

DATE:

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/6

SHEET 6 OF 29

PLATE 4

SENECA BLUE PRINT CO. BUFFALO, N. Y.

UTILITY LINES AND STRUCTURES REQUIRING ADJUSTMENT				
DESCRIPTION	LOCATION STATION	LOCATION BANK	ADJUSTMENT REQUIRED	ADJUSTING AGENCY
2" steel drain	41+20M	Rt.	Extended to channel	This contract
6"C.I. drain	45+20M	Rt.	Cut pipe off at intersection with slope	" "
Oil storage tank	51+30M	Lt.	Removed	Local interest
Power pole	51+70M	Lt.	Protection	" "
12"C.I. drain	52+90M	Lt.	Cut pipe off at intersection with slope	This contract
Power pole	53+15M	Rt.	Protection	Local interest
16"V.T. outfall	56+23M	Lt.	Cut pipe off at intersection with slope	This contract
48"C.I. drain	57+70M	Lt.	See sheet 18	" "
48"R.C. drain	45+75M	Rt.	Cut pipe off at intersection with slope	" "

COORDINATES		
P.I. NO.	NORTH	EAST
6M	3096.00	1063.00
7M	2643.00	1443.00
8M	2516.00	1703.00
9M	2816.00	1950.00
10M	2934.00	2378.00

CHANNEL CURVE DATA					
CURVE NO.	Δ	RADIUS	P.C. STATION	P.T. STATION	TANGENT
6M	8°16'-21"	2000.00'	40+10.28M	42+39.04M	144.63'
7M	23°58'-29"	420.00'	46+56.51M	48+32.25M	89.18'
8M	76°34'-04"	250.00'	48+35.11M	51+69.20M	197.32'
9M	35°-07'-14"	200.00'	52+97.19M	54+19.78M	63.29'
10M	57°45'-42"	150.00'	57+17.72M	58+68.94M	82.74'

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR ADDITIONAL RIPRAP DETAILS, SEE SHEET 6.

PLAN

SCALE: 1" = 50'

PROFILE

SECTION A-A

SCALE: 1" = 10'

DETAIL OF RIPRAP PLACED ON BOTH BANKS AND CHANNEL BOTTOM

SCALE 1" = 20'

AS CONSTRUCTED

SUBMITTED: CHIEF, OPERATIONS DIVISION

APPROVED: COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
2	10/21/65	Revised channel between bridges 5 and 6	RW
1	5/17/65	Added riprap left bank between bridges 7 and 8.	RW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY: A.H.P.
CHECKED BY: KRH
SUBMITTED BY: Joseph D. Wermuth, CHIEF, DESIGN BRANCH
APPROVED: Chief, Engineering Division

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
PLAN AND PROFILE
STA. 40+50M TO STA. 59+00M

APPROVED: COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

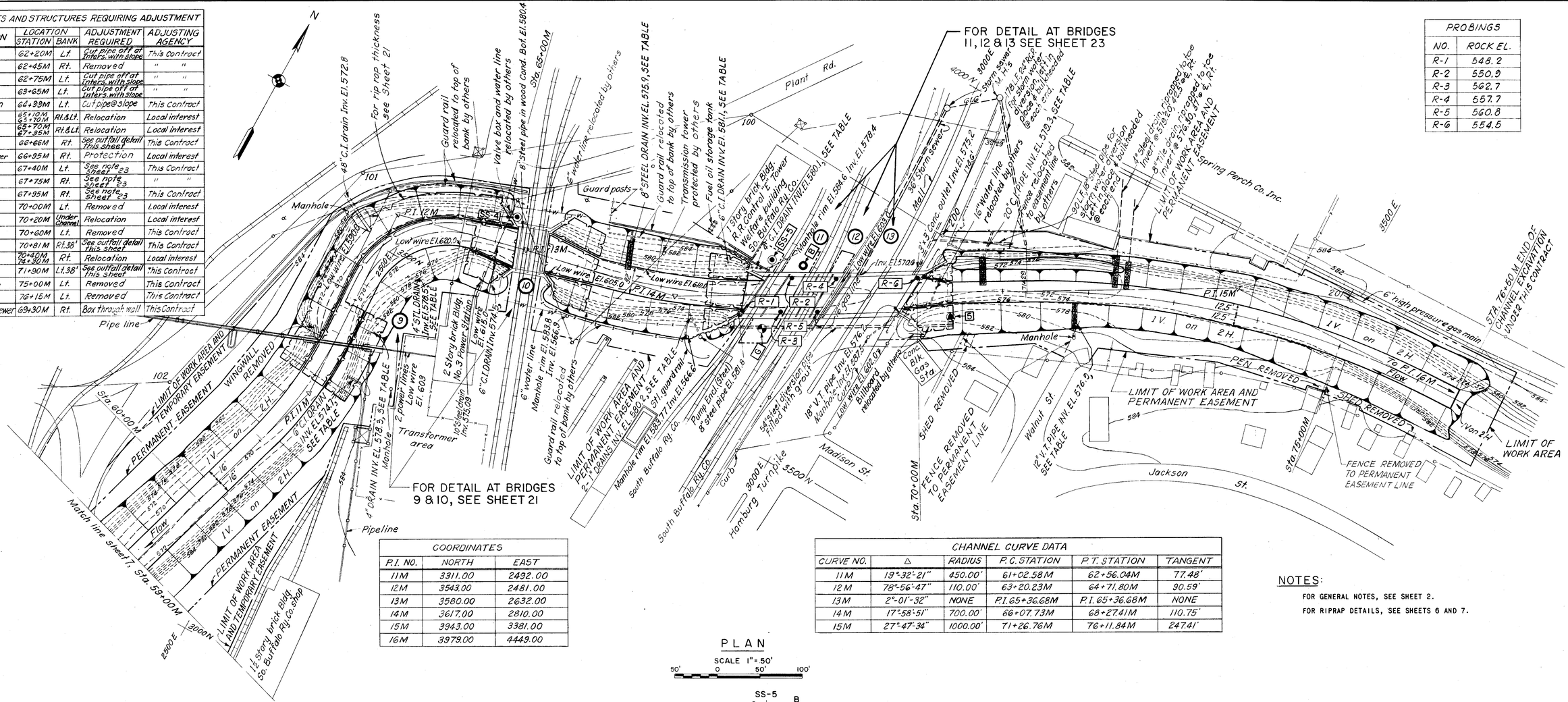
DRAWING NUMBER
182-A-5/7
SHEET 7 OF 29

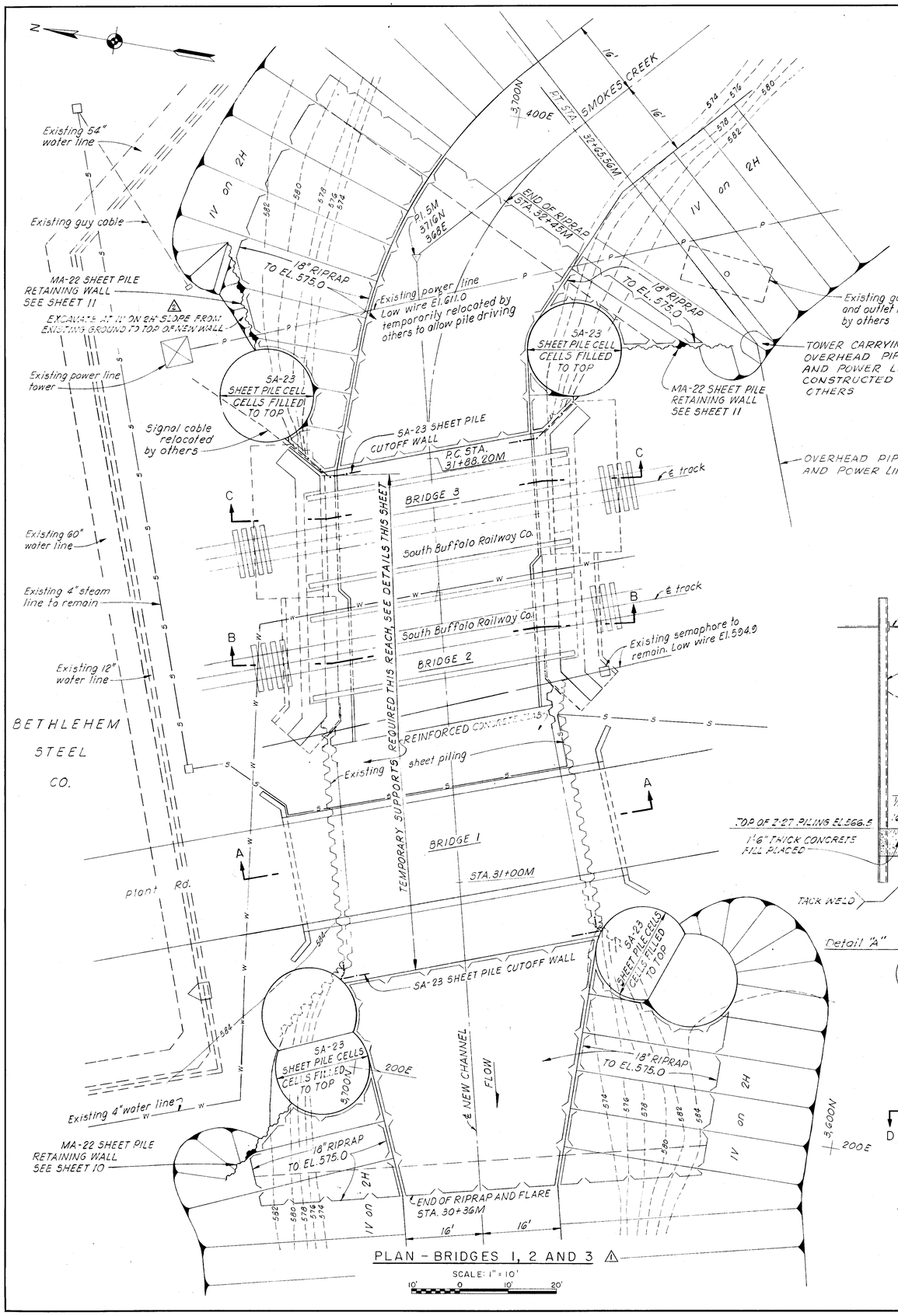
PLATE 5

SENECA BLUE PRINT CO. BUFFALO, N. Y.

UTILITY LINES AND STRUCTURES REQUIRING ADJUSTMENT				
DESCRIPTION	LOCATION STATION	BANK	ADJUSTMENT REQUIRED	ADJUSTING AGENCY
6"C.I. drain	62+20M	Lt.	Cut pipe off at Inlets. with slope	This Contract
Wingwall	62+45M	Rt.	Removed	" "
4" drain	62+75M	Lt.	Cut pipe off at Inlets. with slope	" "
4"steel drain	63+65M	Lt.	Cut pipe off at Inlets. with slope	" "
10"steel drain	64+99M	Lt.	Cut pipe@slope	This Contract
Valve box and 6"water line	65+10M, 65+10M	Rt.&Lt.	Relocation	Local interest
Guard rail	65+70M 67+35M	Rt.&Lt.	Relocation	Local interest
8" steel drain	66+66M	Rt.	See outfall detail This sheet	This Contract
Transmission tower	66+95M	Rt.	Protection	Local interest
2-1"steel drains	67+40M	Lt.	See note sheet e3	This Contract
6" C.I. drain	67+75M	Rt.	See note sheet e3	" "
4" C.I. drain	67+95M	Rt.	See note Sheet e3	This Contract
Billboard	70+00M	Lt.	Removed	Local interest
16"water line	70+20M	Under Channel	Relocation	Local interest
Shed	70+60M	Lt.	Removed	This Contract
20" C.I. pipe	70+81M	Rt.38'	See outfall detail this sheet	This Contract
Fence	70+40M, 74+30M	Rt.	Relocation	Local interest
12"V.T. pipe	71+90M	Lt.38'	See outfall detail this sheet	This Contract
Fence and pen	75+00M	Lt.	Removed	This Contract
Shed	76+15M	Lt.	Removed	This Contract
36"R.C.P. Storm sewer	69+30M	Rt.	Box through wall	This Contract

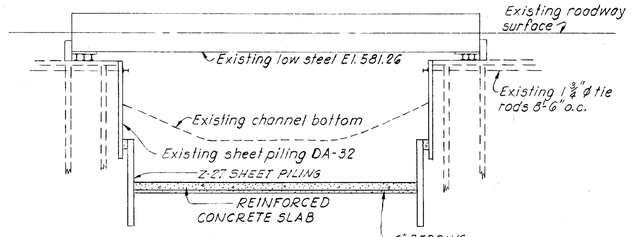
PROBINGS	
NO.	ROCK EL.
R-1	548.2
R-2	550.9
R-3	562.7
R-4	557.7
R-5	560.8
R-6	554.5


N
FOR DETAIL AT BRIDGES 11, 12 & 13 SEE SHEET 23
FOR DETAIL AT BRIDGES 9 & 10, SEE SHEET 21
48"C.I. drain Inv. El. 572.8
For rip rap thickness see Sheet 21
Guard rail relocated to top of bank by others
Valve box and water line relocated by others
8"steel pipe in wood cond. Bot. El. 580.4
Sta. 65+00M
6" water line relocated by others
8"STEEL DRAIN INV. EL. 575.9, SEE TABLE
Guard rail relocated to top of bank by others
Transmission tower protected by others
Fuel oil storage tank
6"C.I. DRAIN INV. EL. 581.1, SEE TABLE
Plant Rd.
1 story brick Bldg. R.R. Control Tower Meltare Building So. Buffalo Ry. Co.
6"C.I. DRAIN INV. EL. 580.1, SEE TABLE
Manhole rim El. 584.6 Inv. El. 578.4
Manhole
Guard posts
Pipe line
Low wire El. 620.0
Low wire El. 605.0
Low wire El. 610.0
P.I. 12M
P.I. 13M
P.I. 14M
P.I. 11M
4"STL. DRAIN Inv. El. 578.5 SEE TABLE
2 Power lines Low wire El. 623
2 Story brick Bldg. No. 3 Power Station
Low wire El. 615.0
6"C.I. DRAIN Inv. 574.5
12"steel drain Inv. 576.09
Transformer area
4"DRAIN INV. EL. 578.3, SEE TABLE
Manhole
Pipeline
Guard rail relocated to top of bank by others
Manhole rim El. 585.8 Inv. El. 566.9
LIMIT OF WORK AREA AND PERMANENT EASEMENT
2"DRAINS INV. EL. 580.2, SEE TABLE
Manhole rim El. 588.77 Inv. El. 566.6
Stl. guard rail
South Buffalo Ry. Co.
Pump End (Steel) 8"steel pipe El. 581.8
54"steel diversion pipe filled with grout
18"V.T. pipe Inv. El. 576.1
Manhole Conc. Curve 2-585.5
Low wire El. 602.0
Billboard relocated by others
Conc. Blk. Gas Sta.
Curb
Hamburg Turnpike
Madison St.
Sta. 70+00M
SHED REMOVED
FENCE REMOVED TO PERMANENT EASEMENT LINE
Walnut St.
12"V.T. PIPE INV. EL. 576.0, SEE TABLE
Jackson St.
Sta. 75+00M
FENCE REMOVED TO PERMANENT EASEMENT LINE
Sta. 59+72M Grade El. 563.49
Match line sheet 7, Sta. 59+00M
2500 E
3000 N
1½ story brick Bldg. So. Buffalo Ry. Co. Shop
LIMIT OF WORK AREA AND TEMPORARY EASEMENT
LIMIT OF WORK AREA AND PERMANENT EASEMENT
WINGWALL REMOVED
Sta 60+00M
6"C.I. DRAIN INV. EL. 574.3 SEE TABLE
1V. on 2H.
1V. on 1½
Flow
PERMANENT EASEMENT
Sta. 67+00M
3000 E
3500 N
4000 N
3000 E
3500 E
Storm sewer
78" Storm sewer
For storm water diversion place 1 gate in each end
Inv. El. 570.3, SEE TABLE
90°C.I. pipe for storm water diversion
Inv. El. 578.0
Inv. El. 575.2
16"water line relocated by others
20"C.I. PIPE INV. EL. 570.3
Fence relocated to easement line by others
90°C.I. pipe for storm water diversion
4"steel drain capped to be filled in place & bulkheaded
8"TILE DRAIN CAPPED TO BE REMOVED
L.W.I. OF WORK AREA AND PERMANENT EASEMENT
Spring Perch Co. Inc.
STA. 76+60 M. END OF CHANNEL EXCAVATION UNDER THIS CONTRACT
6"high pressure gas main
P.I. 15M
12.5
1V. on 2H.
PEN. REMOVED
SHED REMOVED
LIMIT OF WORK AREA
Flow
Manhole
Inv. El. 570.6
Low wire El. 602.0
Low wire El. 610.0
Low wire El. 605.0
Low wire El. 620.0
Low wire El. 623
Low wire El. 615.0



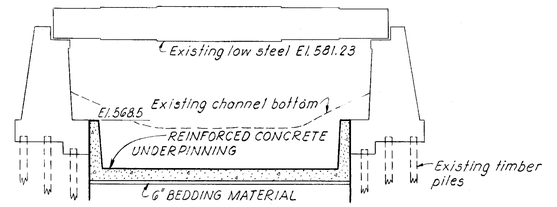
PLAN - BRIDGES 1, 2 AND 3 ⚠

SCALE: 1" = 10'



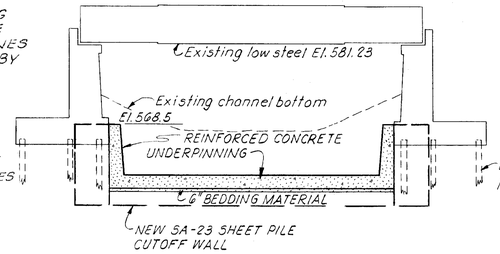
SECTION A-A ⚠

SCALE: 1" = 10'



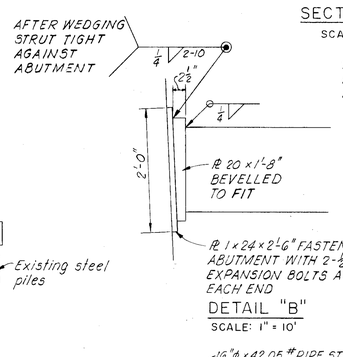
SECTION B-B

SCALE: 1" = 10'



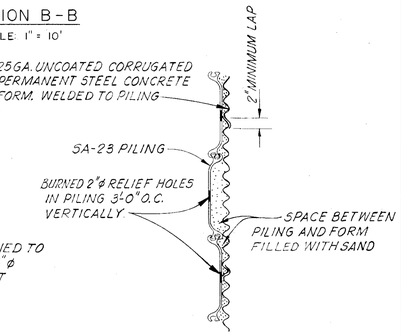
SECTION C-C

SCALE: 1" = 10'



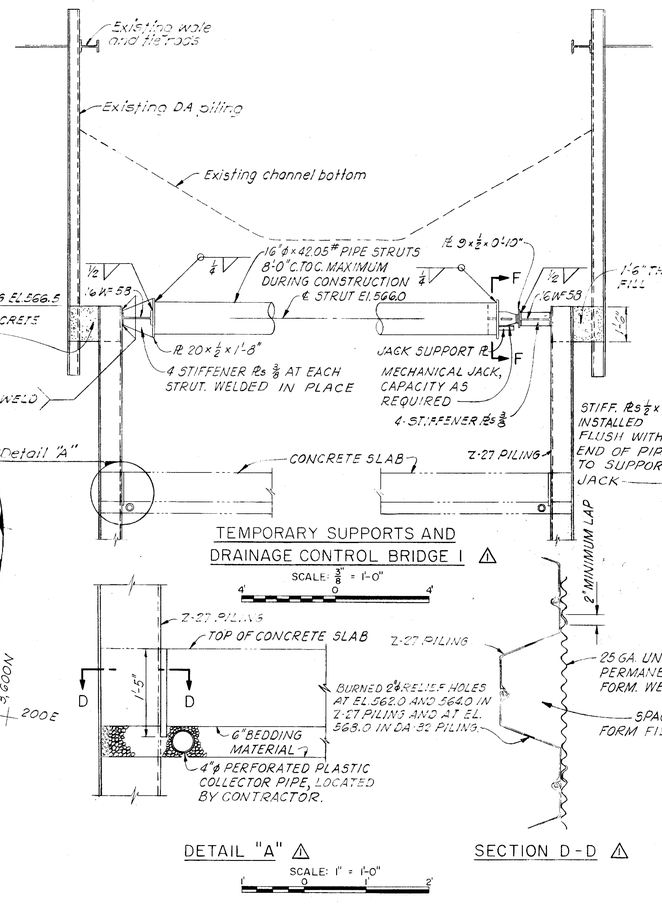
DETAIL "B"

SCALE: 1" = 10'



SECTION E-E

SCALE: 1" = 1'-0"

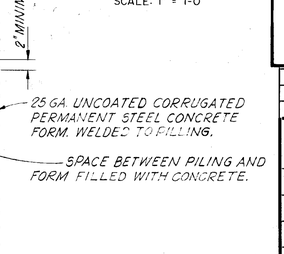


TEMPORARY SUPPORTS AND DRAINAGE CONTROL BRIDGE 1 ⚠

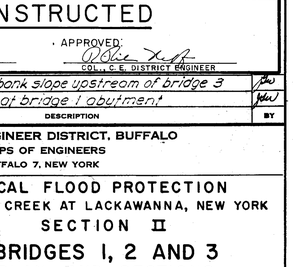
SCALE: 1" = 1'-0"

DETAIL "A" ⚠

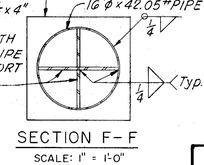
SCALE: 1" = 1'-0"



NOT TO SCALE



TEMPORARY SUPPORTS AND DRAINAGE CONTROL BRIDGES 2 AND 3



SECTION F-F

SCALE: 1" = 1'-0"

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR DETAILED REQUIREMENTS REGARDING TEMPORARY SUPPORTS AND DRAINAGE CONTROL, SEE SPECIFICATIONS.

FOR CONCRETE UNDERPINNING, CELLS AND PILING DETAILS, SEE SHEETS 10 AND 11.

