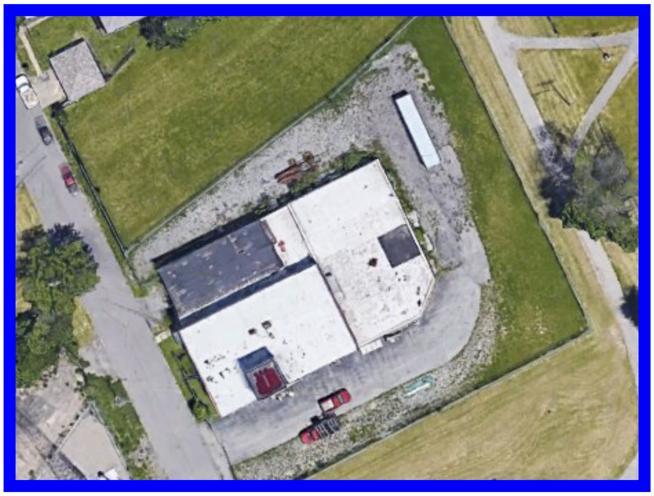
Remedial Investigation/Interim Remedial Measures Work Plan

1 Howell Street Site
Buffalo, New York May 2022 0258-022-002

Prepared For:

Howell Street Venture LLC



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REMEDIAL INVESTIGATION/INTERIM REMEDIAL MEASURES WORK PLAN

1 HOWELL STREET SITE
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May 2022 0258-022-002

Prepared for:

Howell Street Venture LLC

Prepared by:

Benchmark Civil/Environmental Engineering & Geology, PLLC

In Association With:

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Certification

I, Thomas H. Forbes, certify that I am currently a NYS registered professional engineer and that this May 2022 Remedial Investigation/Interim Remedial Measures (RI/IRM) Work Plan for the 1 Howell Street Site was prepared in accordance with applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

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Date

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1.0 INTRODUCTION

This document presents the proposed scope of work and implementation procedures for completion of a Remedial Investigation (RI) and planned Interim Remedial Measures (IRM) at the 1 Howell Street Site (Site), located at 1 Howell Street, Buffalo, New York (see Figures 1 and 2).

The Applicant, Howell Street Venture LLC, acting as a Volunteer, has elected to pursue investigation, cleanup, and redevelopment of the Site under the New York State Brownfield Cleanup Program (BCP), and has submitted a BCP Application to NYS Department of Environmental Conservation (NYSDEC) for eligibility determination. The RI/IRM will be completed by Benchmark Civil/Environmental Engineering & Geology, PLLC (Benchmark), in association with TurnKey Environmental Restoration LLC (TurnKey), on behalf of Howell Street Venture LLC. The work will be completed in general accordance with NYSDEC DER-10 guidelines.

1.1 Site Background

The Site consists of a single 0.73-acre tax parcel (SBL No. 88.36-2-6), addressed at 1 Howell Street, Buffalo, New York (see Figures 1 and 2). The Site is located in a highly developed mixed use residential and commercial area of the City of Buffalo and is currently vacant. The Site includes the existing building, asphalt and gravel covered parking areas, and grass covered areas. The Site was used as a robe manufacturing facility including dye house operations and has a history of petroleum storage and distribution as early as 1915. Historic records indicate robe production including animal hide robe manufacturing. A petroleum service station was located on-Site in the early 1930s, and petroleum terminal bulk storage and distribution operated on-Site from the late 1930s through the 1970s. Multiple commercial operations including window and door repair and manufacturing, roofing contractor, and construction operations have occupied the site.

A portion of the Site, and surrounding off-Site areas, were previously remediated under NYS Spill No. 9507939. NYSDEC Spill documents indicate that gross petroleum contaminated soils remain around the existing building, and in select areas along the property boundary of the Site. Additionally, remedial measures were completed related to elevated polychlorinated biphenyls (PCBs) in sludges that were improperly handled from on-

Site aboveground storage tank (AST) removal in accordance with the Resource Conservation and Recovery Act (RCRA) listing 915173.

A February 2022 Limited Phase II Site Investigation verified that grossly contaminated petroleum soil-fill is present on-Site, as indicated in the NYSDEC Spill records, and Spill No. 2109702 was opened for the Site. Elevated benzene, toluene, ethylbenzene, and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), and metals were identified exceeding the regulatory Part 375 Restricted Residential Use Soil Cleanup Objectives (SCOs). Elevated chlorinated volatile organic compounds (VOCs) were also identified in on-Site soils. Details of the previous investigations are presented in Section 2.8 below and copies of the reports are provided electronically in Appendix B.

1.2 Project Objectives

For sites entering the Brownfield Cleanup Program (BCP) at the point of investigation, NYSDEC requires completion of an RI. However, due to the timing of the project schedule, an IRM component has been included in this work plan to address known contamination and that identified during the RI. The primary objectives of the RI/IRM/AA are to:

- Collect additional on-Site media samples, under appropriate quality assurance/quality control criteria, to better delineate the nature and extent of contamination; and determine if contamination has and/or has potential to migrate off-Site;
- Assess the groundwater flow direction and groundwater quality conditions at the Site;
- Determine if the concentrations of constituents of concern in soil, groundwater, and/or soil gas pose potential unacceptable risks via on-Site and off-Site qualitative exposure assessment in accordance with DER-10 Appendix 3b; and,
- Provide the data needed to evaluate potential remedial measures and determine appropriate actions to address potential risks.

As part of the RI/IRM/AA process, sampling data will be used to evaluate whether remedial alternatives can meet the objectives. The intended uses of these data dictate the confidence levels. Two (2) data confidence levels will be employed in the RI/AA: screening level data and definitive level data. In general, screening level confidence will apply to field measurements, including photoionization detector (PID) measurements, groundwater elevation measurements, and field analyses (i.e., pH, temperature, dissolved oxygen (DO), oxygen reduction potential (ORP) specific conductivity, and turbidity). Definitive level confidence will apply to samples for chemical analysis. The applicability of these levels of data will be further specified in the Quality Assurance Project Plan (QAPP) discussed in Section 4.0. Sampling and analytical acceptance and performance criteria such as precision, accuracy, representativeness, comparability, completeness, and sensitivity, are defined in the QAPP.

An IRM is planned to address known environmental impacts at the Site and those identified during the RI. An IRM will quickly mitigate risks to public health and the environment. In general, IRM activities may include: demolition of building, excavation and removal of underground storage tanks (USTs) and appurtenant piping known to be present beneath the building, excavation of grossly contaminated petroleum soil/fill, including beneath the existing building, and excavation of impacted soil/fill to achieve a minimum Restricted Residential Use cleanup. This Work Plan presents the scope of anticipated IRM activities based on current information and may be modified, subject to Department approval, after the RI fieldwork is completed.

The Volunteer's intent is for the planned IRMs to constitute the remedy for those specific areas of the Site, and additional remedial measures will be evaluated in the Alternatives Analysis.

Details of the planned IRM activities are included in Section 4.0.

1.3 Project Organization and Responsibilities

The Volunteer, Howell Street Venture LLC, has applied to the NYS BCP as a non-responsible party (Volunteer) per ECL§27-1405. Benchmark will complete the RI and manage the brownfield cleanup on behalf of the Volunteer. Benchmark will verify and certify that the brownfield investigation and remedial action was completed in conformance with the approved work plan(s) and NYSDEC DER-10 requirements. The NYSDEC Division of Environmental Remediation (Region 9), in consultation with the New York State Department of Health (NYSDOH) shall monitor the investigation and remedial actions to verify that the work is performed in general accordance with the Brownfield Cleanup Agreement (BCA), the Department approved Work Plan(s), and DER-10 guidance.

Site related contact information for this project is listed below. Appendix A includes resumes for Benchmark's project personnel. Once subcontract agreements are in place and a field schedule determined, information for subcontractors will be available for NYSDEC review.

Company	Role	Name	Contact Information
Howell Street Venture LLC	BCP Volunteer	S. Savarino	(716) 332-5959
Benchmark EES	Principal Engineer (BCP)/Project Officer	Thomas H. Forbes, P.E.	(716) 856-0599
Benchmark-TurnKey	Sr. Project Manager	Michael Lesakowski	(716) 856-0635
Benchmark-TurnKey	Project Manager	Nathan Munley	(716) 856-0635
TBD	Analytical Testing	TBD	TBD
TBD	Drilling Services	TBD	TBD
TBD	Excavation Services	TBD	TBD
Data Validation	DUSR	TBD	TBD

2.0 SITE DESCRIPTION

2.1 General

The Site is located at the southernmost end of Howell Street, in a mixed use commercial and residential area of the City of Buffalo, Erie County, New York. The Site is bordered by Howell Street to the west, the Scajaquada Creek Greenway Trail and a commercial retail center (grocery store) to the east, a municipal park and Scajaquada Creek to the south, and commercial and residential properties to the north. The Site is currently vacant, with the existing building, asphalt and gravel parking areas, and grass covered areas (see Figure 2).