FOR REINFORCEMENT, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: V. H. Hannigan, CHIEF OPERATIONS DIVISION

APPROVED: Col. C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	10/20/65	Revised right bank slope upstream of bridge 3	DW
⚠	7/7/65	Added piling at bridge 1 abutment	JWW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

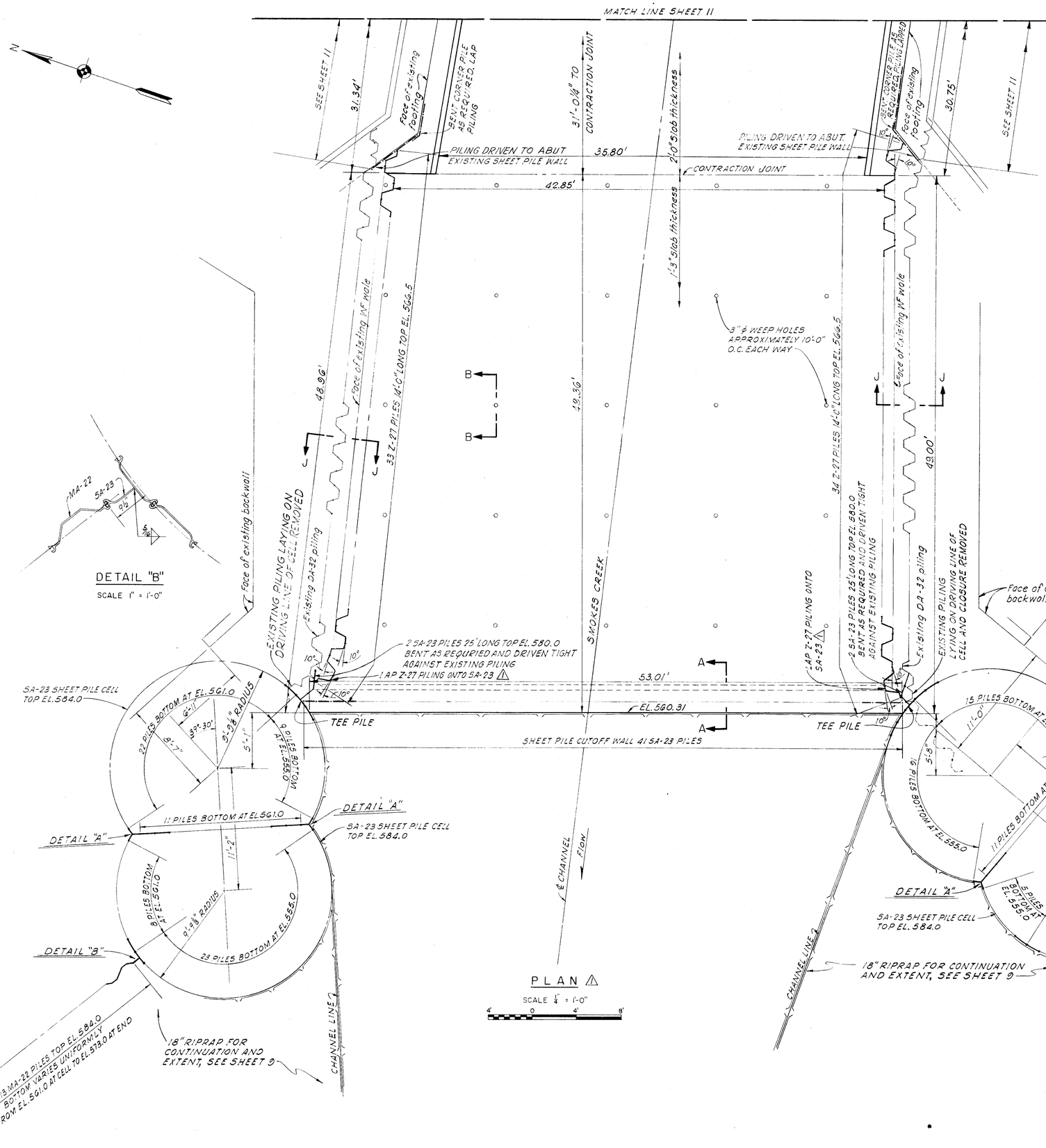
DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY: KPH
SUBMITTED BY: CHIEF DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 1, 2 AND 3
PLAN AND SECTIONS

APPROVED: Col. C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 182-A-5/9
SHEET 9 OF 29

PLATE 7

SENECA BLUE PRINT CO. BUFFALO, N. Y.



PLAN ⚠

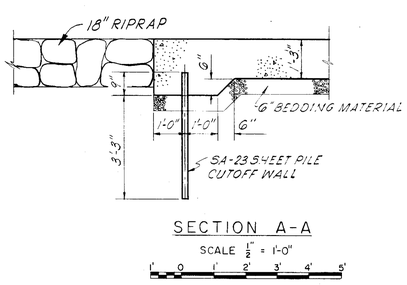
SCALE 1" = 1'-0"

DETAIL "B"

SCALE 1" = 1'-0"

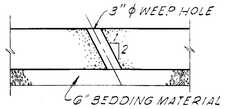
DETAIL "A"

SCALE 1" = 1'-0"



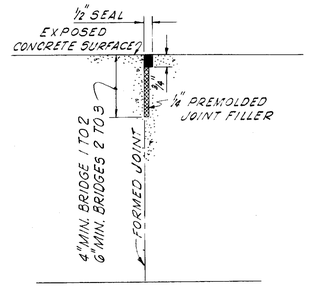
SECTION A-A

SCALE 1/2" = 1'-0"



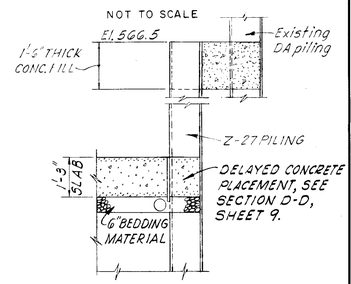
SECTION B-B

NOT TO SCALE



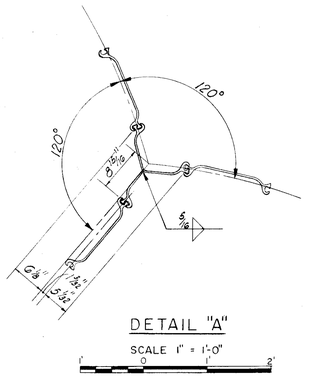
CONTRACTION JOINT DETAIL

NOT TO SCALE



SECTION J-J ⚠

SCALE: 1/2" = 1'-0"



DETAIL "A"

SCALE 1" = 1'-0"

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR REINFORCEMENT, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: U. H. Harrigan — CHIEF, OPERATIONS DIVISION

APPROVED: R. Blee Reft — COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	7/7/65	Added piling at bridge 1 abutments and revised Sect. J-J	JDW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY: KRH
SUBMITTED BY: Chief, Design Branch
APPROVED: Chief, Engineering Division

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 1 AND 2
UNDERPINNING AND CELLS

APPROVED: U. Wilson Reft, Col., C.E. District Engineer — DATE: 4 JAN. 1965

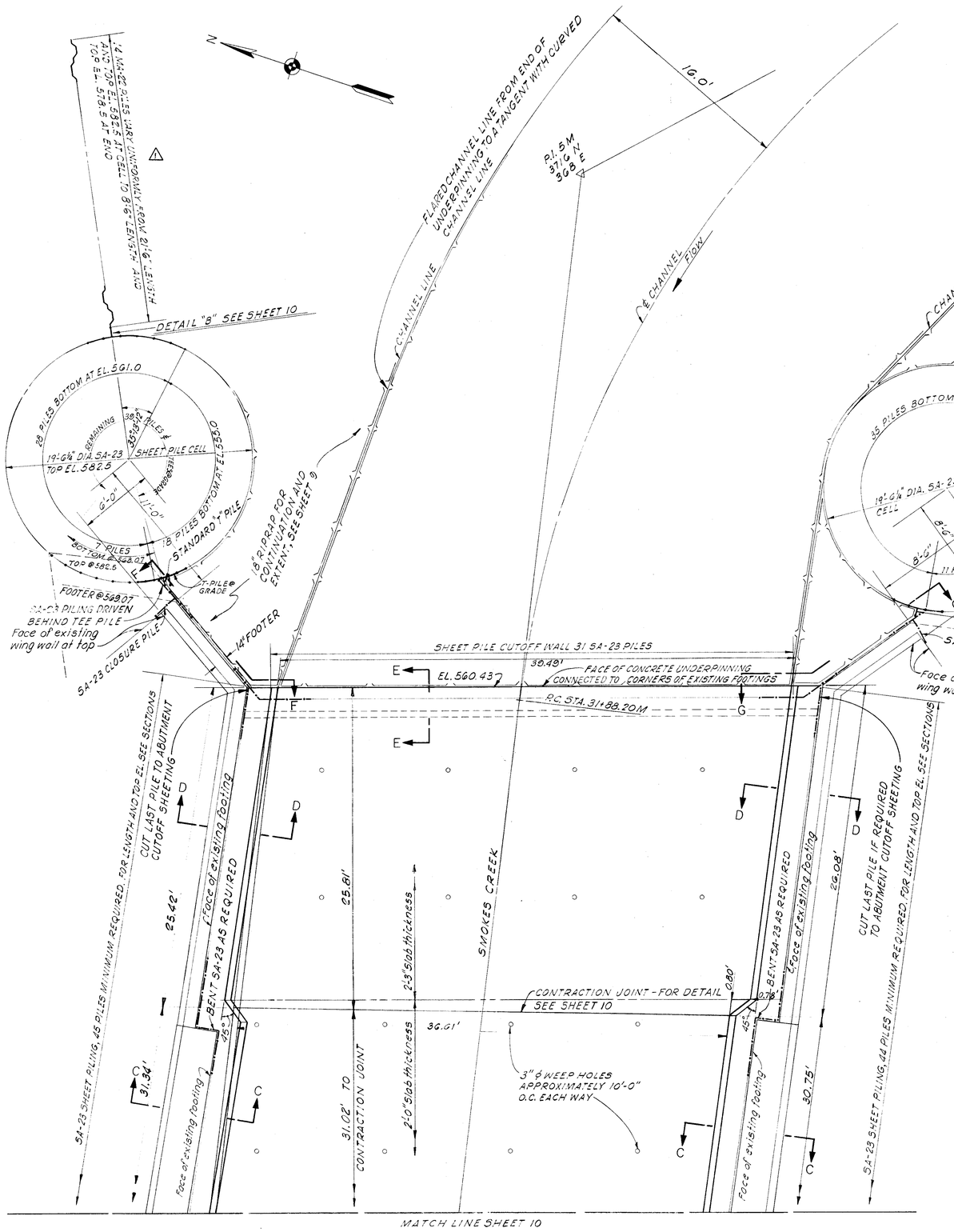
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/10
SHEET 10 OF 29

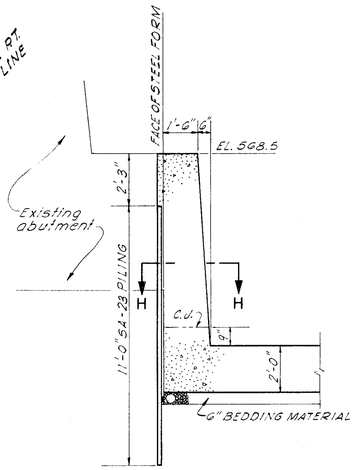
PLATE 8

SENECA BLUE PRINT CO. BUFFALO, N. Y.



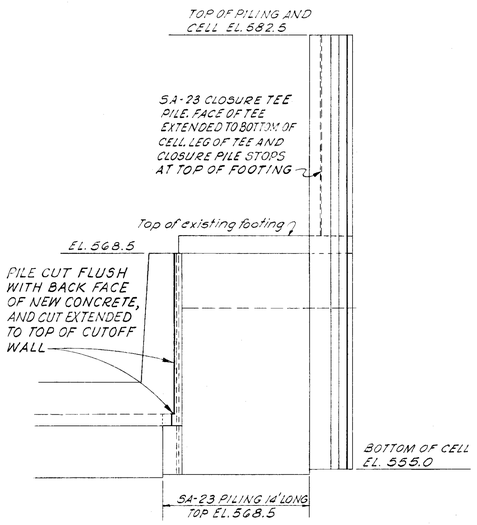
PLAN

SCALE 1/4" = 1'-0"



SECTION C-C

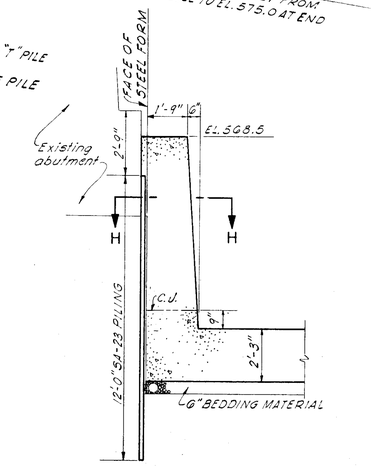
SCALE 3/8" = 1'-0"



SECTION F-F

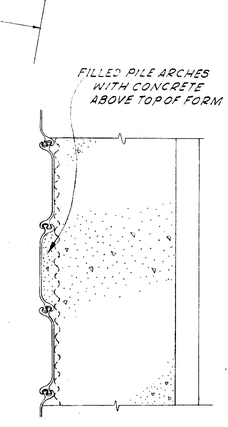
SECTION G-G OPPOSITE HAND AND SIMILAR

SCALE 1/4" = 1'-0"



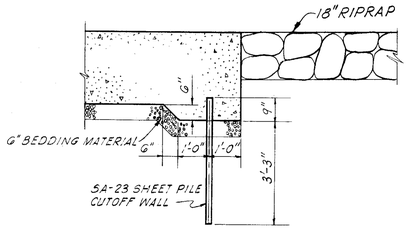
SECTION D-D

SCALE 3/8" = 1'-0"



SECTION H-H

SCALE 1" = 1'-0"



SECTION E-E

SCALE 1/2" = 1'-0"

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR REINFORCEMENT, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: C. H. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: Col. Dick Neff, COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
1	10/20/65	Revised pile wall upstream right bank	PW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY: RJD
CHECKED BY: KAH
SUBMITTED BY: Joseph P. Wemmuk, CHIEF, DESIGN BRANCH
APPROVED: Ralph M. Harding, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 2 AND 3
UNDERPINNING AND CELLS

APPROVED: Col. Dick Neff, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

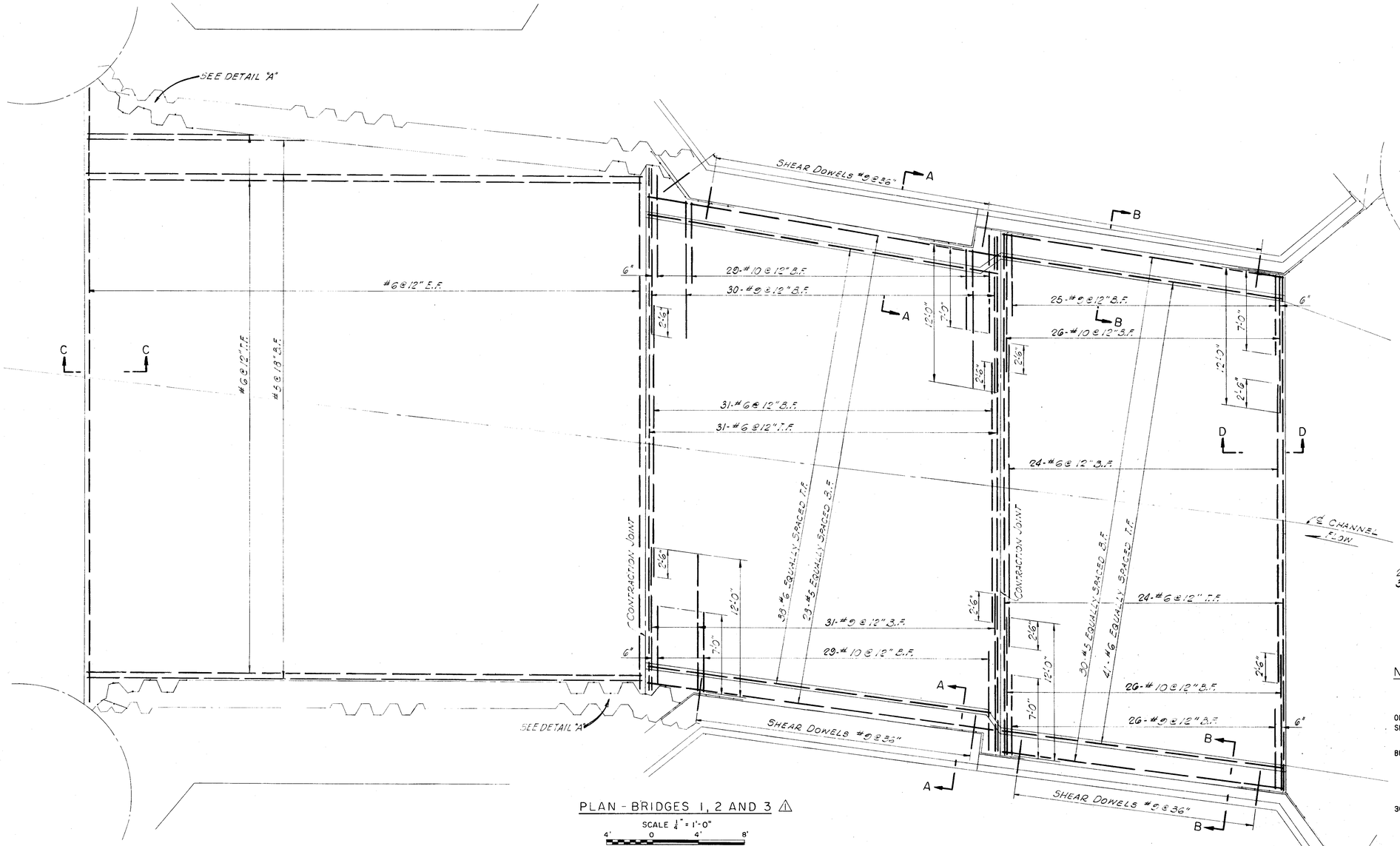
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/11
SHEET 11 OF 29

PLATE 9

SENECA BLUE PRINT CO. BUFFALO, N. Y.



PLAN - BRIDGES 1, 2 AND 3 ⚠

SCALE $\frac{1}{4}$" = 1'-0"

4' 0 4' 8'

2" Clear required on outer face
3" Clear required on inner face

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

WHERE A LAYER OF REINFORCEMENT IS CUT BY A SECTION ON THE DRAWING, ONLY THE CUT BARS AT THE ENDS OF THE SECTION AND THOSE AT BENDS HAVE BEEN SHOWN. INTERMEDIATE CUT BARS HAVE BEEN OMITTED FOR SIMPLICITY.

UNLESS OTHERWISE NOTED, ALL BENDS ARE BE IN ACCORDANCE WITH A.C.I. BUILDING CODE.

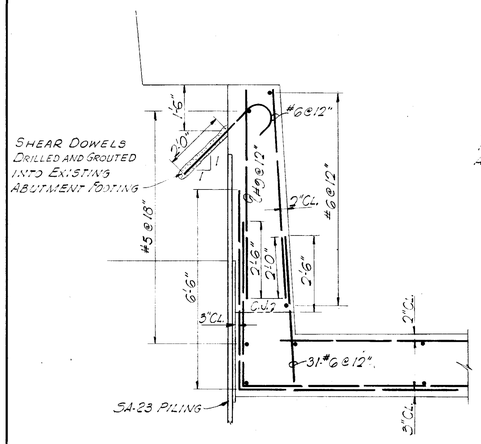
ALL DIMENSIONS ARE TO CENTER LINE OF BARS UNLESS OTHERWISE NOTED.

REINFORCEMENT NOT CONTINUOUS ACROSS CONTRACTION JOINTS.

ALL SPLICES LOCATED AS SHOWN ON THE DRAWINGS AND EQUAL 30 DIAMETERS OF THE SMALLER BAR UNLESS OTHERWISE NOTED.