2.2 Site Topography and Drainage

The Site is generally flat lying with limited topographic features. The surface of the Site is covered with the existing building, asphalt and gravel parking areas, and limited green space. Precipitation (i.e., rain or melting snow) infiltrates through the non-hardscaped surfaces or moves to the storm drains on-Site and/or in the roadways via overland flow. It would be assumed that waters flow south to the Scajaquada Creek. Groundwater will be further assessed during the RI.

2.3 Geology and Hydrogeology

2.3.1 Overburden

According to the United States Department of Agriculture (USDA) Web soil survey Site soils are characterized as Urban Land (Ud). Soils within the City of Buffalo are characterized as urban land (Ud) with surface covered by asphalt, concrete, buildings, or other impervious structures, typical of an urban environment. The presence of overburden fill material is widespread and common throughout the City of Buffalo.

Previous investigations have identified fill material in accessible areas on-Site ranging from approximately 0.5-3 fbgs, generally described as consisting of ash, cinders, brick, and concrete underlain by assumed native (potentially reworked) sandy lean clay to at least 16 fbgs. Previous remedial excavations have been backfilled with offsite fill material to depths of at least 12 fbgs. The geology of the Site and backfill will be further investigated as part of the RI activities.

2.3.2 Bedrock

Based on the bedrock geologic map of Erie County, the Site overlies the Onondaga Formation of the Middle Devonian Series. The Onondaga Formation is comprised of a varying texture from coarse to very finely crystalline with a dark gray to tan color and chert and fossils within. The unit has an approximate thickness of 110 to 160 feet.

Bedrock was not encountered during previous investigations.

2.3.3 Hydrogeology

The Site is located within the Lake Erie-Niagara River major drainage basin, which is typified by little topographic relief, except in the immediate vicinity of major drainage ways. In the Erie-Niagara Basin, the major areas of groundwater are within coarser overburden deposits and limestone and shale bedrock. Regional groundwater appears to flow south towards Scajaquada Creek approximately 125-150 feet south of the Site. Local groundwater flows are likely influenced by subsurface features, such as utilities, and localized subgrade development conditions.

On-Site groundwater quality and flow will be investigated during the RI.

2.4 Climate

The City of Buffalo has a cold continental climate, with moisture from Lake Erie causing increased precipitation. Average annual precipitation is reported as 40.5 inches and average snowfall is 94 inches. The average temperature is 48.3 degrees Fahrenheit. The ground and lakes typically remain frozen from December to March. Winds are generally from the southwest (USClimateData.com).

2.5 Population and Land Use

The City of Buffalo, encompassing 40.38 square miles, has a population of 278,349 (2020 US Census Bureau). The Site is located in Census Tract 55, in the area of the City zoned for residential use.

The current zoning for the Site per the City of Buffalo green Code is N-2R which are defined as residential areas adjoining more intense mixed-use centers with compact residential blocks and mixed use buildings. The surrounding land-use is predominantly mixed use commercial and residential.

2.6 Utilities and Groundwater Use

The Site has access to major public and private utilities, including potable water (Buffalo Water Authority), sanitary and storm sewers (Buffalo Sewer Authority), electric (National Grid), and natural gas (National Fuel Gas).

Groundwater at the Site is assigned Class "GA" by 6NYCRR Part 701.15. Currently, there are no deed restrictions on the use of groundwater at the Site; however, the City of Buffalo does not allow the use of groundwater within the City limit and there are no groundwater supply wells on the property. Regionally, groundwater in the area has not been developed for industrial, agriculture, or public supply purposes. Municipal potable water service is provided on-Site and to areas surrounding the Site.

2.7 Wetlands and Floodplains

There are no State or Federal wetlands located on Site.

A Zone AE Regulatory Floodway exists approximately 75 ft south of the Site associated with Scajaquada Creek.

2.8 Previous Investigations

A summary of the previous investigation that occurred at the Site is presented below and included in Appendix B. Results are summarized on Tables 1 and 2 and locations are identified on Figure 3.

2.8.1 Historic Environmental Records

Historic records relative to the Site and previous remedial activities associated with it indicate the following:

- Historic operations including robe manufacturing with dye house operations, petroleum bulk storage and distribution, window manufacturing, and other commercial operations.
- Multiple underground storage tanks (USTs) and aboveground storage tanks (ASTs) were present on Site, including subgrade distribution piping.
- Historic records indicate potential tanks beneath a portion of the existing building – removal records are not available.