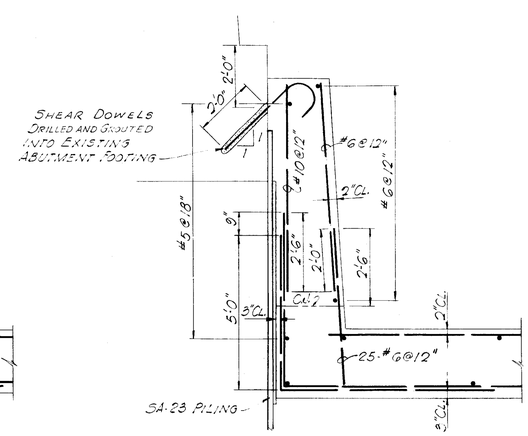
DESIGNATION OF SYMBOLS:

t.f. - TOP FACE
b.f. - BOTTOM FACE
c.j. - CONSTRUCTION JOINT
e.f. - EACH FACE



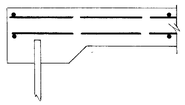
SECTION A-A

SCALE $\frac{1}{2}$" = 1'-0"



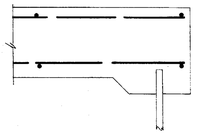
SECTION B-B

SCALE $\frac{1}{2}$" = 1'-0"



SECTION C-C

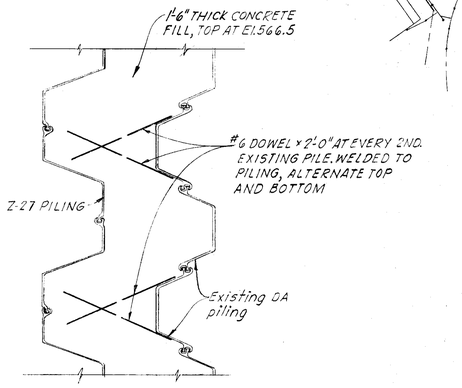
SCALE $\frac{1}{2}$" = 1'-0"



SECTION D-D

SCALE $\frac{1}{2}$" = 1'-0"

1' 0 1' 2' 3' 4' 5'



DETAIL "A" ⚠

SCALE 1" = 1'-0"

1' 0 1' 2'

AS CONSTRUCTED

SUBMITTED: J. H. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Blue Keff, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	7/7/65	Added piling at bridge abutments and detail "A"	gdw

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: LRL
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Chief, Design Branch
APPROVED: Chief, Engineering Division
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

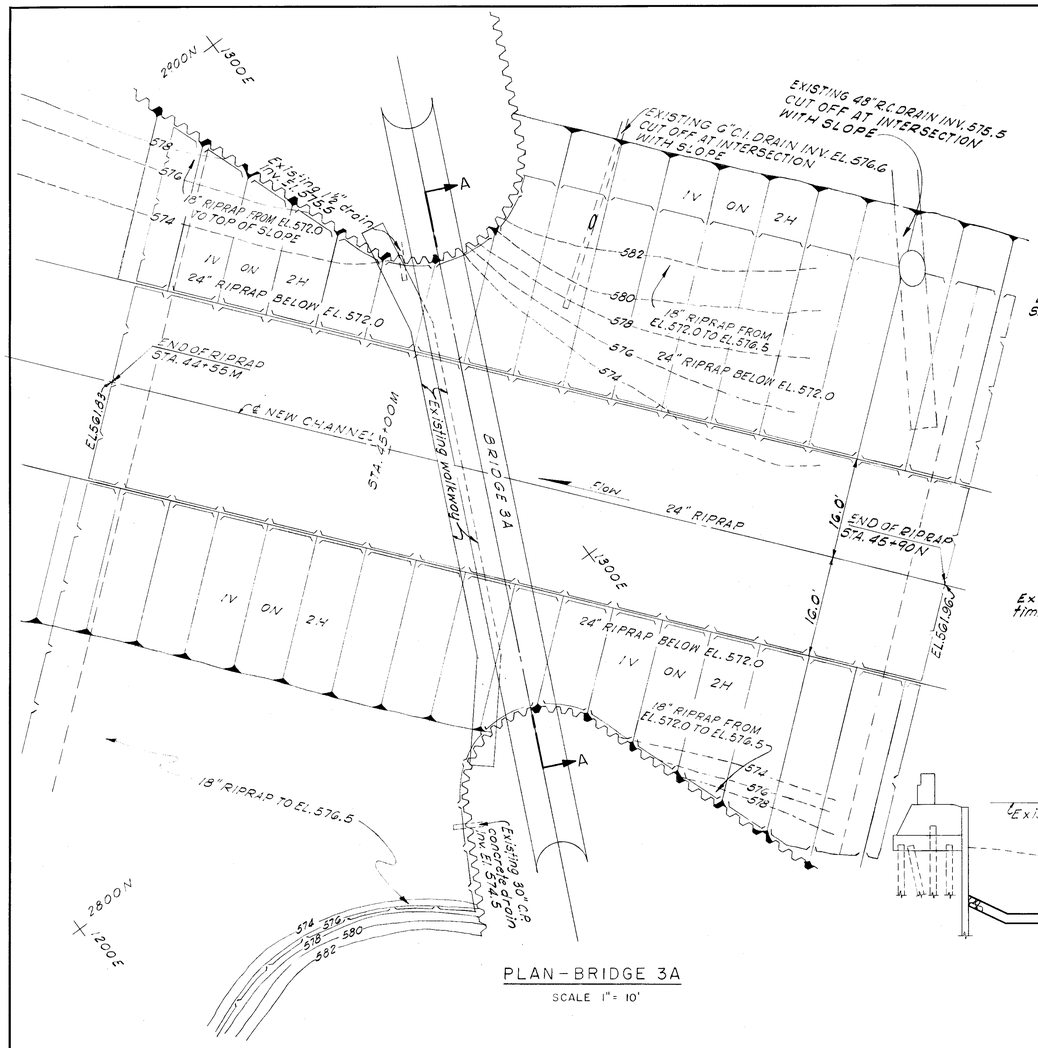
BRIDGES 1, 2 AND 3
REINFORCEMENT

APPROVED: R. Blue Keff, COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER
182-A-5/12
SHEET 12 OF 29

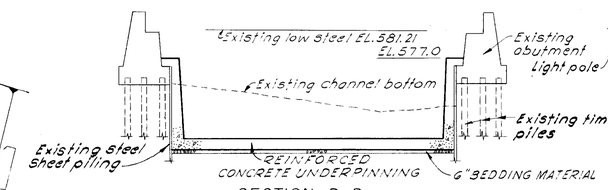
PLATE 10

SENECA BLUE PRINT CO. BUFFALO, N. Y.



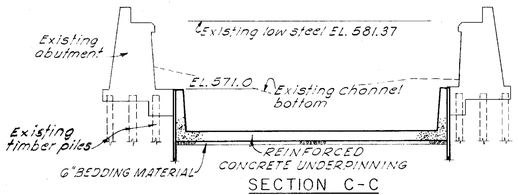
PLAN - BRIDGE 3A

SCALE 1" = 10'



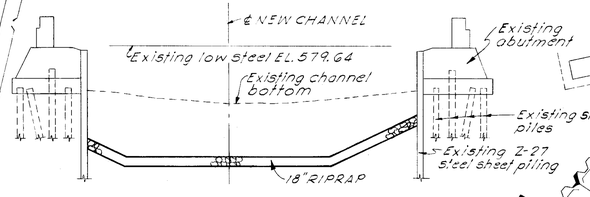
SECTION D-D

SCALE 1" = 10'



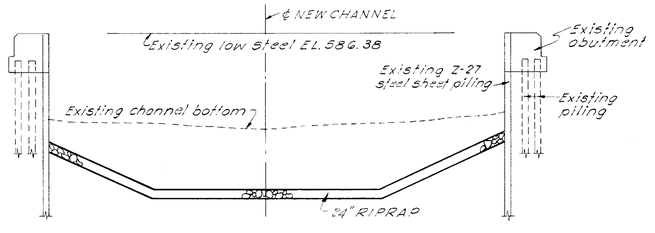
SECTION C-C

SCALE 1" = 10'



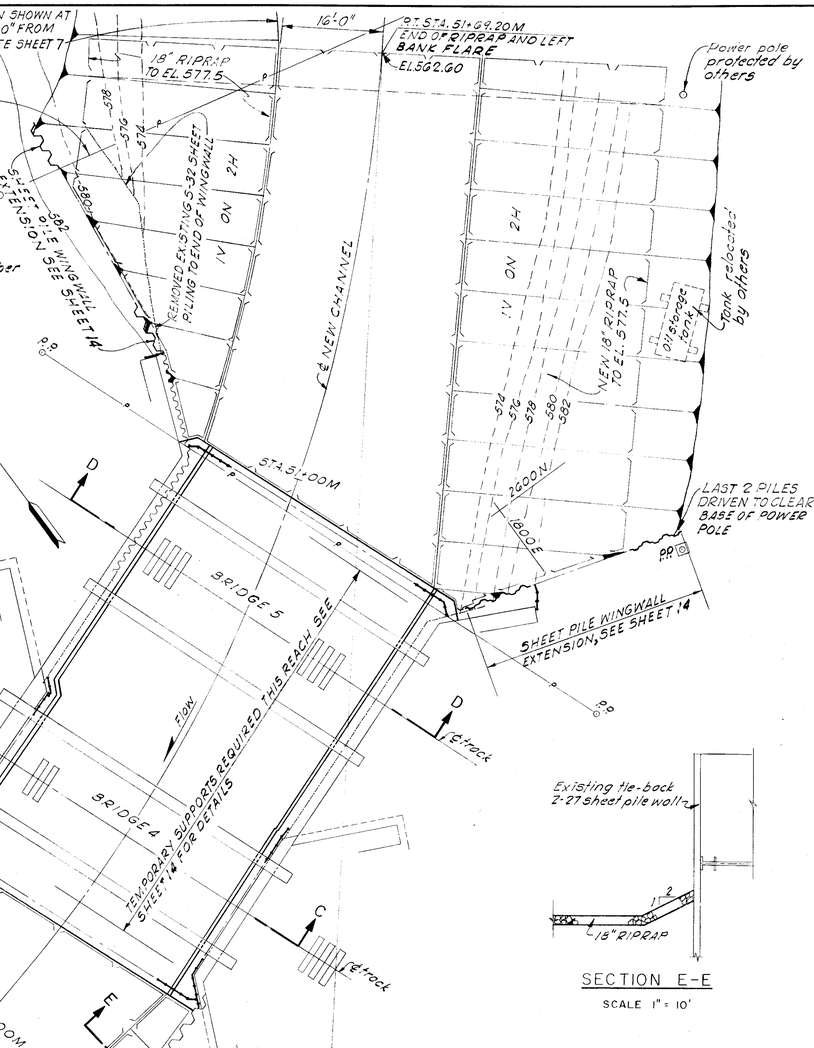
SECTION B-B

SCALE 1" = 10'



SECTION A-A

SCALE 1" = 10'



PLAN - BRIDGES 3B, 4 AND 5

SCALE 1" = 10'

10' 0 10' 20'

SECTION E-E

SCALE 1" = 10'

NOTES:

FOR GENERAL NOTES SEE SHEET 2.

AS CONSTRUCTED

SUBMITTED: D. H. Finnigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Sloan Reed, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
1	10/21/65	Changed Rt. bank channel line upstream from Bridge 5	jaw

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph D. Wemmett, CHIEF, DESIGN BRANCH
APPROVED: Gary M. Dallinger, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

BRIDGES 3A, 3B, 4 AND 5
PLANS AND SECTIONS

APPROVED: R. Sloan Reed, COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

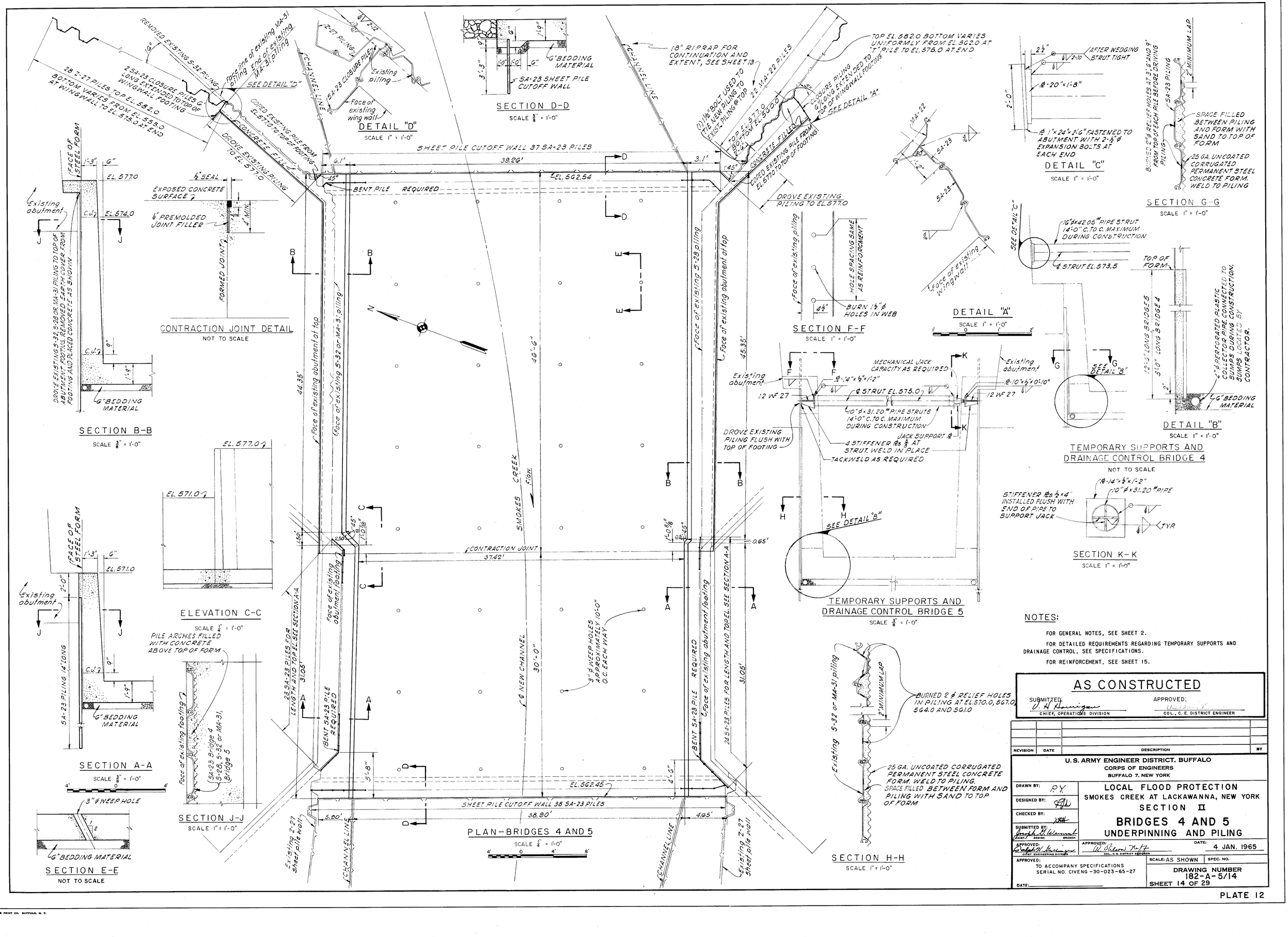
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER 182-A-5/13
SHEET 13 OF 29

PLATE 11

SENECA BLUE PRINT CO. BUFFALO, N. Y.



NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR DETAILED REQUIREMENTS REGARDING TEMPORARY SUPPORTS AND DRAINAGE CONTROL, SEE SPECIFICATIONS.

FOR REINFORCEMENT, SEE SHEET 15.

AS CONSTRUCTED

SUBMITTED: J. H. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: , COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph E. Wemmer, CHIEF, DESIGN BRANCH
APPROVED: Ralph A. Hansen, CHIEF, ENGINEERING DIVISION
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

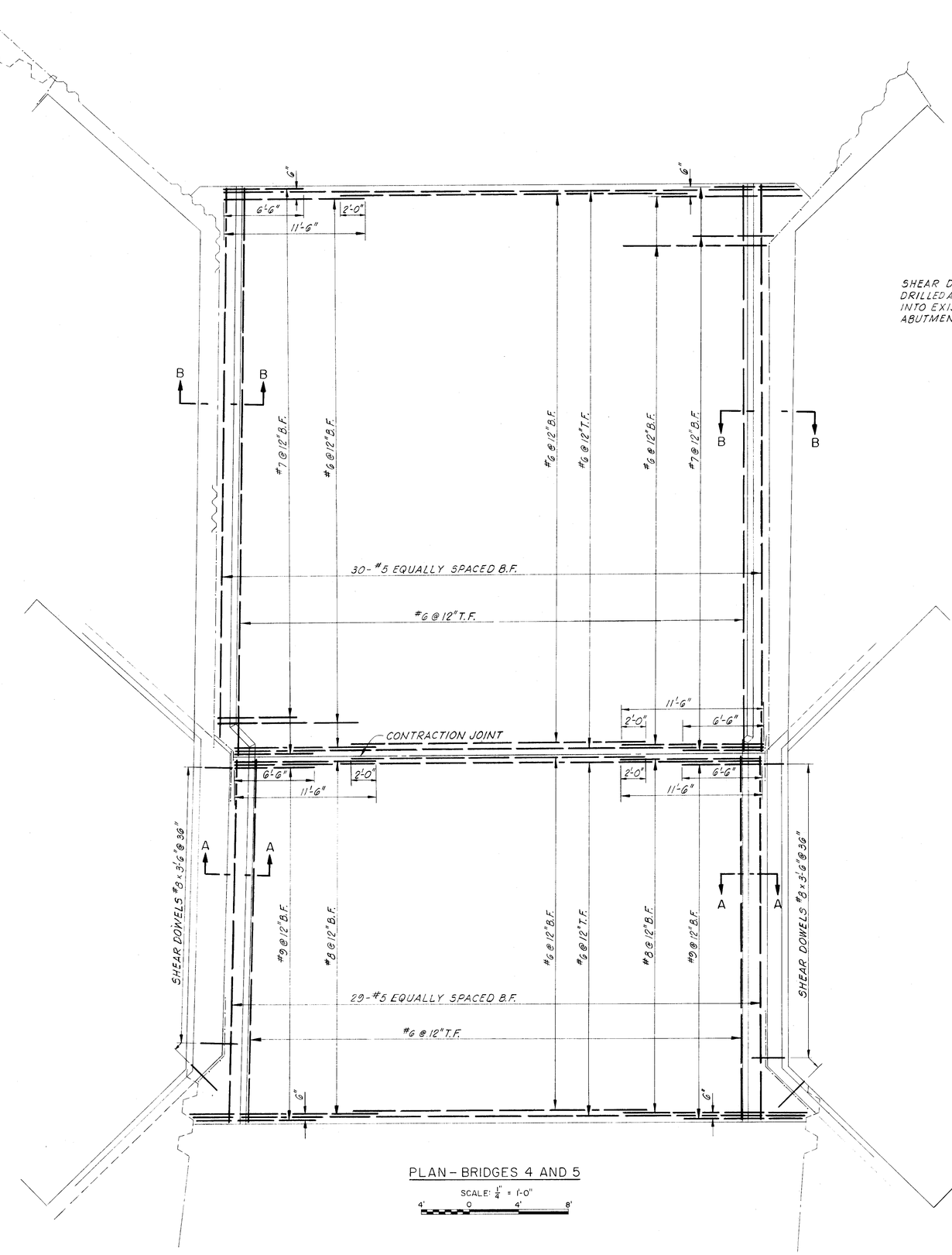
LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

BRIDGES 4 AND 5
UNDERPINNING AND PILING

APPROVED: W. Wilson Goode, COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 182-A-5/14
SHEET 14 OF 29

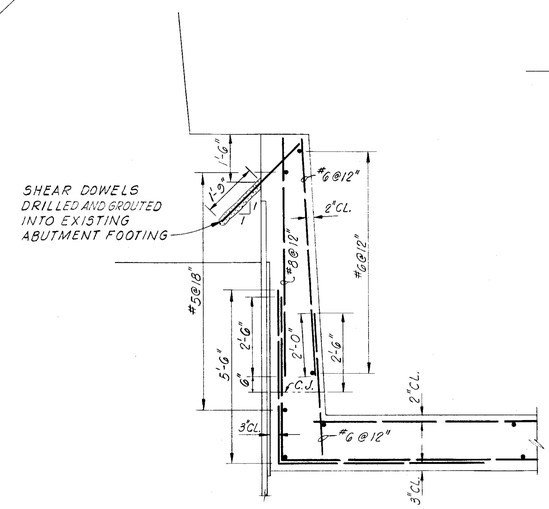
PLATE 12

SENECA BLUE PRINT CO. BUFFALO, N. Y.



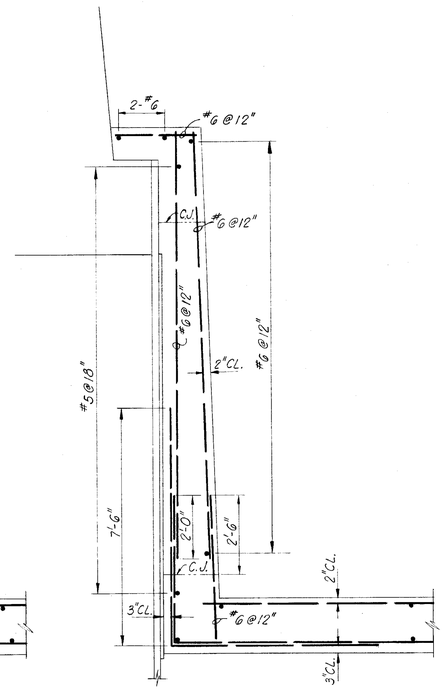
PLAN - BRIDGES 4 AND 5

SCALE: 1" = 1'-0"



SECTION A-A

SCALE: 1/2" = 1'-0"



SECTION B-B

SCALE: 1/2" = 1'-0"

NOTES:

FOR REINFORCEMENT NOTES, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: J. H. Hourigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Shea Heft, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 4 AND 5
REINFORCEMENT

APPROVED: R. Shea Heft, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

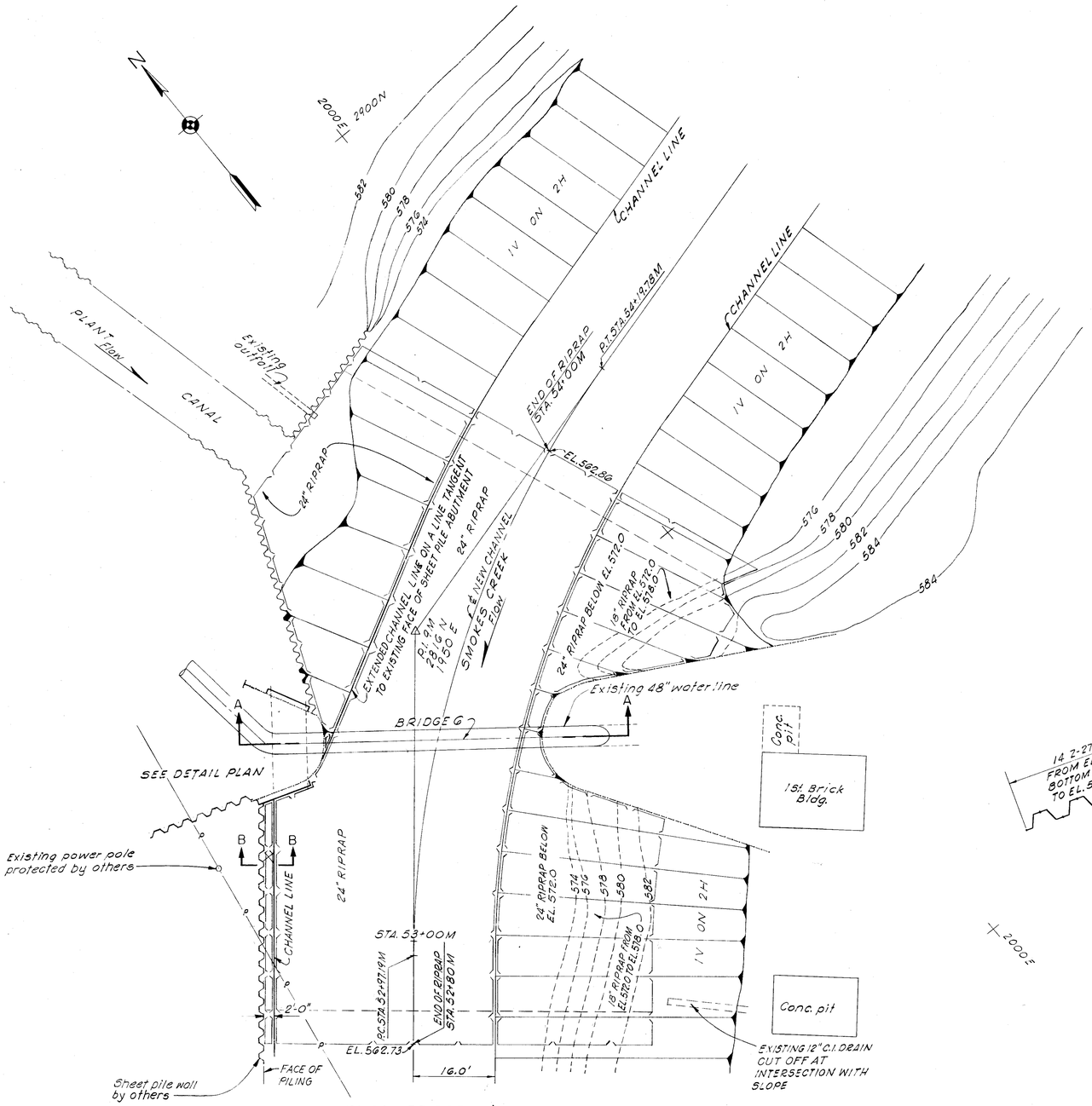
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER 182-A-5/15
SHEET 15 OF 29

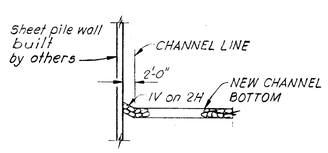
PLATE 13

SENECA BLUE PRINT CO. BUFFALO, N. Y.



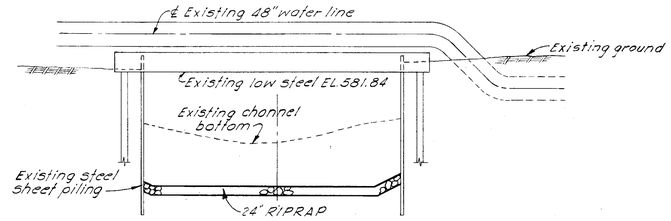
PLAN – BRIDGE 6 ⚠

SCALE 1" = 10'



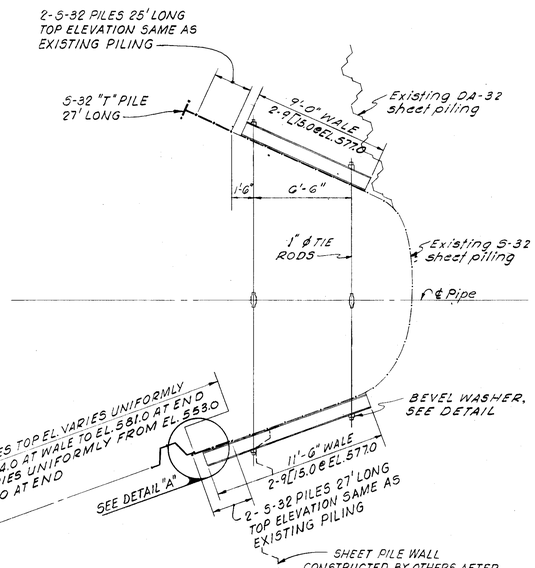
SECTION B-B ⚠

SCALE: 1" = 10'



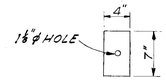
SECTION A-A ⚠

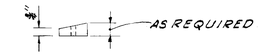
SCALE 1" = 10'



DETAIL PLAN ⚠

SCALE 1/4" = 1'-0"

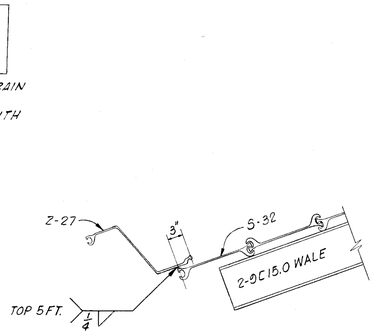




BEVEL WASHER

NOT TO SCALE

+2000 E

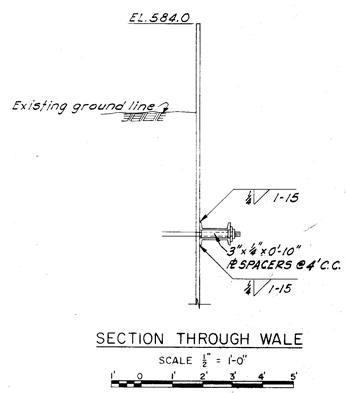


DETAIL "A"

SCALE 1" = 1'-0"

+2700 N

+1900 E



SECTION THROUGH WALE

SCALE 1/2" = 1'-0"

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

AS CONSTRUCTED

SUBMITTED: J. N. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: Alex Kelly, COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	10/21/65	Revised channel at bridge 6	JWW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph D. Wermuth, CHIEF, DESIGN BRANCH
APPROVED: Rudolph E. Bruneau, CHIEF, ENGINEERING DIVISION
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 6
PLAN, SECTIONS AND PILING

APPROVED: W. Alex Kelly, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 182-A-5/16
SHEET 16 OF 29

PLATE 14

SENECA BLUE PRINT CO. BUFFALO, N. Y.

MATCH LINE SHEET 18

DRIVE Z-27 PILING TIGHT AGAINST EXISTING SA-32 PILING

SHEET PILING 23' LONG TOP EL. 573.0

2-SA-23 PILES

DETAIL "A"

CONCRETE FILL TOP EL. 573.0

Face of existing wing wall

DRIVEN SA-23 BENT PILE TIGHT AGAINST AND PAST END OF EXISTING PILING

40'-0"

40'-0" TO CONTRACTION JOINT

REMOVED EXISTING DEFLECTOR PILING AND STEEL FRAMING FOR SECTION SEE SHEET 18

Existing framing to remain

Face of existing concrete apron EL. 573.0

DRIVE Z-27 PILING TIGHT AGAINST EXISTING DEFLECTOR PILING

12 Z-27 PILES TOP EL. 573.0 17' LONG

18" RIPRAP TO EL. 578.0

DRIVE Z-27 PILING TIGHT AGAINST AND PAST END OF EXISTING PILING

END OF CONCRETE

CONTRACTION JOINT AND END OF CONCRETE UNDERPINNING FOR CONTRACTION JOINT DETAIL, SEE SHEET 18

Existing steel sheet piling

45'-7"

PC STA 57+17.72 M

3" WEEP HOLES APPROX. MARLY 10'-0" O.C. EACH WAY SEE SECTION C-C SHEET 18

CHANNEL

Face of existing abutment at junction with footing

Existing steel sheet piling

C.J.

EL. 568.17

A

30'-0"

SPLIT SA-23 PILING AS REQUIRED TO ABUT MA-22 PILING

SHEET PILE CUTOFF WALL 23 SA-23 PILES

DRIVE EXISTING PILING TO EL. 573.0

DETAIL "B"

Face of existing wing wall at top

DRIVE MA-22 PILING 73 FT AGAINST AND PAST END OF EXISTING PILING

CONCRETE FILL TOP EL. 573.0

5 MA-22 PILES SHEET PILING 16' LONG TOP EL. 573.0

DETAIL "C"

30 PILES BOTTOM EL. 573.0

11'-10"

16'-6" DIA. SA-23 SHEET PILE CELL TOP EL. 582.0

16 PILES BOTTOM EL. 566.0

18" RIPRAP FOR CONTINUATION AND EXTENT, SEE SHEET 7

CHANNEL LINE

PLAN - BRIDGE 7

SCALE 1" = 1'-0"

18" RIPRAP

6" BEDDING MATERIAL

SA-23 SHEET PILE CUTOFF WALL

SECTION A-A

SCALE 1" = 1'-0"

FACE OF STEEL FORM

DRIVE EXISTING PILING TO TOP OF ABUTMENT FOOTING REMOVE EARTH COVER FROM FOOTING AND PLACE CONCRETE AS SHOWN

EL. 573.0

Top of footing

Existing abutment

Existing piling

6" BEDDING MATERIAL

SECTION B-B

SCALE 1" = 1'-0"

End of existing wing wall

SA-23

Face of existing wingwall footing

DETAIL "D"

DETAIL "B" OPPOSITE HAND

SCALE 1" = 1'-0"

TOP OF FOOTING AND PILING

COPE PILE TOP OF PILING EL. 573.0

Existing piles

MA-22 PILE

SA-23 PILE

SECTION E-E

SCALE 1" = 1'-0"

Face of existing abutment at junction with footing

DRIVE MA-22 PILING, 17' LONG, TIGHT AGAINST AND PAST END OF EXISTING PILING.

BENT SA-23 PILING 18' LONG AS REQUIRED

MA-22

SA-23

TOP OF LEG AT EL. 573.0

TOP OF PILE AT EL. 583.0

DETAIL "E"

SCALE 1" = 1'-0"

CONCRETE FILL FROM TOP OF FOOTING TO EL. 573.0

9 MA-22 PILES SHEET PILING 16' LONG TOP EL. 573.0

30 PILES BOTTOM EL. 573.0

11'-0"

16'-6" DIA. SA-23 SHEET PILE CELL TOP EL. 583.0

16 PILES BOTTOM EL. 566.0

18" RIPRAP FOR CONTINUATION AND EXTENT, SEE SHEET 7

POURED CONCRETE AGAINST EXISTING PILING ABOVE TOP OF FORM

FILLED SPACE WITH SAND BELOW TOP OF FORM

SECTION C-C

SCALE 1" = 1'-0"

18" RIPRAP TO EL. 578.0 ALONG EXISTING BANK SURFACE, LEFT BANK ONLY

FOR EL. SEE PLAN

Existing ground varies

NEW PILING, SEE PLAN

STEEL FORM SEE SHEET 19

FILLED SPACE BETWEEN PILING AND FORM WITH CONCRETE AFTER SLAB HAD BEEN COMPLETED AND BEFORE TEMPORARY SUPPORTS WERE REMOVED

6" BEDDING MATERIAL

SECTION D-D ⚠

SCALE 1/2" = 1'-0"

NOTES

CELLS FILLED TO TOP WITH EXCAVATED MATERIAL.

FOR GENERAL NOTES, SEE SHEET 2.

FOR REINFORCEMENT, SEE SHEET 20.

AS CONSTRUCTED

SUBMITTED: J. N. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION
⚠	6/28/66	Rev. Conc. slab at right bank between bridges 7 and 8
⚠	5/17/65	Added riprap left bank between bridges 7 and 8

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY:
DESIGNED BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:
APPROVED:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 7
UNDERPINNING AND CELLS

DATE: 4 JAN 1965

TO ACCOMPANY SPECIFICATIONS SERIAL NO. DIVENG-30-023-65-27

SCALE: AS SHOWN

DRAWING NUMBER: NFBP-A-1-17

SHEET 17 OF 20

DATE:

FLOW

CHANNEL LINE

CHANNEL LINE

18" RIPRAP FOR CONTINUATION AND EXTENT, SEE SHEET 7

18" RIPRAP FOR CONTINUATION AND EXTENT, SEE SHEET 7

FLARED CHANNEL LINE FROM STA. 58+68.98M TO A TANGENT AT CELL DRIVING LINE

90 PILES BOTTOM EL. 564.0

16'-6" DIA. SA-23 SHEET PILE CELL TOP EL. 582.0

16 PILES BOTTOM EL. 558.0

EXISTING DA-32 PILING

DETAIL "F"

22 PILES BOTTOM EL. 558.0

16'-6" DIA. SA-23 SHEET PILE CELL TOP EL. 582.0

SPLIT SA-23 PILE AS REQ'D TO ABUT EXISTING PILING

45-SA-23 PILES

FACE OF CONCRETE CONNECTS TO INTERSECTION OF CELL PILES WITH REDRIVEN SPLIT PILE

EL. 563.32

DETAIL "F"

20'-3"

WALE, TIE ROD AND ANCHOR WALL SEE DETAILS DWG. 182-A-5/31 ⚠

24 PILES BOTTOM EL. 564.0

10'-5"

21'-1"

WALE, TIE ROD, FOR DETAILS SEE DWG. 182-A-5/31 ⚠

DEBRIS BOOM

3"ø WEEP HOLE APPROXIMATELY 10'-0" O.C. EACH WAY

EXISTING 24"ø STEEL DEBRIS BOOM (HALF OF 2 CELLS, 1 - 12"ø PILE AT EACH END AND 5 - 12"ø PILES SPACED 5'-0" C. TO C.)

Face of existing concrete backwall

P.I. 10 M. 2934 N 2378 E

10'-3"

F

F

K

K

DN.

Existing DA-32 piling

Existing DA-32 piling

G

G

Face of existing concrete backwall

EXISTING 48" C.I. DRAIN CUT OFF

L

L

Existing piling to remain

2-60" existing R.C. concrete pipes

Existing Fromby to remain

REMOVED EXISTING DEFLECTOR PILING AND STEEL FRAMING

CONTRACTION JOINT

CONTRACTION JOINT

40'-0" O.C.

MATCH LINE SHEET 17

PLAN - BRIDGE 8 ⚠

SCALE 1" = 1'-0"

0 4' 8'

18" RIPRAP

6" BEDDING MATERIAL

SA-23 SHEET PILE CUTOFF WALL

SECTION H-H

SCALE 1" = 1'-0"

CUT EXISTING WALE AT CELL LINE AND REMOVE PILE LYING ON DRIVING LINE OF CELL. SPLIT PILE AS REQUIRED AND REC TO ABUT CELL. WELD WALE TO CELL

½" ℄ top and bottom

Existing DA-32 piling

EXISTING WALE

DETAIL "F"

SCALE 1" = 1'-0"

Existing piling

STEEL FORM, SEE SHEET 19

SPACE FILLED BETWEEN PILING AND FORM WITH CONCRETE AFTER SLAB HAS BEEN COMPLETED AND BEFORE TEMPORARY SUPPORTS WERE REMOVED

6" BEDDING MATERIAL

SECTION G-G

SCALE: ½" = 1'-0"

Face of existing DA-32 piling

SPACE FILLED BETWEEN PILING AND FORM WITH CONC. AFTER SLAB HAS BEEN COMPLETED AND BEFORE TEMPORARY SUPPORTS WERE REMOVED

5'-0"

EL. 565.5

STEEL FORM

6" BEDDING MATERIAL

SECTION K-L ⚠

SCALE ½" = 1'-0"

5'-0"

INTERSECTION OF EXIST. DA-32 PILING AND SHEET PILE CELL EL. 565.5

J

EL. 563.32

SA-23 SHEET PILE CUTOFF WALL

SECTION J-J ⚠

SCALE ½" = 1'-0"

SA-23 SHEET PILE CUTOFF WALL

3"ø WEEP HOLE

12"

6" BEDDING MATERIAL

SECTION F-F

SCALE ½" = 1'-0"

½" SEAL

EXPOSED CONCRETE SURFACE

4" MIN.

¾"

½" PREMOLDED JOINT FILLER

FORMED JOINT

CONTRACTION JOINT DETAIL

NOT TO SCALE

⚠ WALE, TIE ROD AND ANCHOR WALL SEE DETAILS DWG. 182-A-5/31

NOTES:

CELLS FILLED TO TOP WITH EXCAVATED MATERIAL.

FOR GENERAL NOTES, SEE SHEET 2.

FOR REINFORCEMENT, SEE SHEET 20.

AS CONSTRUCTED

SUBMITTED: J. W. Flanigan, CHIEF, OPERATIONS DIVISION

APPROVED: COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	6/28/66	Added tie-back anchorage and revised slab at Ft. bank.	JW

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

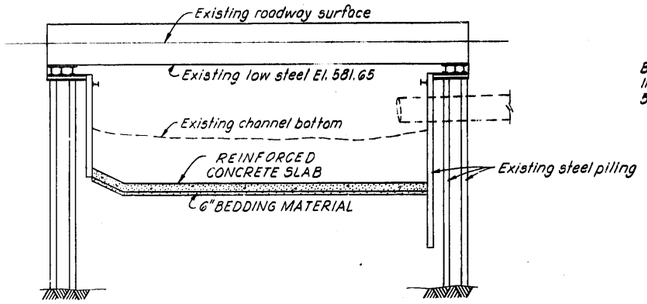
DRAWN BY: IR/
DESIGNED BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:
APPROVED:
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 8
UNDERPINNING AND CELLS

DATE: 4 JAN. 1965

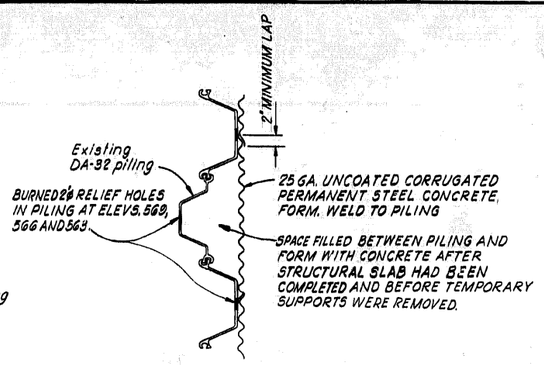
SCALE: AS SHOWN SPEC. NO.

DRAWING NUMBER 182-A-5/18
SHEET 18 OF 29



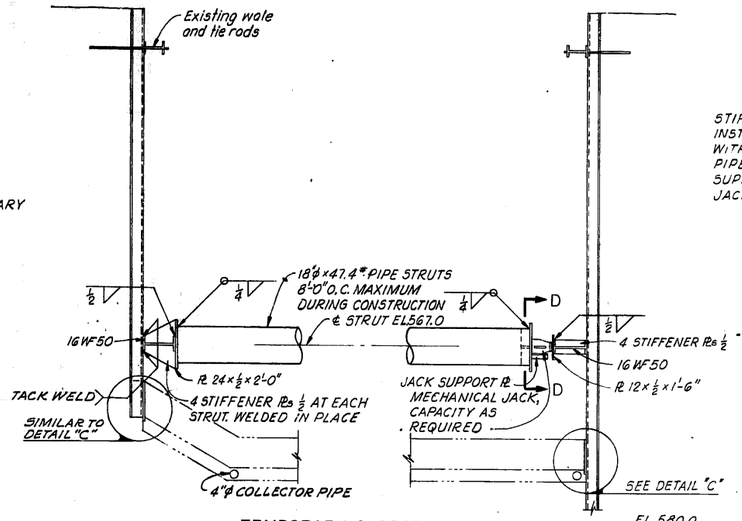
SECTION THRU BRIDGE 8 ⚠

SCALE: 1" = 10'



SECTION B-B

SCALE: 1" = 1'-0"

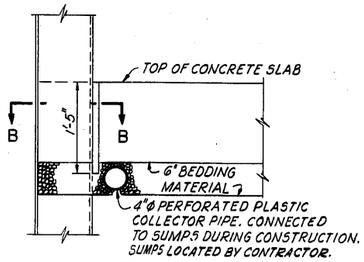


SECTION D-D

SCALE: 1" = 1'-0"

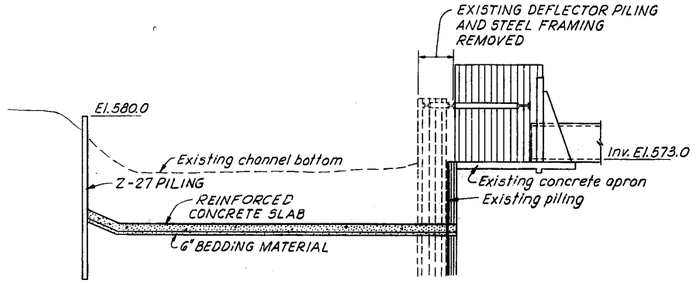
TEMPORARY SUPPORTS AND DRAINAGE CONTROL BRIDGE 8 ⚠

SCALE: ⅜" = 1'-0"



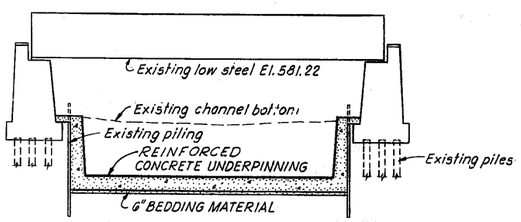
DETAIL "C"

SCALE: 1" = 1'-0"



SECTION THRU DEFLECTOR STRUCTURE ⚠

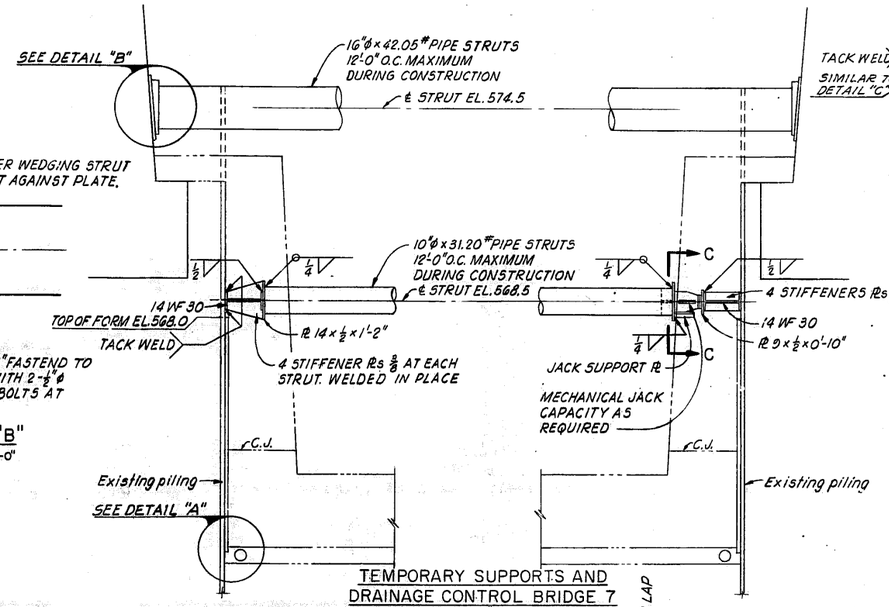
SCALE: 1" = 10'



SECTION THRU BRIDGE 7

SCALE: 1" = 10'

10' 0 10' 20'

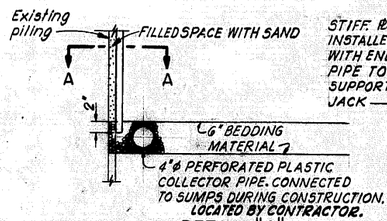


DETAIL "B"

SCALE: 1" = 1'-0"

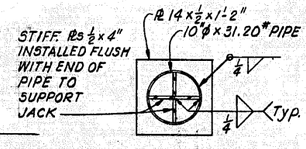
TEMPORARY SUPPORTS AND DRAINAGE CONTROL BRIDGE 7

SCALE: ½" = 1'-0"



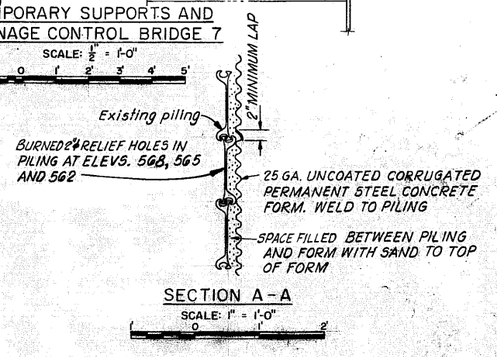
DETAIL "A"

SCALE: 1" = 1'-0"



SECTION C-C

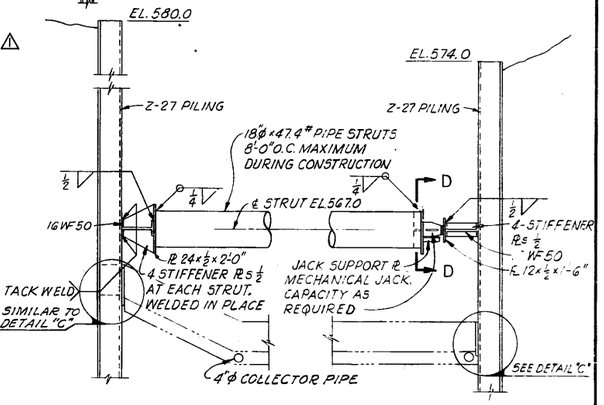
SCALE: 1" = 1'-0"



SECTION A-A

SCALE: 1" = 1'-0"

0 1' 2'



TEMPORARY SUPPORTS AND DRAINAGE CONTROL BETWEEN BRIDGES 7 AND 8 ⚠

SCALE: ⅜" = 1'-0"

NOTE:

FOR GENERAL NOTES, SEE SHEET 2.