- NYSDEC Spill 9507939 records indicate grossly contaminated petroleum soils (GCPS) remain on Site post-Spill closure activities.
- Records indicate the presence of subgrade petroleum piping present beneath the existing building, assumed along the southern, eastern, and northern portions of the building where former piping was located.
- PCB contamination associated with former AST sludge removal (915173) completed in 2001.
- Gross contamination is present along the Site boundary in two (2) locations, including Howell Street, post-Spill closure.

2.8.2 February 2022 - Ltd. Phase II Environmental Investigation

TurnKey completed a Limited Phase II Environmental Site Investigation in February 2022 for Howell Street Venture, LLC. Findings of the Phase II are detailed below:

- Grossly contaminated petroleum soils (GCPS) was identified in all 11 test pit locations, including stained black soils, strong odors, elevated PID readings as high as 400 ppm, product in soil-fill, and product-sheen on water.
- Impacts to the assumed backfill from prior removal activities were identified.
- Fill material was generally described as consisting of ash, cinders, and brick at all test pit locations across the Site.
- Elevated BTEX, PAHs, and metals were identified exceeding the Part 375 Restricted Residential Use SCOSs at 5 of 6 investigation locations sampled. Elevated VOCs and SVOCs were identified exceeding RRSCOs in 9 of 14 historic post-removal sample locations, including elevated Total PAHs exceeding 500 ppm.
- Elevated chlorinated VOCs, including PCE, TCE, DCE, and VC were identified in Site soils. No groundwater or VI data was collected.
- Based on the field evidence and analytical results, the NYS Spill hotline was notified, and Spill No. 2109702 was assigned to the Site.

2.9 Primary Constituents of Potential Concern

Based on findings to date, and discussions with the NYSDEC the Primary Constituents of Potential Concern (COPCs) presented by media are:

- ***Soil/Fill:*** Grossly Contaminated Petroleum Soils (GCPS), VOCs, chlorinated solvents, PAHs and select metals.

3.0 REMEDIAL INVESTIGATION SCOPE OF WORK

The RI scope of work is focused on defining the nature and extent of contamination on-Site; delineating the extent of known contamination in soil/fill to be addressed as part of the IRM, identifying the source(s) of contamination; defining chemical constituent migration pathways; qualitatively assessing on- and off-Site human health and ecological risks (if necessary); and obtaining data of sufficient quantity and quality to perform an alternatives analysis.

Field team personnel will collect environmental samples in accordance with the rationale and protocols described in the QAPP in Section 5. USEPA and NYSDEC-approved sample collection and handling techniques will be used. Samples for chemical analysis will be analyzed in accordance with USEPA SW-846 methodology with an equivalent Category B deliverable package to meet the definitive-level data requirements. Analytical results will be evaluated by a third-party data validation expert in accordance with provisions described in the QAPP. Data submittals will be provided to the NYSDEC in accordance with the most current electronic data deliverables (EDD) protocols.

During intrusive activities, a Community Air Monitoring Plan (CAMP) will be followed. The CAMP is consistent with the requirements for community air monitoring at remediation sites as established by the New York State Department of Health (NYSDOH) and NYSDEC. Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 (May 2010) Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

The investigation approach is described below. The proposed RI sample locations are presented on Figure 4 and the planned sampling and analytical program is detailed on Table 2.

3.1 Pre-Investigation Activities

3.1.1 Utility Clearance

Prior to intrusive activities, Dig Safely New York (Call 811 or similar) will be contacted by the Site contractor a minimum of three (3) business days in advance of the work and informed of the intent to perform intrusive work at the Site. If underground utilities are present on the property and are anticipated to interfere with intrusive activities, the Applicant and the NYSDEC will be contacted to discuss mitigating measures.

3.2 Building Demolition

Based on the current condition of the existing buildings, above-grade demolition is necessary to allow for safe completion of the planned RI/IRM activities. Evidence of a former fire in the building is clearly visible, and multiple areas of the existing roof have failed. It is apparent from the exterior, that interior walls have failed also. The building is currently unsafe for subsurface drilling and/or excavation equipment and workers to complete remedial activities within the current building condition.

Therefore, the Volunteer intends to retain a demolition contractor to remove the building prior to completion of the RI field activities. After completion of the pre-demolition activities, demolition of the above grade structure will be completed to the lowest intact slab elevation and foundation(s).

Based on the presence of petroleum contamination beneath the building, the building foundations and slab(s) will not be removed prior to RI activities but will be removed as part of the planned IRMs in accordance with the City of Buffalo demolition permit.