AS CONSTRUCTED

SUBMITTED: J. H. Flanigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Stiles Huff, COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
1 ⚠	6/28/66	Changed slab at bridge 8	

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph A. Wemmer, CHIEF, ENGINEERING BRANCH
APPROVED: Joseph N. Gallagher, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

BRIDGES 7 AND 8
SECTIONS AND TEMPORARY SUPPORTS

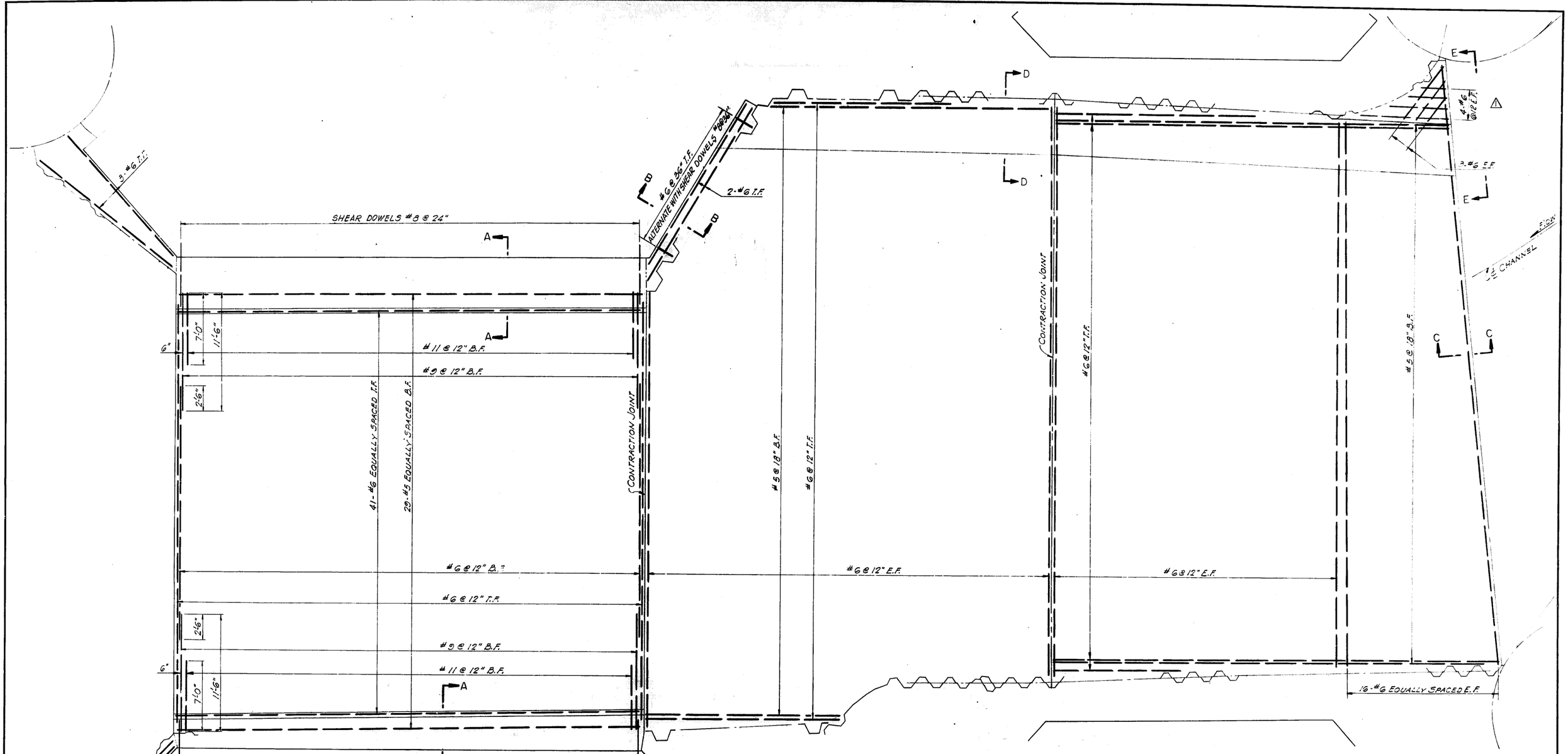
APPROVED: R. Stiles Huff, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

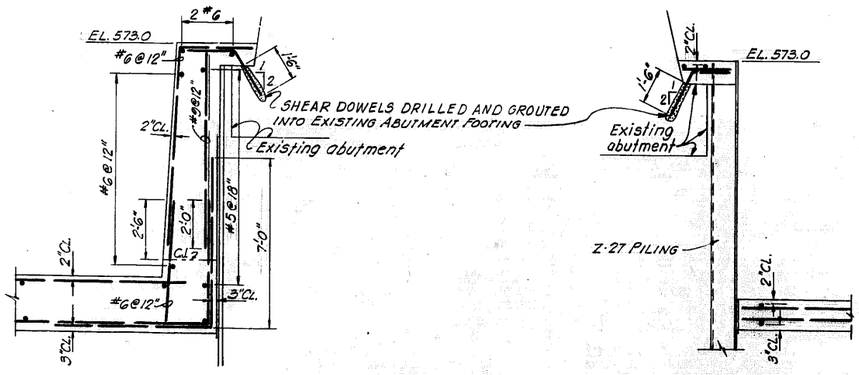
DRAWING NUMBER 182-A-5/19
SHEET 19 OF 29

PLATE 17



NOTE:

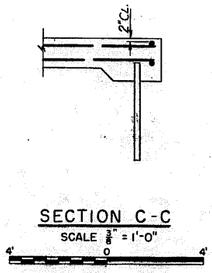
FOR REINFORCEMENT NOTES, SEE SHEET 12.



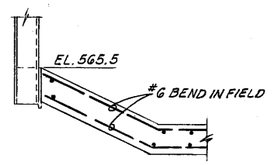
SECTION A-A
SCALE 3/8" = 1'-0"

SECTION B-B
SCALE 3/8" = 1'-0"

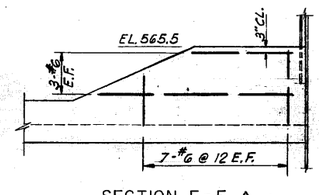
PLAN-BRIDGES 7 AND 8 ⚠
SCALE 1/4" = 1'-0"
4' 0 4' 8'



SECTION C-C
SCALE 3/8" = 1'-0"
4' 0 4'



SECTION D-D ⚠
SCALE: 3/8" = 1'-0"



SECTION E-E ⚠
SCALE: 3/8" = 1'-0"

AS CONSTRUCTED

SUBMITTED: U. H. Hunziger, CHIEF, OPERATIONS DIVISION
APPROVED: R. R. Lee Kelly, COL. C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY
⚠	6/28/66	Changed reinforcement at Rt. bank bridge 8	gdw

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: WR
DESIGNED BY: RJD
CHECKED BY: RRH
SUBMITTED BY: Joseph H. Wemmel, CHIEF, DESIGN BRANCH
APPROVED: Dwight H. Gross, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 7 AND 8
REINFORCEMENT

APPROVED: R. R. Lee Kelly, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/20
SHEET 20 OF 29

24" RIPRAP BELOW EL. 572.0 CONTINUES UPSTREAM APPROXIMATELY TO STATION 64+71.8M. SEE PLAN-BRIDGE 10 THIS SHEET.

24" RIPRAP BELOW EL. 572.0

END OF RIPRAP LEFT BANK STA. 62+93M

Existing power lines Low Wire El. 600.0

EXISTING WINGWALL REMOVED

SPECIAL CORNER PILE

13 Z-27 PILES

P.T. STA. 62+56.04M

BRIDGE 9

Existing pipeline

14 Z-27 PILES

18" RIPRAP FROM EL. 572.0 TO EL. 574.50

24" RIPRAP BELOW EL. 572.0

5-Z-27 PILES

Existing 4" DRAIN CUT OFF AT INTERSECTION WITH SLOPE

Existing power lines Low Wire El. 603.0

Existing 6" C.I. DRAIN CUT OFF AT INTERSECTION WITH SLOPE

CHANNEL

CREEK

SMOKES

16.0'

END OF RIPRAP STA. 61+93M

P.I. IN 3,910.0N 2,492.0E

3400N

2500E

FLOW

1V on 2H

PLAN - BRIDGE 9

SCALE 1" = 10'

12 Z-27 PILES - 9.0'

15 Z-27 PILES

SPECIAL CORNER PILE

3300N

BRIDGE # 9 EAST ABUT.

6'-0" LONG TOP EL. 579.75'

SCALE: 1" = 4'

NOTE:

Reason for piling being @ Distances & EL. Shown from abutment is due to protruding abutment footing.

Existing pipeline

Existing concrete abutments

Existing ground line

Existing low steel El. 587.65

EL. 578.50

EL. 578.5

EL. 574.0

EL. 574.00

Existing channel bottom

EL. 565.0

EL. 558.5

3 PILES EACH FACE

7-27 SHEET PILE PIER PROTECTION

EL. 554.0

EL. 579.5

EL. 579.75

2 PILES UPSTREAM FACE

EL. 576.0

EL. 571.75

EL. 568.0

EL. 565.0

24" RIPRAP

Approximate rock line

SECTION A-A

SCALE 1" = 10'

BETHLEHEM STEEL CO.

Existing Guard Rail Relocated To Top Of Bank By Others

Existing Railing Cut Off To Top Of Slope

Existing hydrant

Z-27 Sheet Pile Wingwall Extension See Sheet 22

Existing 6" water line relocated by others to clear new work

18" RIPRAP TO EL. 579.0

10-Z-27 PILES

END OF FLARE AND RIPRAP STA. 66+21M

16.0'

2700E

2600E

Existing manhole

Existing 16" concrete ind. Low Wire El. 606.5

Existing 6" C.I. water line

18" RIPRAP TO EL. 579.0

8-Z-27 PILES

5A-23 SHEET PILE CUTOFF WALL - SEE SHEET 22

5A-23 CLOSURE PILE SEE SHEET 22

Z-27 SHEET PILE WINGWALL EXTENSION SEE SHEET 22

Top of abutment rear face

BRIDGE 10

SOUTH BUFFALO RAILWAY CO.

STA. 65+36.68M

P.I. 13M 3580.0N 2632.0E

℄ track

Existing water line in wood conduit Bottom El. 580.40

Existing power line Low Wire El. 615.0

Existing Valve Box and Water Line Relocated By Others To Clear New Work

7-Z-27 PILES

6-Z-27 PILES

Existing 6" C.I. DRAIN Cut Off At Intersection With Slope

3500N

Existing Power Station

2600E

PLANT ROAD

Existing power line Low Wire El. 620.0

P.I. STA. 64+71.8M END OF RIPRAP END FLARE, LEFT BANK

END OF FLARE, RIGHT BANK STA. 64+62M

18" RIPRAP ABOVE EL. 572.0

24" RIPRAP BELOW EL 572.0 APPROXIMATELY TO STA. 64+71.8 M.

PLAN - BRIDGE 10

SCALE 1" = 10'

AS CONSTRUCTED

SUBMITTED: J. N. Flannigan CHIEF, OPERATIONS DIVISION

APPROVED: R. Wilson Neff COL., C. E. DISTRICT ENGINEER

Existing low steel El. 581.18

Existing channel bottom

EL. 570.70

EL. 568.60

REINFORCED CONCRETE UNDERPINNING

6" BEDDING MATERIAL

5A-23 SHEET PILE CUTOFF WALL SEE SHEET 22

Existing timber piles

WINGWALL CUTOFF PILING

SECTION B-B

SCALE 1" = 10'

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR BRIDGE 10 UNDERPINNING AND REINFORCEMENT, SEE SHEET 22.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: RV
DESIGNED BY: RJ
CHECKED BY: KPH
SUBMITTED BY: Joseph H. Wemmer, Jr. CHIEF, ENGINEERING DIVISION
APPROVED: Ralph W. Tallmage CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 9 AND 10
PLANS AND SECTIONS

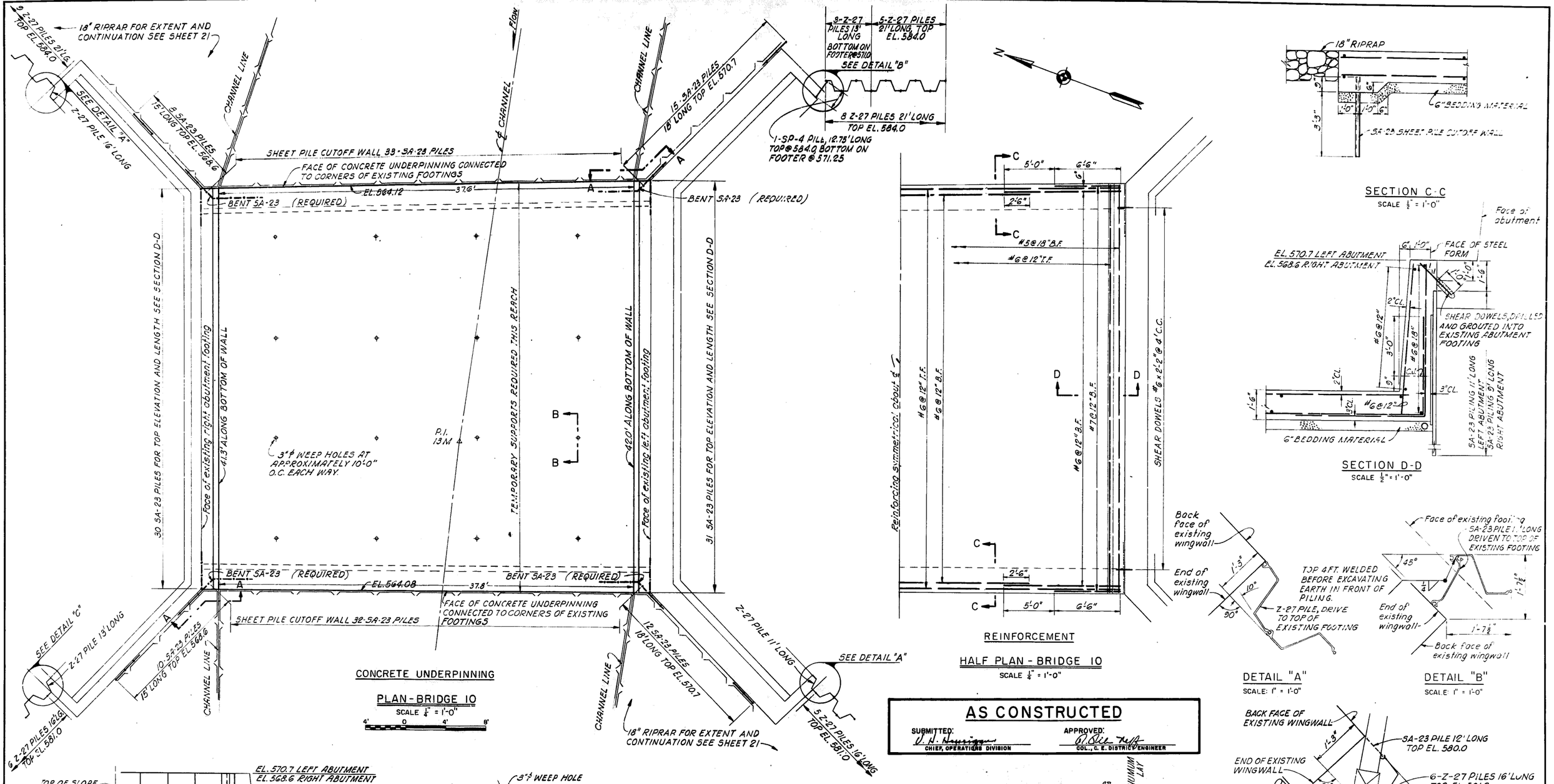
APPROVED: R. Wilson Neff COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER 182-A-5/21
SHEET 21 OF 29

PLATE 19



NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR REINFORCEMENT NOTES, SEE SHEET 12.

REVISION	DATE	DESCRIPTION	BY

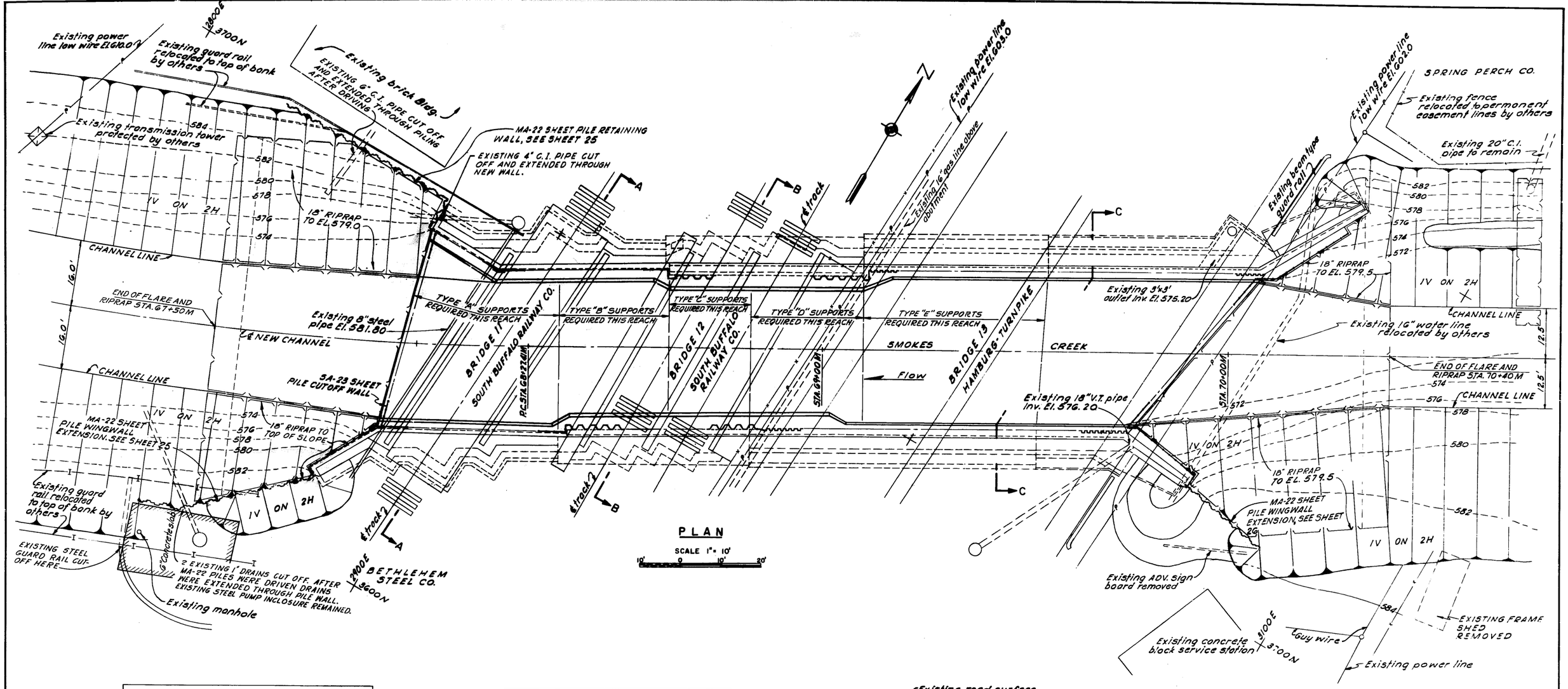
U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: JR
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 10
UNDERPINNING AND REINFORCEMENT

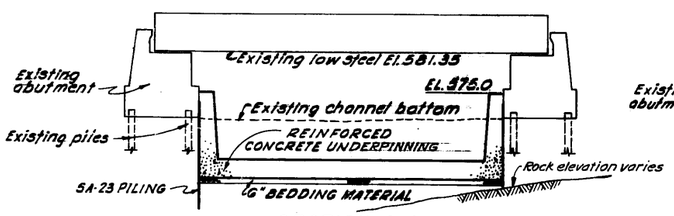
SCALE: AS SHOWN
SPEC. NO.
DRAWING NUMBER 182-A-5/22
SHEET 22 OF 29

PLATE 29



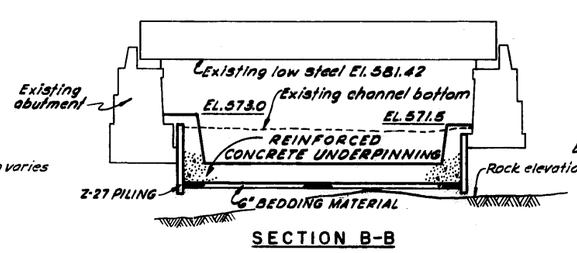
PLAN

SCALE 1" = 10'



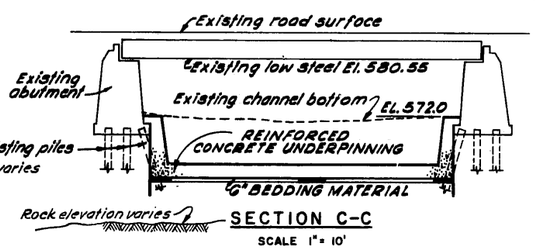
SECTION A-A

SCALE 1" = 10'



SECTION B-B

SCALE 1" = 10'



SECTION C-C

SCALE 1" = 10'

NOTES:

FOR GENERAL NOTES, SEE SHEET 2.

FOR DETAILS OF TYPES "A","B","C","D", AND "E" TEMPORARY SUPPORTS AND DRAINAGE CONTROL, SEE SHEET 24.

FOR DETAILS OF UNDERPINNING, AND PILING, SEE SHEETS 25 AND 26.

FOR REINFORCEMENT, SEE SHEETS 27 AND 28.

AS CONSTRUCTED

SUBMITTED: J. A. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Olsen, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 11, 12 AND 13
PLAN AND SECTIONS

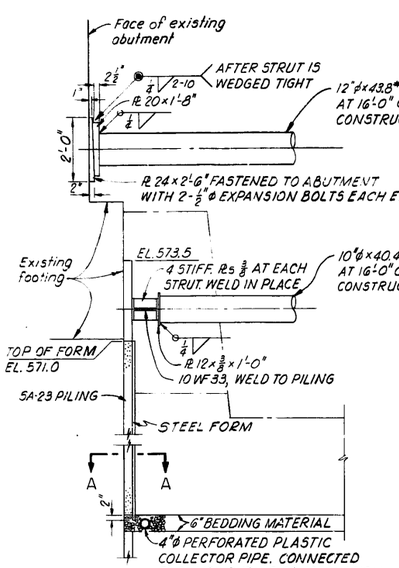
APPROVED: R. Olsen, COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER 182-A-5/23
SHEET 23 OF 29

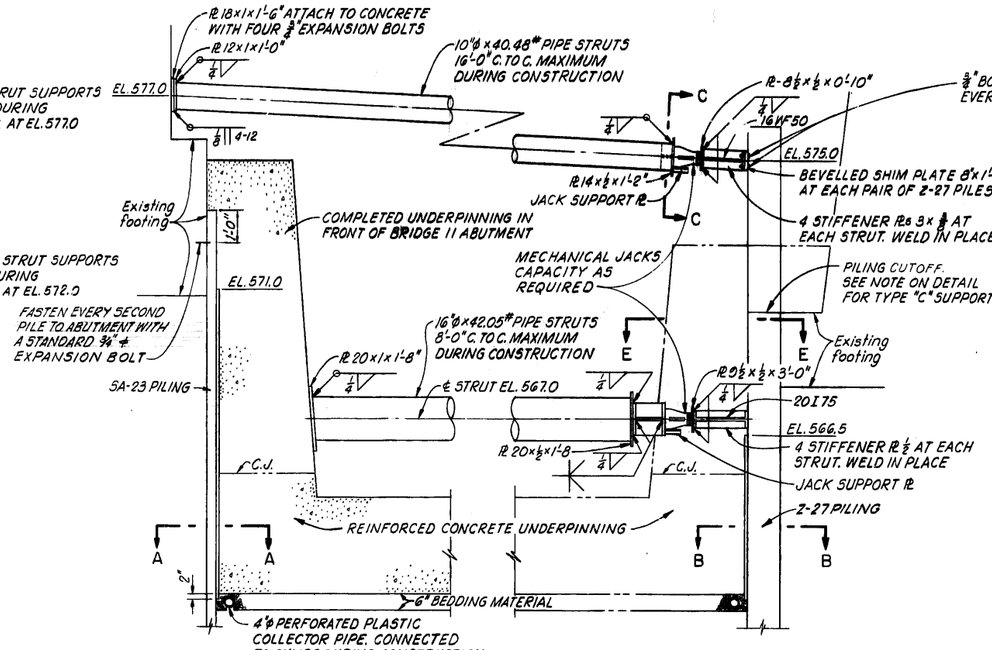
PLATE 21



TYPE "A" TEMPORARY SUPPORTS

AND DRAINAGE CONTROL

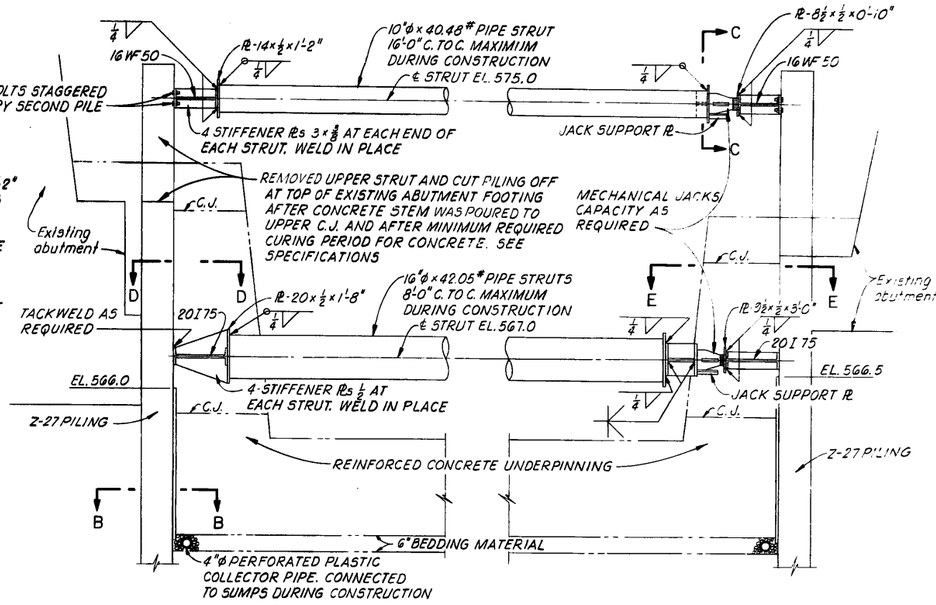
SCALE: ½" = 1'-0"



TYPE "B" TEMPORARY SUPPORTS

AND DRAINAGE CONTROL

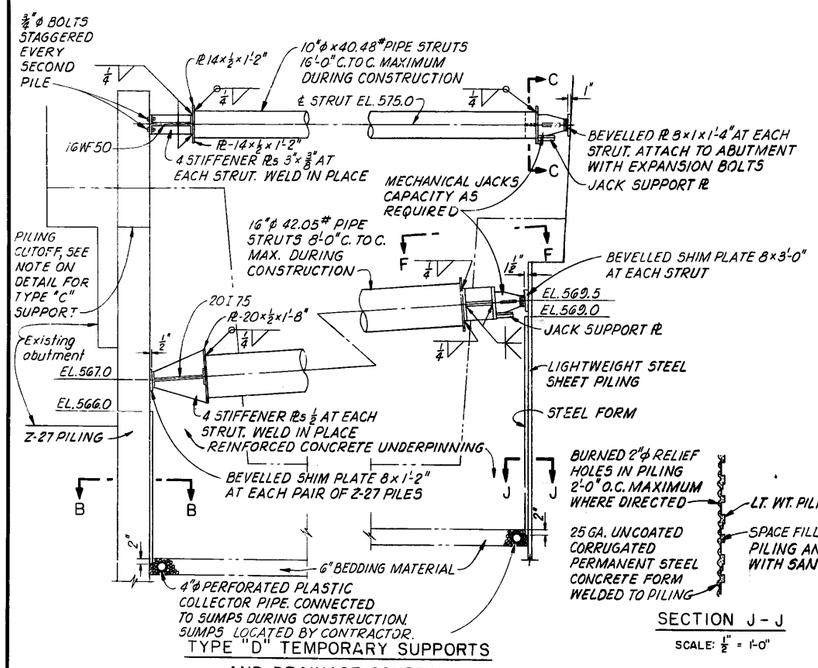
SCALE: ½" = 1'-0"



TYPE "C" TEMPORARY SUPPORTS

AND DRAINAGE CONTROL

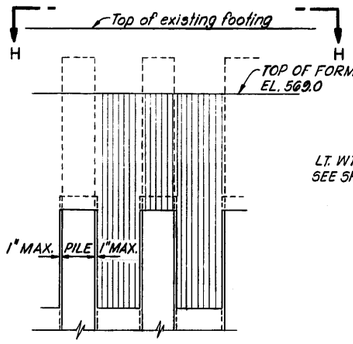
SCALE: 1" = 1'-0"



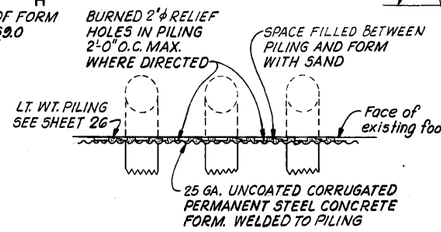
TYPE "D" TEMPORARY SUPPORTS

AND DRAINAGE CONTROL

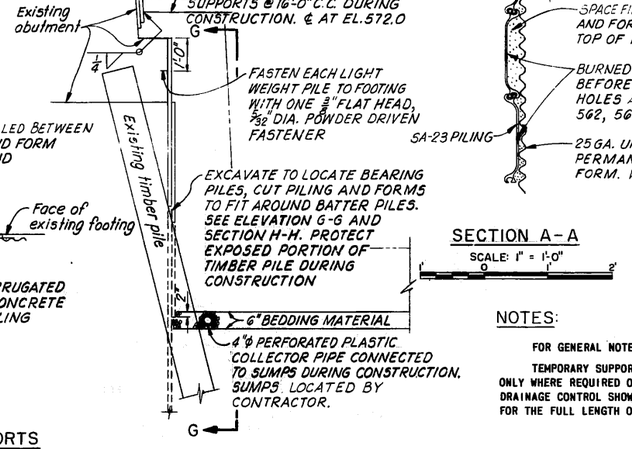
SCALE: ½" = 1'-0"



ELEVATION G-G



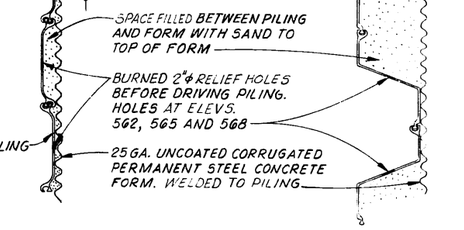
SECTION H-H



TYPE "E" TEMPORARY SUPPORTS

AND DRAINAGE CONTROL

SCALE: ½" = 1'-0"



SECTION A-A

SCALE: 1" = 1'-0"

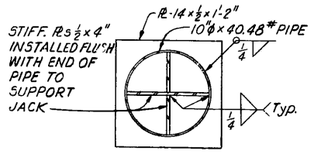
SECTION B-B

SCALE: 1" = 1'-0"

NOTES:

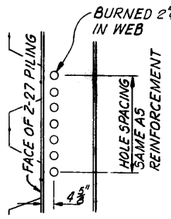
FOR GENERAL NOTES, SEE SHEET 2.

TEMPORARY SUPPORT STRUTS DESIGNATED AS TYPE "E" INSTALLED ONLY WHERE REQUIRED ON SHEET 23. LIGHTWEIGHT PILING, STEEL FORMS AND DRAINAGE CONTROL SHOWN ON TYPE "E" SUPPORT DETAILS INSTALLED FOR THE FULL LENGTH OF BOTH ABUTMENTS AT BRIDGE 13.



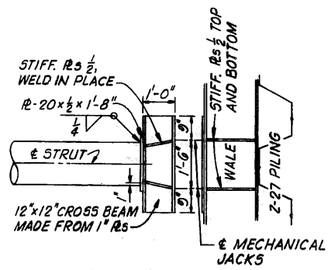
SECTION C-C

NOT TO SCALE



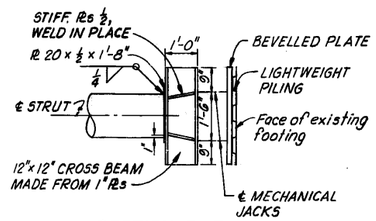
SECTION D-D

SCALE: ½" = 1'-0"



SECTION E-E

SCALE: ½" = 1'-0"



SECTION F-F

SCALE: ½" = 1'-0"

AS CONSTRUCTED

SUBMITTED: J. N. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: [illegible], COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO, NEW YORK 14207

DRAWN BY: V.C.B.
DESIGNED BY: R.M.D.
CHECKED BY: [illegible]
SUBMITTED BY: Joseph H. Wemmer, CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED: [illegible], CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 11, 12 AND 13
TEMPORARY SUPPORTS

APPROVED: [illegible], COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

SCALE: AS SHOWN

TO ACCOMPANY SPECIFICATIONS
SERIAL NO. CIVENG-30-023-65-27

DRAWING NUMBER
182-A-5/24
SHEET 24 OF 29

PLATE 22

SECTION B-B
SCALE 3/8" = 1'-0"

DETAIL "A"
SCALE 1" = 1'-0"

SECTION C-C
SCALE 3/8" = 1'-0"

ELEVATION D-D
SCALE 1/4" = 1'-0"

SECTION E-E
SCALE 3/8" = 1'-0"

PLAN
SCALE 1/8" = 1'-0"

SECTION A-A
SCALE 3/8" = 1'-0"

SECTION J-J
SCALE 3/8" = 1'-0"

NOTES

FOR GENERAL NOTES, SEE SHEET 2.

SHEET PILES DRIVEN TO THE INDICATED ELEVATIONS, TOPS WERE CUT OFF AT INDICATED ELEVATIONS.

FOR REINFORCEMENT, SEE SHEETS 27 AND 28.

AS CONSTRUCTED

SUBMITTED: U. N. Lemingen, CHIEF, OPERATIONS DIVISION

APPROVED: R. Blum Kuff, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph M. Wemmlinger, CHIEF, ENGINEERING DIVISION
APPROVED: Edgar N. Hess, CHIEF, ENGINEERING DIVISION
APPROVED: R. Blum Kuff, COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

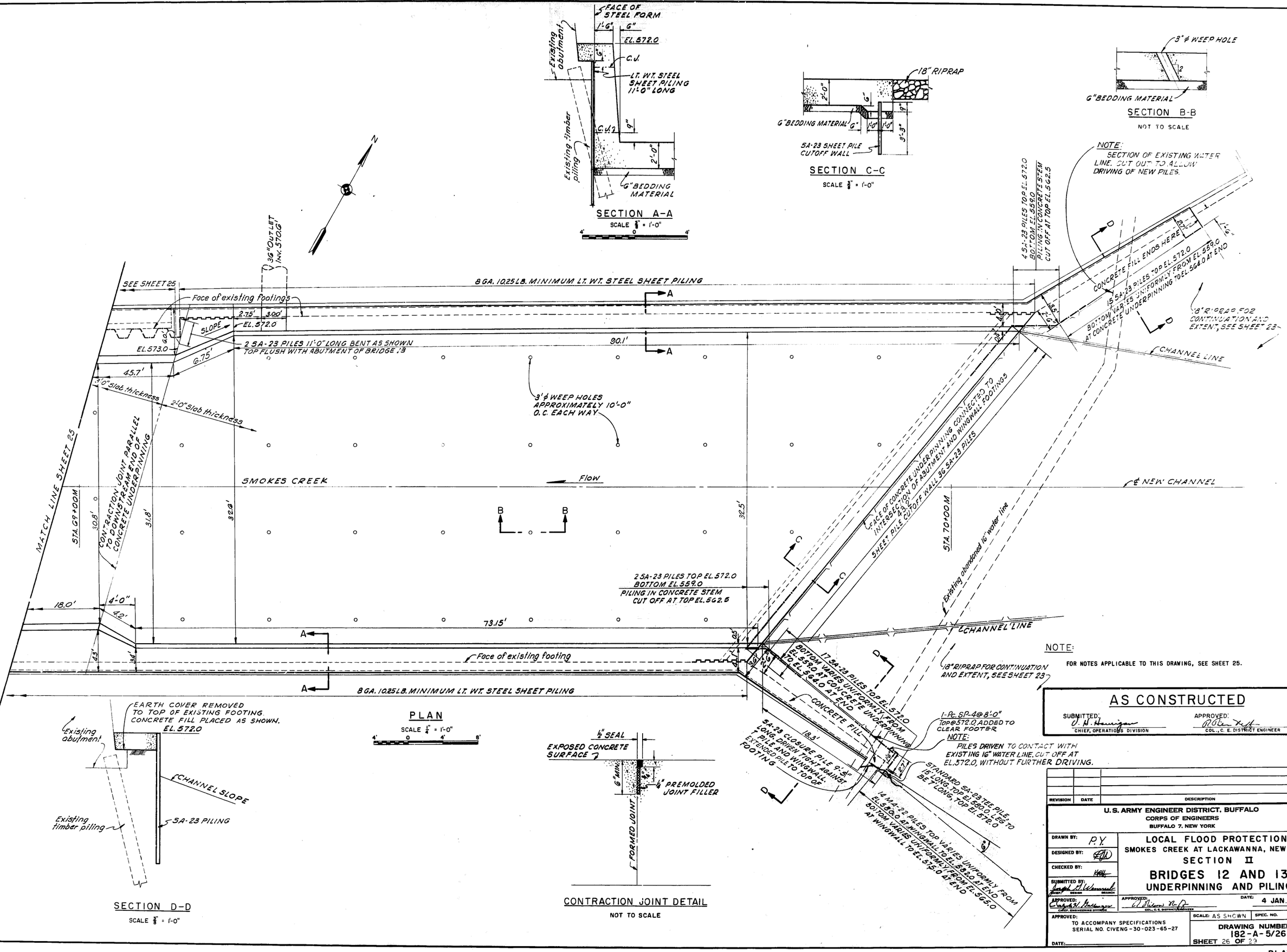
LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 11, 12 AND 13
UNDERPINNING AND PILING

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN
SPEC. NO.

DRAWING NUMBER 182-A-5/25
SHEET 25 OF 29

PLATE 23



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: P.Y.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: Joseph D. Womack, CHIEF, DESIGN BRANCH
APPROVED: Ralph H. Anderson, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 12 AND 13
UNDERPINNING AND PILING

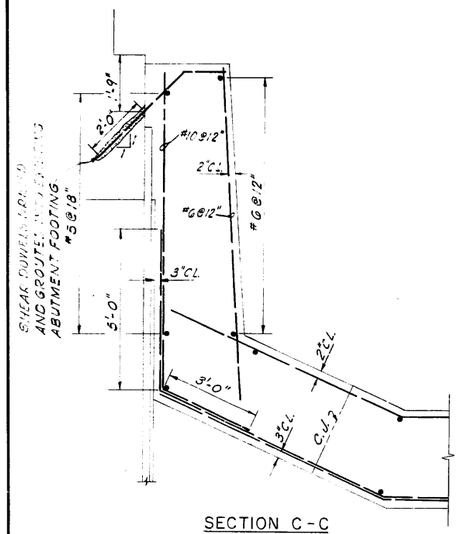
APPROVED: W. Wilson N. P., COL., C. E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN | SPEC. NO.