3.3 RI Soil/Fill Investigation

A soil/fill investigation will be completed across the Site to further assess whether additional impacts exist beyond the limits of, and to assess the extent of, known historical contamination. The soil/fill investigation will include the collection of shallow and deeper ranging soil/fill samples. The soil/fill investigation will consist of surface soil samples and test pit investigation soil samples to allow for characterization of soil/fill material and sample collection. The proposed RI sample locations are presented on Figure 4 and the sampling and analytical program is presented on Table 3. Benchmark will provide oversight for the investigation work and create a field log (including photographs) of investigation locations. Field Operating Procedures (FOPs) are provided in Appendix D.

3.3.1 Surface Soil Sampling

Select areas of the Site along the eastern boundary are currently grass covered. Three (3) surface soil (SS) samples will be collected from this area of the Site during the RI (see Figure 4). SS samples will be collected from 0-6-inches below surface vegetative cover to allow for characterization and assessment. Soil samples will be visually inspected and screened with PID. Table 2 details the planned surface soil sample analysis. If elevated PID readings, and/or visual or olfactory evidence of impacts are detected, additional VOC analysis will be completed.

In the event that shallow non-soil fill material is identified in the upper 6-inches, no SS sample will be collected at that location and soil/fill at that location will be analyzed as part of the subsurface soil/fill characterization, as described below.

3.3.2 Subsurface Soil/Fill Investigation

A total of sixteen (16) additional subsurface soil/fill investigation locations will be advanced across the Site during the RI. Twelve (12) test pits, identified as TP-12 through TP-23, will be completed across the Site (see Figure 4). Test pits will be excavated to a target minimum depth of 15 fbgs, or equipment refusal, whichever is shallower. Excavated test pit spoils will be placed on the ground surface next to the test pit location. Once the test pit work is complete, spoils will be placed back into the excavation in the general order in which it was removed.

Four (4) soil borings, identified as MW-1 through MW-4, will be advanced to collect soil samples and allow for the installation of groundwater monitoring wells. Soil borings will be advanced to target minimum depth of 15 fbgs or equipment refusal, whichever is shallower.

All soil samples will be field screened for the presence of volatile organics using a photoionization detector (PID) with a 10.6 eV lamp, as a procedure for ensuring the health and safety of personnel at the Site, and to identify potential impacts in soil/fill samples for laboratory analysis. Upon reaching the completion depth of each location, field visual/olfactory and PID results will be reviewed, and sample intervals will be determined.

3.3.3 Soil/Fill Sample Analysis

Table 2 summarizes the proposed sample collection and analytical program. The soil samples will be collected to further delineate the horizontal and vertical extent of the known contamination, delineate known or suspected impacted areas, and determine if other impacts requiring remediation are present at the Site. The sample interval identified as the most impacted (i.e., greatest PID scan result and/or visual-olfactory evidence of impact) will be selected for laboratory analysis. If either the impacts are ubiquitous from grade to final depth or no impacts are identified, the soil/fill directly above water table will be selected for analysis. If the impacts are ubiquitous from grade to final depth, no impacts are identified, and water is not encountered at a particular sample location or within a particular layer, the sample interval will be selected based on the professional discretion of the field personnel and in consultation with the NYSDEC. If differentiable impacts are noted during the investigation, additional sample location(s) will be collected.

Select soil samples will be collected and analyzed for Target Compound List (TCL) plus CP-51 List VOCs plus Tentatively Identified Compounds (TICs), TCL semi-volatile organic compounds (SVOCs) plus TICs, Target Analyte List (TAL) metals, polychlorinated biphenyls (PCBs), pesticides, herbicides, 1,4-Dioxane, and per- and polyfluoroalkyl substances (PFAS).

En-core samplers will be used to collect RI VOC soil samples. Remaining samples will be collected and placed into pre-cleaned laboratory provided sample bottles, cooled to 4ºC in the field, and transported under chain-of-custody command to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory. Soil samples will be analyzed in accordance with the Sampling and Analysis Plan (SAP) presented on Table 3.

3.4 Groundwater Investigation

Four (4) groundwater monitoring wells, identified as MW-1 through MW-4, will be advanced to allow for assessment of groundwater quality and flow. Proposed groundwater monitoring well locations are shown on Figure 4. Monitoring well installation and groundwater sample collection details are discussed in the following sections.