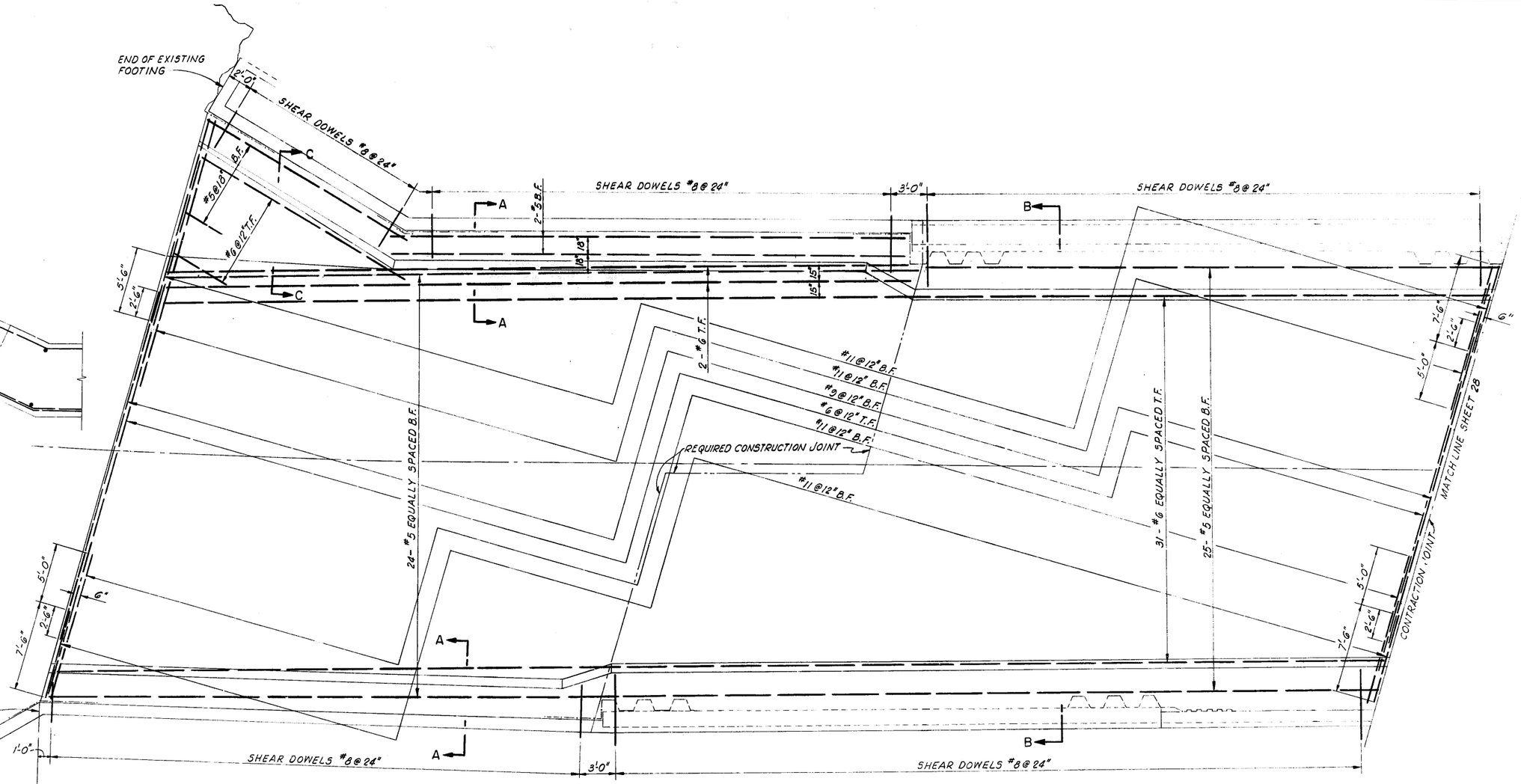
DRAWING NUMBER 182-A-5/26
SHEET 26 OF 23

PLATE 24



SECTION C-C

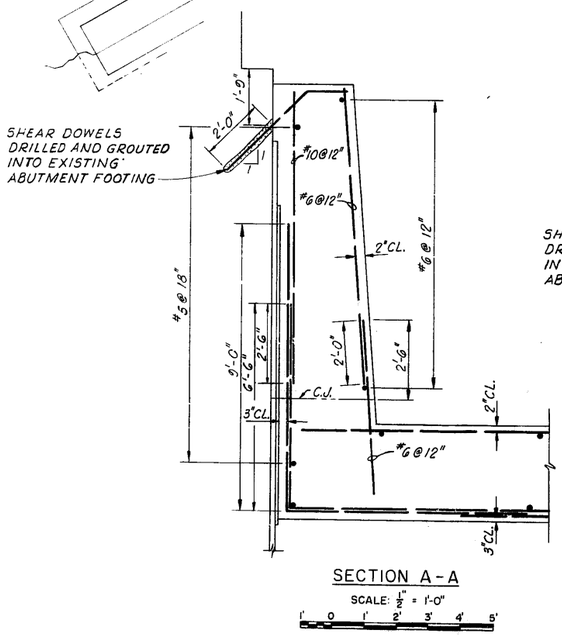
SCALE $\frac{1}{2}$" = 1'-0"



PLAN - BRIDGES 11, 12 AND 13

SCALE: $\frac{1}{4}$" = 1'-0"

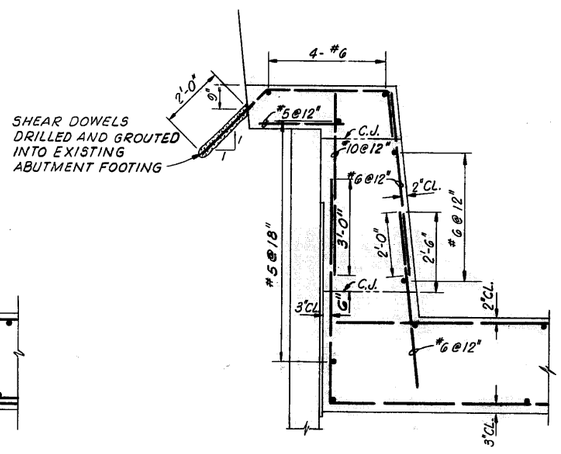
4' 0 4' 8'



SECTION A-A

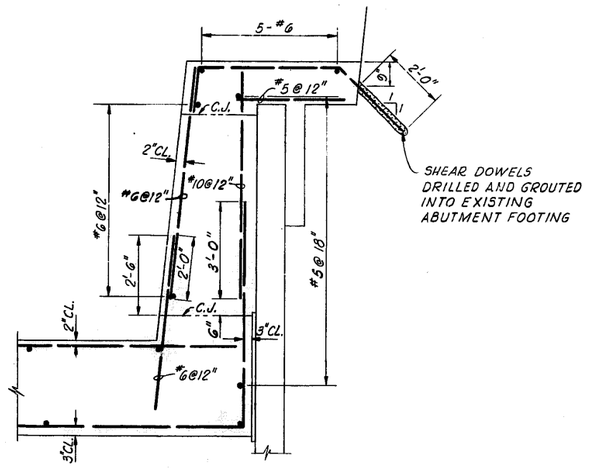
SCALE: $\frac{1}{2}$" = 1'-0"

1' 0 1' 2' 3' 4' 5'



SECTION B-B

SCALE: $\frac{1}{2}$" = 1'-0"



NOTE:

FOR REINFORCEMENT NOTES, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: J. A. Hourigan, CHIEF, OPERATIONS DIVISION

APPROVED: W. Dike Nagle, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

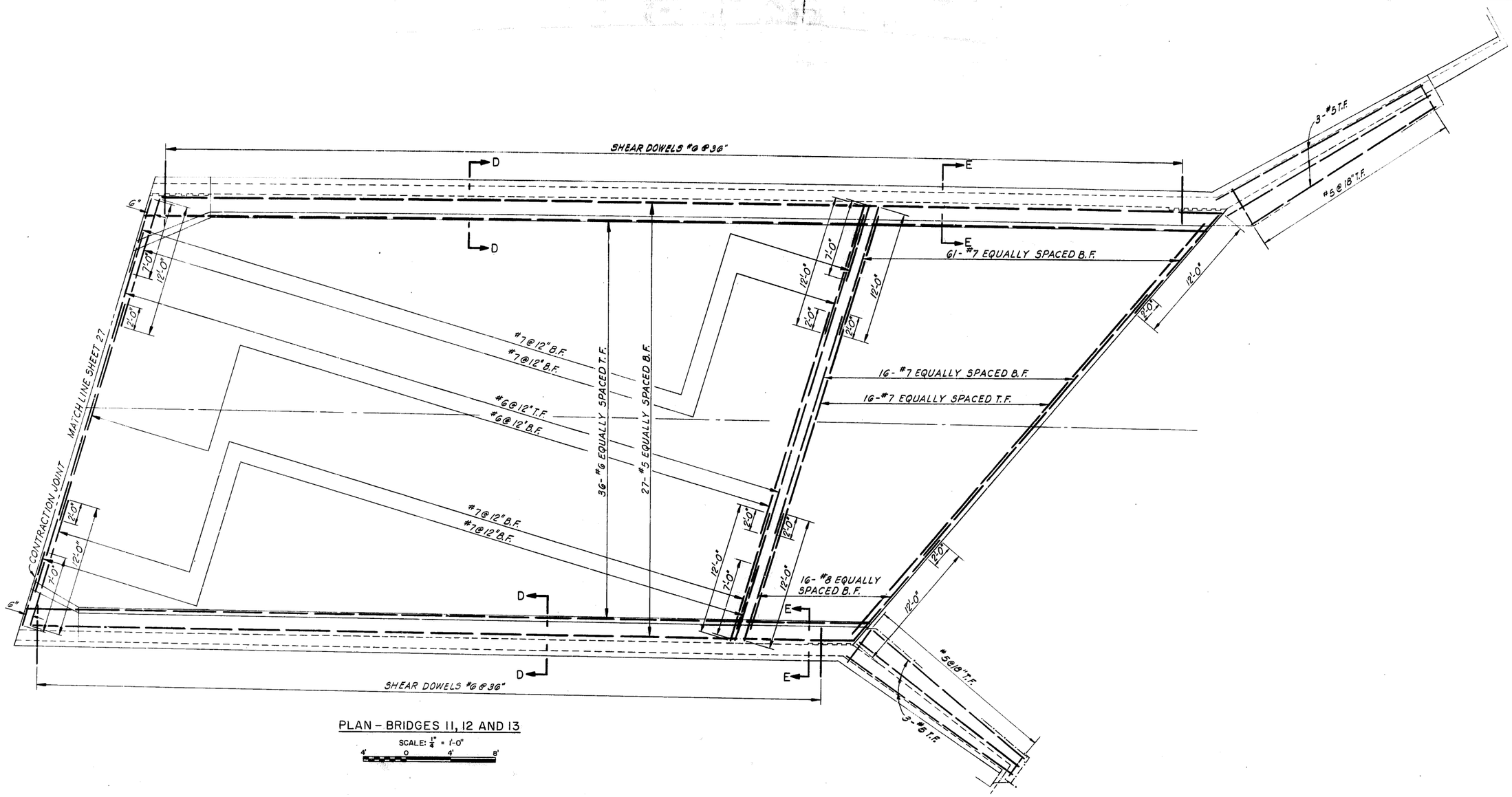
LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGES 11, 12 AND 13
REINFORCEMENT

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/27

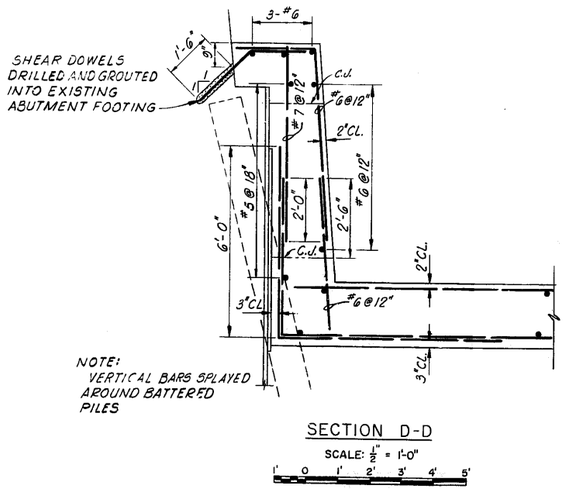
SHEET 27 OF 29

PLATE 25



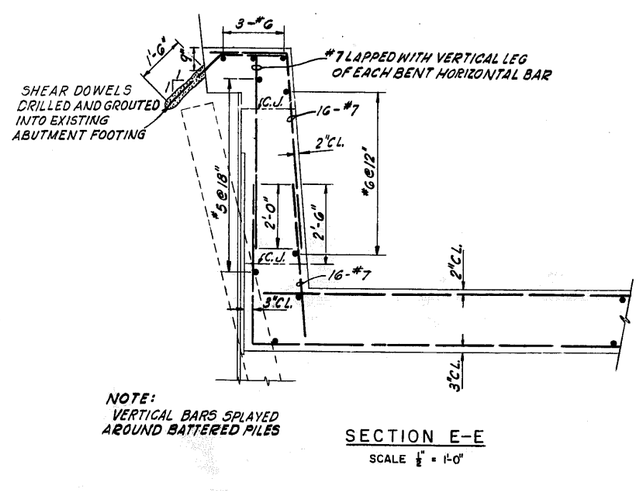
PLAN – BRIDGES 11, 12 AND 13

SCALE: 1/4" = 1'-0"



SECTION D-D

SCALE: 1/2" = 1'-0"



SECTION E-E

SCALE 1/2" = 1'-0"

NOTES:

FOR REINFORCEMENT NOTES, SEE SHEET 12.

AS CONSTRUCTED

SUBMITTED: J. N. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: R. Alex Kelly, COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

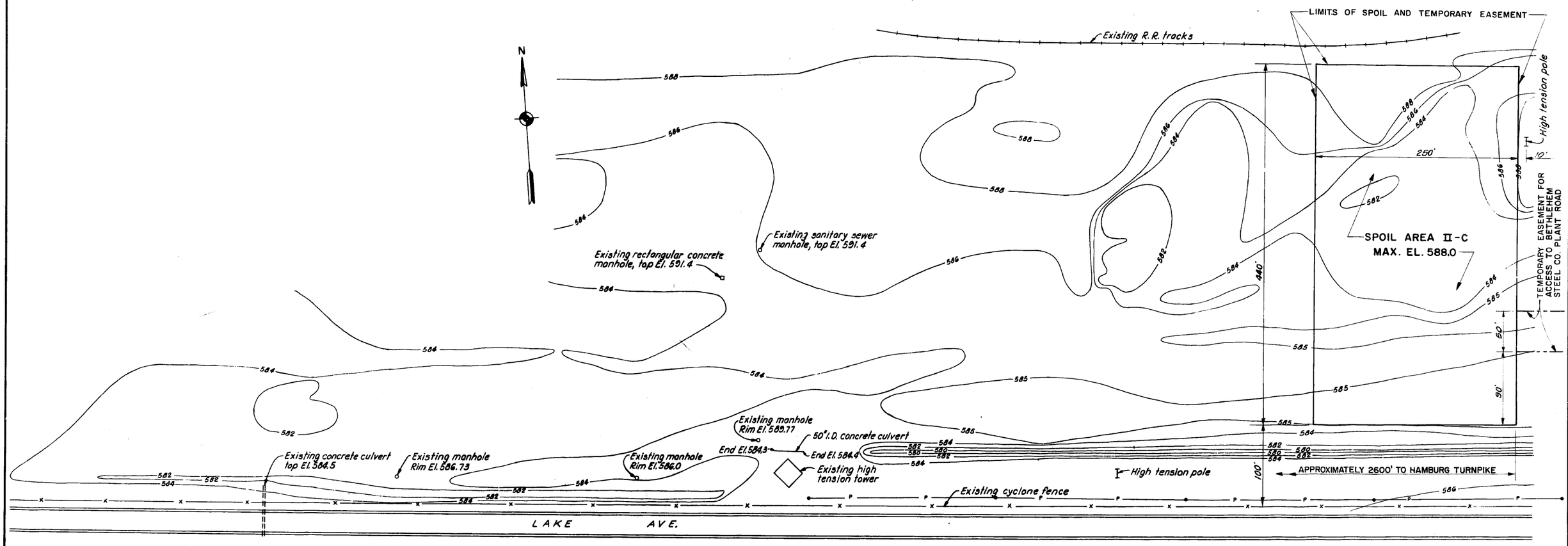
DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY: K.A.H.
SUBMITTED BY: Joseph A. Wemmel, CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL. C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965
APPROVED: TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27
DATE:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 13
REINFORCEMENT

SCALE: AS SHOWN | SPEC. NO.

DRAWING NUMBER 182-A-5/28
SHEET 28 OF 29

PLATE 36



PLAN

SCALE 1"= 50'

50' 0 50' 100'

NOTE:

FOR GENERAL NOTES, SEE SHEET 2.

AS CONSTRUCTED

SUBMITTED: J. N. Hannigan, CHIEF, OPERATIONS DIVISION

APPROVED: [signature], COL., C. E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO 7, NEW YORK

DRAWN BY: V.C.B.
DESIGNED BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II

SPOIL AREA II-C

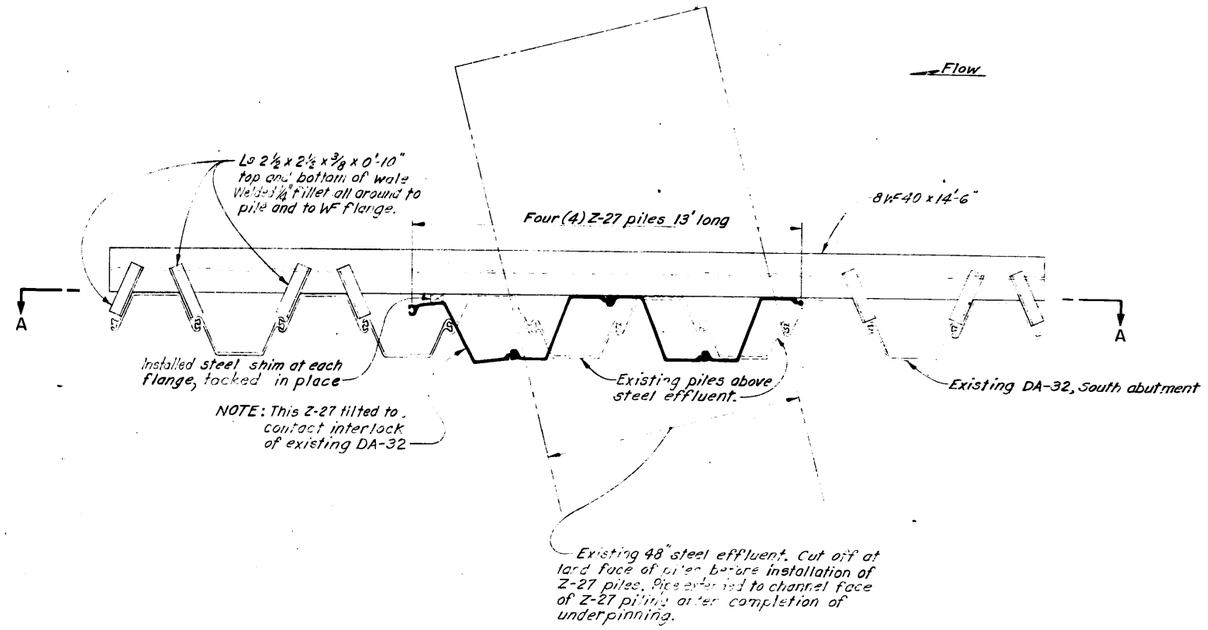
APPROVED: [signature], COL., C.E. DISTRICT ENGINEER
DATE: 4 JAN. 1965

APPROVED:
TO ACCOMPANY SPECIFICATIONS
SERIAL NO. CIVENG-30-023-65-27
DATE:

SCALE: AS SHOWN SPEC. NO.

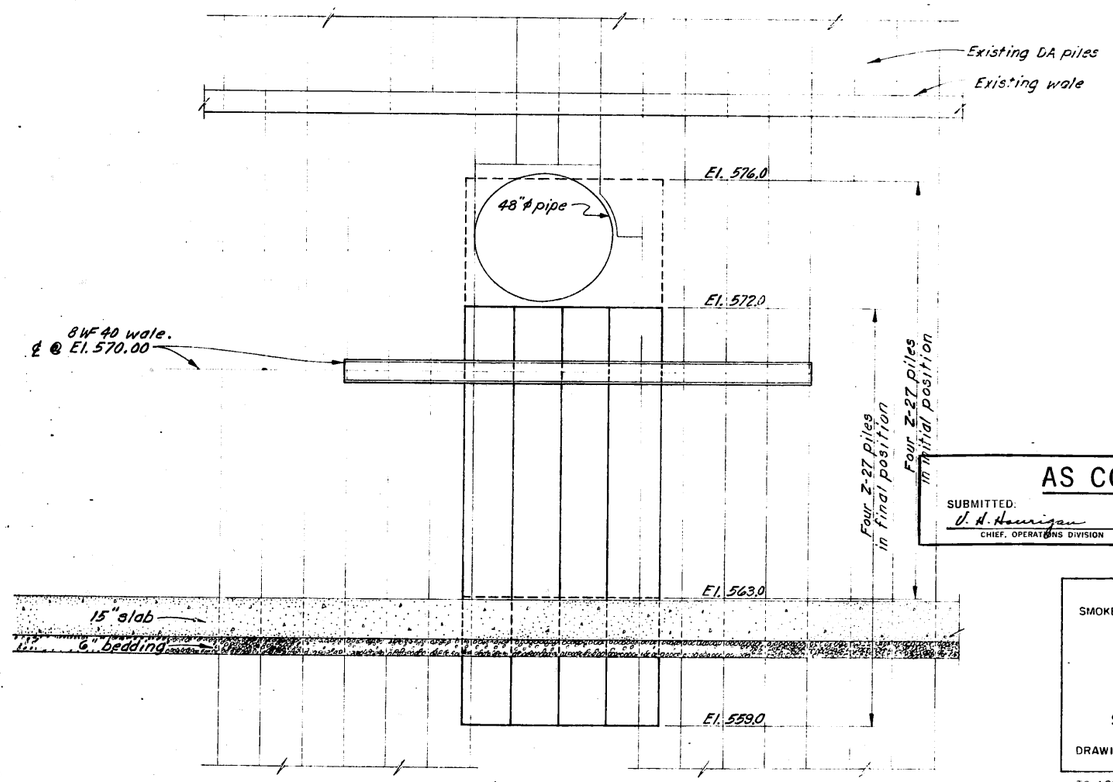
DRAWING NUMBER
182-A-5/29
SHEET 29 OF 29

PLATE 27



PLAN
SCALE: 1"= 1'-0"

BRIDGE NO. 8 – SOUTH ABUTMENT



ELEVATION A-A
SCALE: ½"= 1'-0"

AS CONSTRUCTED

SUBMITTED: U. A. Hannigan
CHIEF, OPERATIONS DIVISION

APPROVED: R. Bee Kelly
COL., C.E. DISTRICT ENGINEER

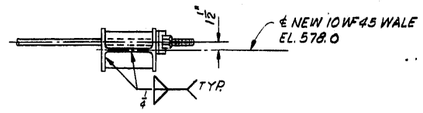
LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK

SECTION II

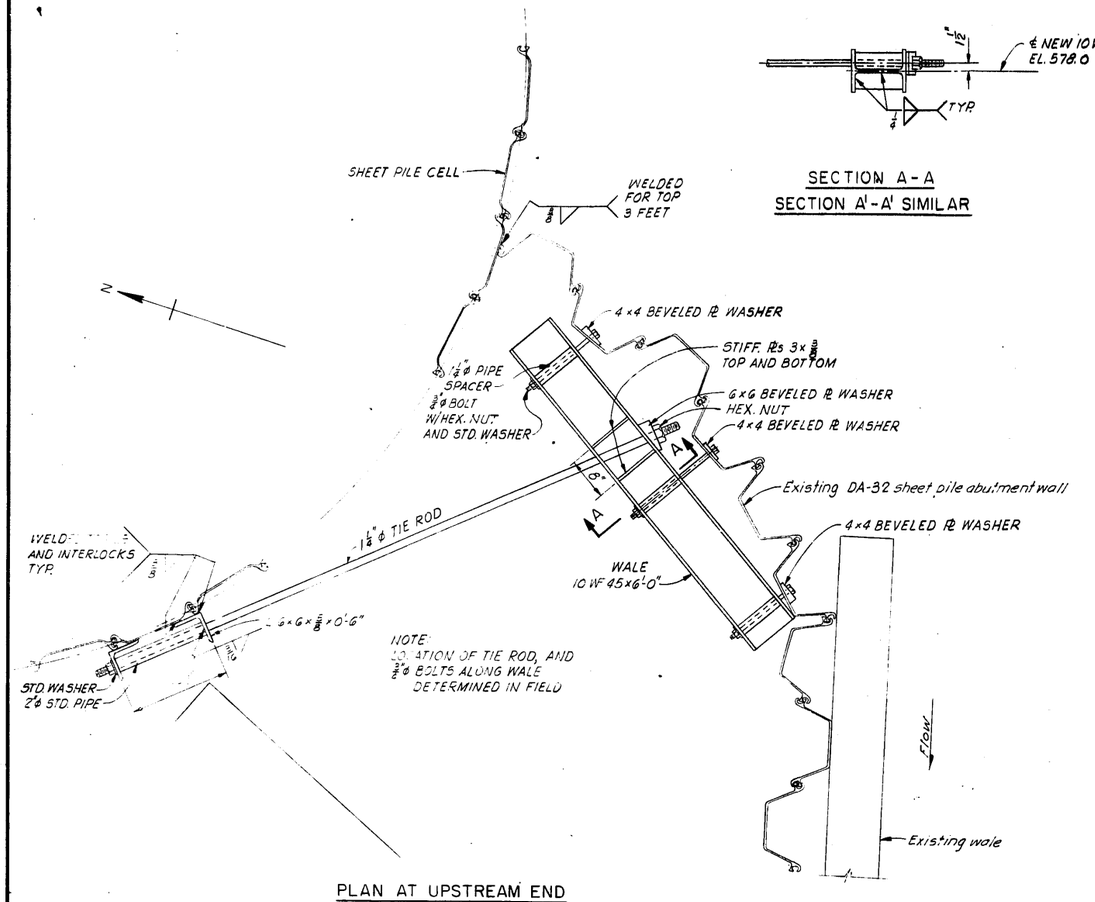
BRIDGE NO. 8
SOUTH ABUTMENT REPAIR

DRAWING NO. 182-5/30 SHEET 30

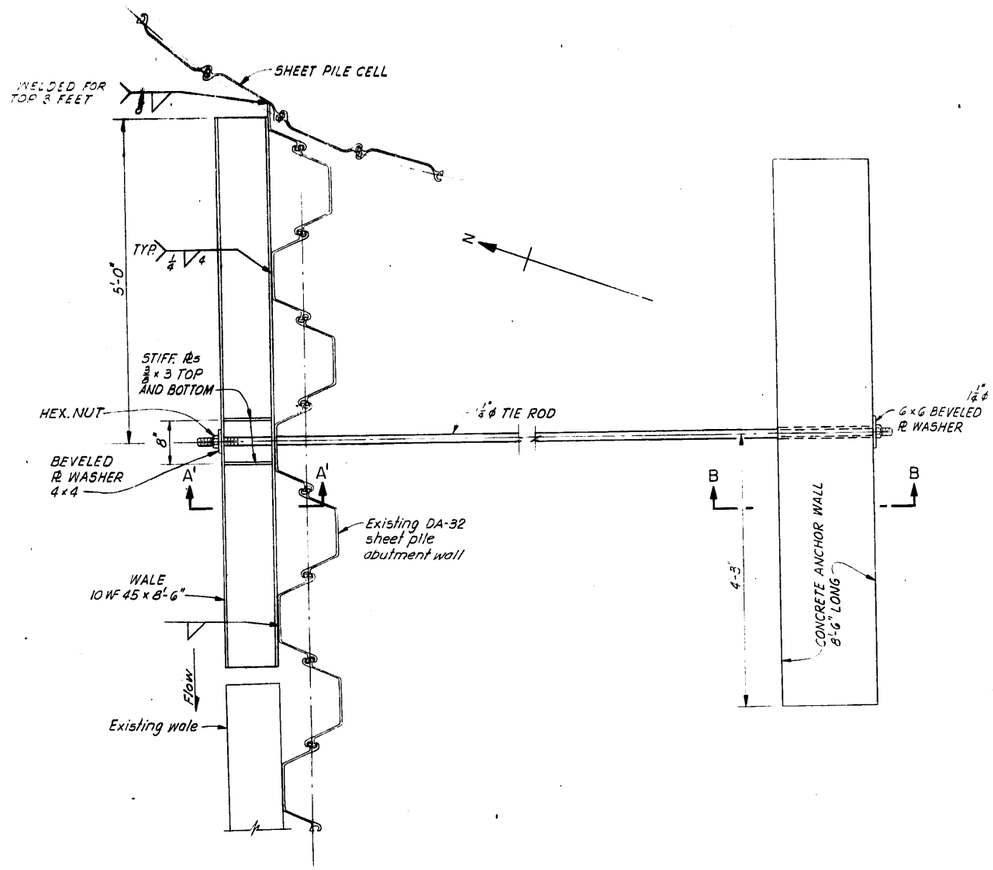
TO ACCOMPANY MODIFICATION NO. 4
TO CONTRACT DA-30-023-CIVENG-65-47



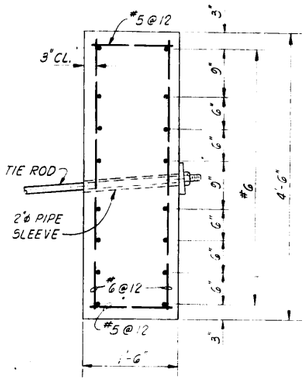
SECTION A-A
SECTION A'-A' SIMILAR



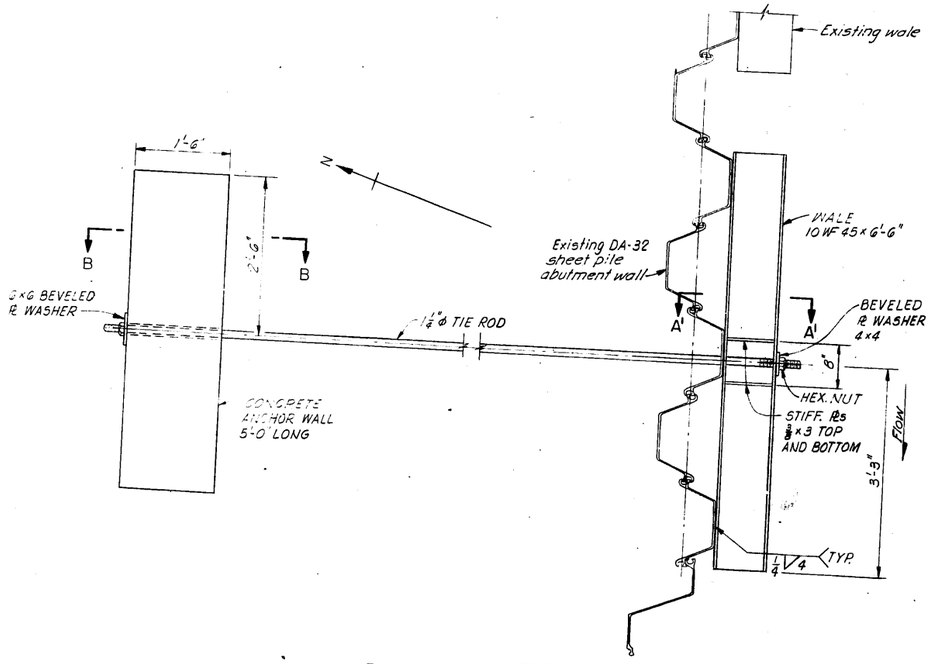
PLAN AT UPSTREAM END
OF RIGHT ABUTMENT
SCALE: 1" = 1'-0"



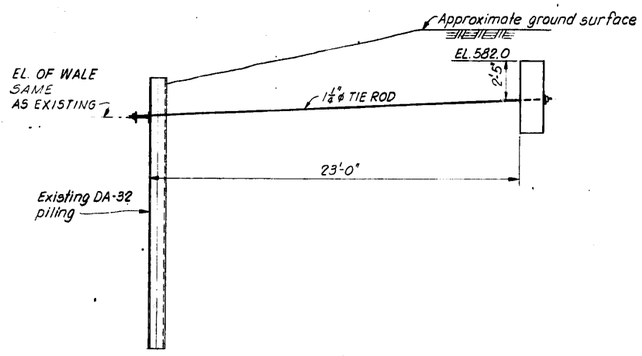
PLAN AT UPSTREAM END
OF LEFT ABUTMENT
SCALE: 1" = 1'-0"



SECTION B-B



PLAN AT DOWNSTREAM END
OF RIGHT ABUTMENT
SCALE: 1" = 1'-0"



TYPICAL SECTION AT TIE ROD
AND ANCHOR WALL
SCALE: ¼" = 1'-0"

NOTES

Anchor walls placed without forms provided 3" minimum reinforcement cover.
Work this sheet with sheet 18.

AS CONSTRUCTED

SUBMITTED: J. H. Hannigan
CHIEF, OPERATIONS DIVISION

APPROVED:
COL., C.E. DISTRICT ENGINEER

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DISTRICT, BUFFALO
CORPS OF ENGINEERS
BUFFALO, NEW YORK 14207

DRAWN BY: V.C.B.
DESIGNED BY: FJL
CHECKED BY: MSH
SUBMITTED BY: Joseph H. Wenzel, CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED: Ralph L. Gallagher, CHIEF, ENGINEERING DIVISION

LOCAL FLOOD PROTECTION
SMOKES CREEK AT LACKAWANNA, NEW YORK
SECTION II
BRIDGE 8
SHEET PILE WALL REPAIRS

APPROVED: COL. C. E. DISTRICT ENGINEER
DATE: 28 JUNE 1966

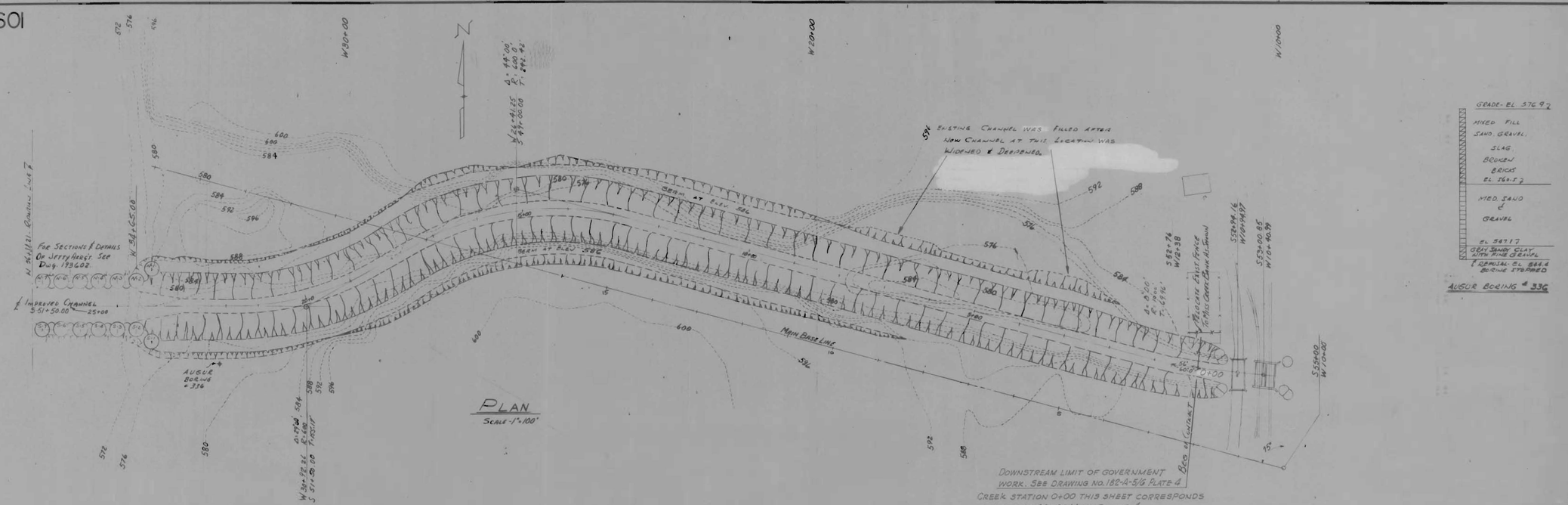
SCALE: AS SHOWN

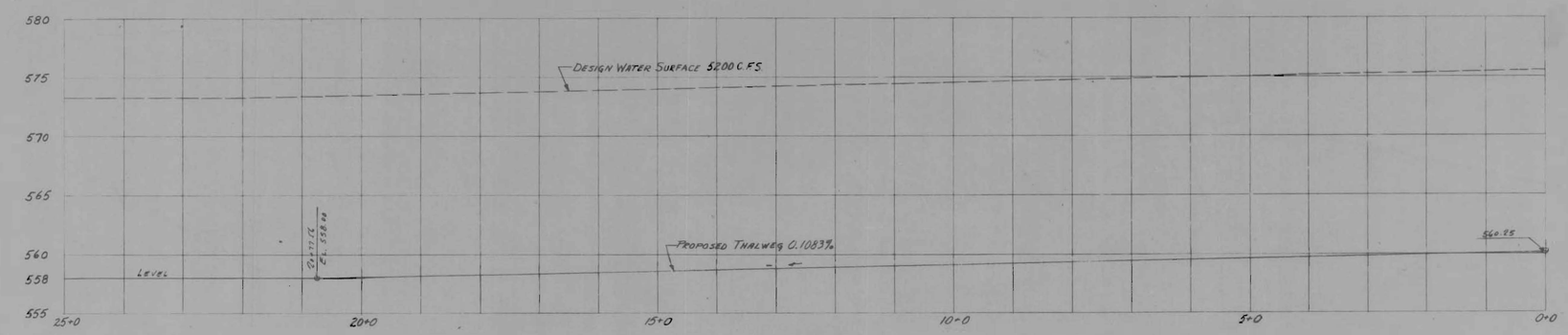
TO ACCOMPANY SPECIFICATIONS SERIAL NO. CIVENG-30-023-65-27

DRAWING NUMBER 182-A-5/31
SHEET 31

PLATE 22

193601





Profile
Scale-Hor. 1"=100'
Vert.-1"=5'

Note:-
Work this drawing with drawing 193602.

Requisition Listing
Construction Services - 327-4624
Fabricated Tee Sections 327-4625
Sheet Piling - 327-5447

AS CONSTRUCTED By Bethlehem Steel Corp.

SUBMITTED: J. H. Harrigan, Chief, Operations Division
APPROVED: R. B. Zuft, Col., C.E. District Engineer

Revision			Finishes on this drawing conform to A. I. S. E. standards
Number	Date	Initial	
	7-64	HBD	SMOKES CREEK FLOOD CONTROL
			WEST END OF CREEK
			CHANNEL IMPROVEMENT &
			JETTY ARRANGEMENT
			GENERAL ARRANGEMENT
			LACKAWANNA

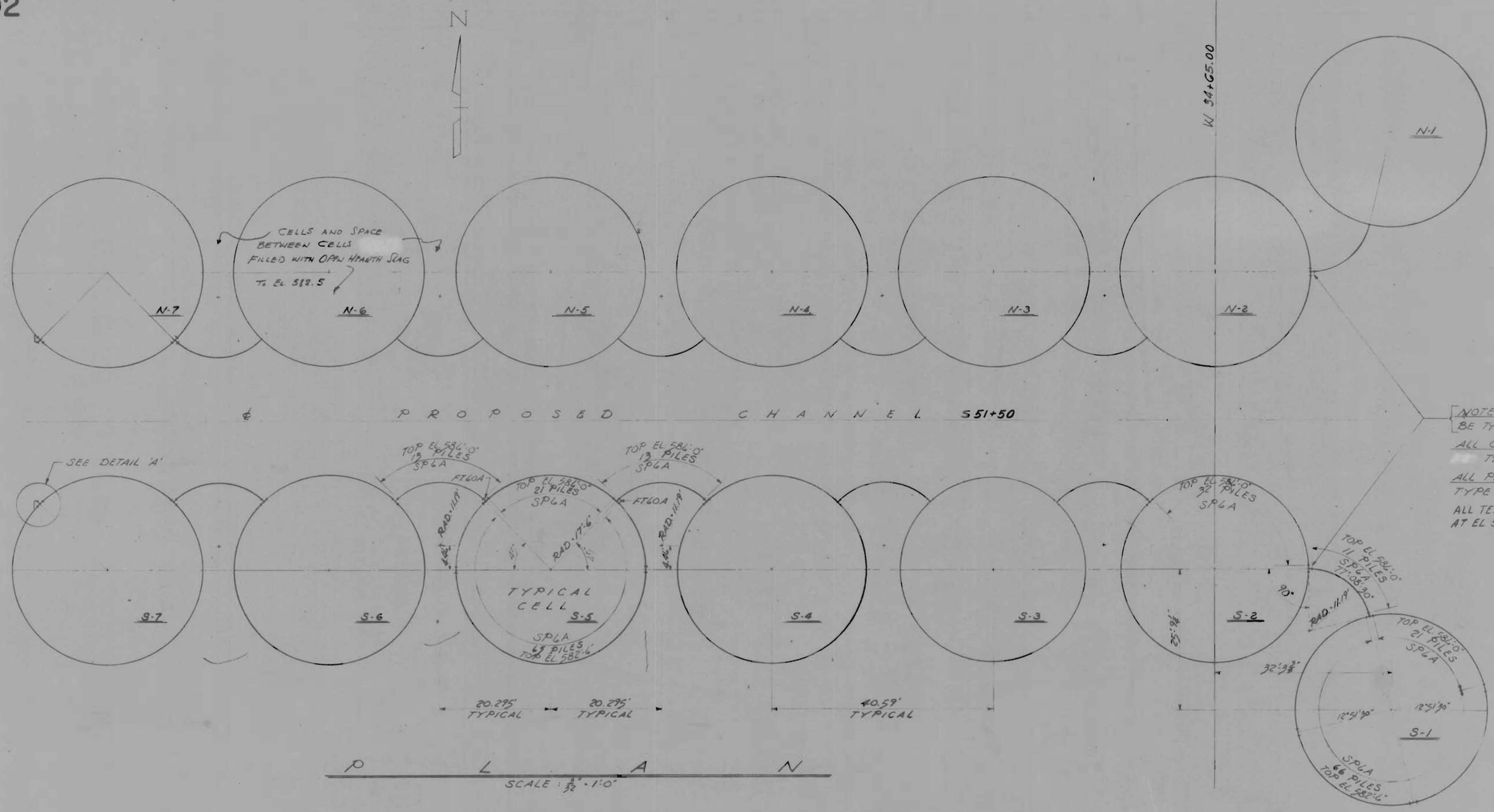
Drawing No. 193601

193602 Plan & Details of Jetty

182-A-10/1

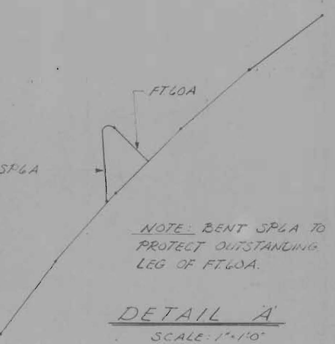
PLATE 31

193602



PLAN

SCALE : 3/32" = 1'-0"



NOTE: BENT SP6A TO PROTECT OUTSTANDING LEG OF FT 60A.

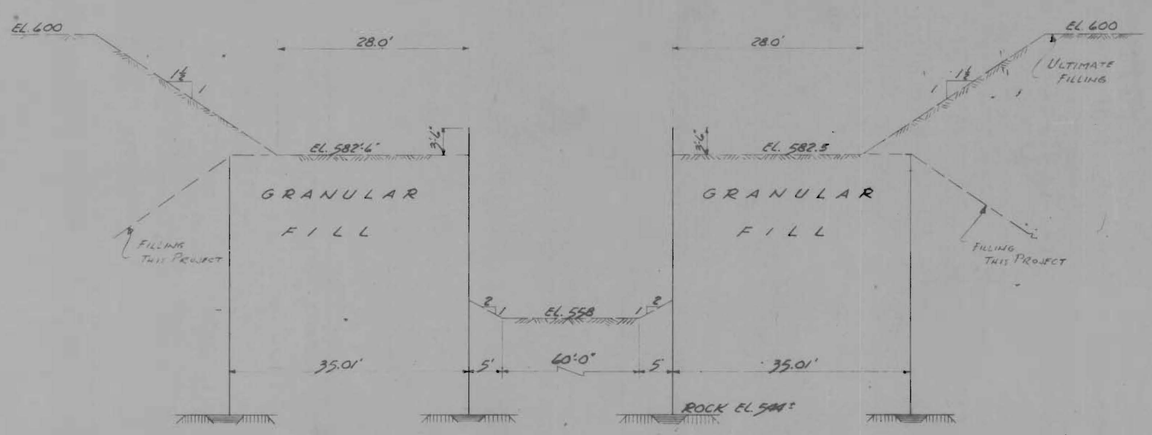
DETAIL 'A'

SCALE: 1"=1'0"

NOTE THIS TEE MUST BE TYPE FT 61A
ALL OTHER TEES TYPE FT 60A.
ALL PILES TYPE SP6A.
ALL TEES CUT AT EL 586'0".

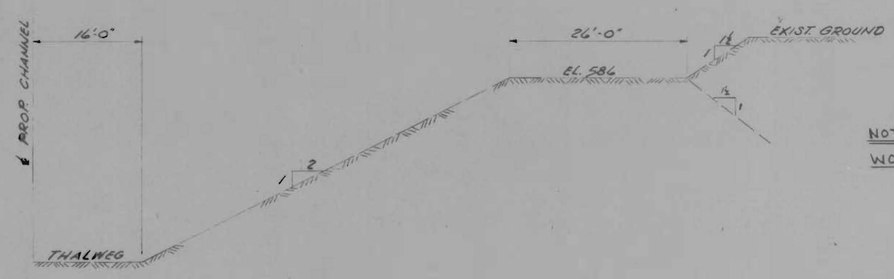
REQUISITION LISTING

CONSTRUCTION SERVICES - 327-4628
FABRICATED TEE SECTIONS: 327-4635
SP6A SHEET PILING - 327-5447
" " " - 327-5588



SECTION THRU CELLS WITH ULTIMATE FILLING

SCALE : 3/32" = 1'-0"



TYPICAL HALF - SECTION THRU CHANNEL SYMMETRICAL ABOUT CENTER LINE

SCALE : 3/32" = 1'-0"

NOTE:-
WORK THIS DRAWING WITH DRAWING 193601

AS CONSTRUCTED By Bethlehem Steel Corp.

SUBMITTED: J. N. Harrigan, CHIEF, OPERATIONS DIVISION
APPROVED: COL., C.E. DISTRICT ENGINEER

REVISION			FINISHES ON THIS DRAWING CONFORM TO A. I. S. E. STANDARDS
Number	Date	Initial	
1	7-3-64	LBD	SMOKES CREEK FLOOD CONTROL
			WEST END OF CREEK
			CHANNEL IMPROVEMENT &
			JETTY ARRANGEMENT
			PLAN, SECTION, & DETAIL

CHECKED BY: B/M 1399, PGS. 865 & 966
PLANT: LACKAWANNA
DRAWN BY: R.F.
SCALE: NOTED-1 ft.
APPROVED: E. K. Barney
BETHLEHEM STEEL
DRAWING NO. 193602

193601	GENERAL ARR'G'T. CHANNEL
DRAWING NO.	REFERENCE

182-A-10/2

PLATE 30