3.4.1 Monitoring Well Installation

Each monitoring well boring will be advanced to a target minimum depth of five feet below the first encountered water. Final depth and placement of wells will be based on the site soil type identified and hydrogeology, and consideration of potential contaminants (e.g., confining clay layer, if encountered). All non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (e.g., Alconox).

Each well will be constructed with two (2)-inch diameter Schedule (SCH) 40 PVC with a minimum five (5)-foot flush joint SCH 40 PVC 0.010-inch machine-slotted well screen. Each well screen and attached riser will be placed at the bottom of the borehole and a silica sand filter pack (size #0) will be installed from the base of the well to a minimum of two (2)-feet above the top of the screen. A seal (e.g., bentonite chip) will then be installed to mitigate the potential for downhole contamination. The newly installed monitoring wells will be completed with keyed-alike locks, a lockable J-plug, and protective casing/road box.

3.4.2 Well Development

After installation, the new monitoring wells will be developed in accordance with Benchmark and NYSDEC protocols. Based on the field measurements during installation, wells will be developed a minimum of 24 hours after installation, or longer based on the well construction and field data. Development of the monitoring wells will be accomplished with dedicated disposable polyethylene bailers via surge and purge methodology. Field parameters including pH, temperature, turbidity, DO, ORP, and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they become relatively stable. Stability will be defined as variation between measurements of approximately 10 percent or less with no overall upward or downward trend in the measurements. A minimum of three (3) well volumes will be evacuated from each monitoring well. Development water from the monitoring wells will be containerized in drums and properly labeled. Based on the RI groundwater analytical results, it will be determined, in consultation with the Department, if the containerized development water is acceptable for surface discharge or requires subsequent on-Site treatment and/or off-Site disposal.

3.4.3 Groundwater Sample Collection

Groundwater samples will be collected a minimum of 24-hours after well development. Prior to monitoring well purging or sample collection, static water levels will be measured and recorded from the monitoring wells to facilitate the preparation of an isopotential map.

Following water level measurement, field personnel will purge (if necessary) and sample monitoring wells using a submersible pump with dedicated pump tubing following low-flow/minimal drawdown purge and sample collection procedures. In the event of pump failure or the saturated unit does not permit the proper implementation of low-flow sampling, a dedicated polyethylene bailer will be used to purge and sample the well. Prior to sample collection via low-flow methodology, groundwater will be evacuated from each well at a low-flow rate (typically less than 0.1 L/min) while maintaining a generally consistent water level. Field measurements for pH, temperature, turbidity, DO, ORP, specific conductance and water level, as well as visual and olfactory field observations will be periodically recorded and monitored for stabilization. Low-flow purging will be considered complete when pH, specific conductivity, DO, ORP, and temperature stabilize and when turbidity measurements fall below 50 Nephelometric Turbidity Units (NTU), or become stable above 50 NTU regardless of volume purged. Purging via disposable bailer, if necessary, will be considered complete following the removal of three (3) well volumes and field parameter stabilization or to dryness, whichever occurs first. In general, stability is defined as variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements.

Groundwater sampling methods will conform with protocol acceptable for the collection of the per- and polyfluoroalkyl substances (PFAS) in accordance with the Department's Sampling, Analysis, and Assessment for PFAS Under NYSDEC's Part 375 Remedial Programs (January 2021). Sampling personnel will wear nitrile gloves while handling empty sample containers, filling sample containers, sealing sample containers, and placement into sample coolers. Clean nitrile gloves be worn while handling sample containers, during the groundwater sampling, and sealing/placement of samples into the laboratory supplied cooler.

Sample collection methods that will be implemented during the RI include:

- **<u>Submersible Pump with Dedicated Pump Tubing</u>**
  Monitoring wells will be purged and sampled using a non-dedicated submersible pump and dedicated HDPE or PVC tubing following low-flow (minimal drawdown) purge and sample collection procedures, as described above. Non-dedicated pumps will require decontamination prior to use at each well location and the collection of an equipment blank.
- **<u>PVC Disposable Bailer</u>**

  If low flow is not feasible (e.g., due to depth to groundwater), wells of any depth (up to 100 fbgs) may be purged and sampled using a PVC disposable bailer via direct grab. In general, a bottom filling dedicated bailer is attached to a length of dedicated nylon rope and lowered into the well smoothly and slowly as not to agitate the groundwater or damage the well. Purging continues until a predetermined volume of water has been removed (typically three (3) well volumes) or to dryness. Measurements for pH, temperature, specific conductance, DO, ORP, and turbidity are recorded following removal of each well volume. The well is purged until the readings for indicator parameters stabilize or the well is purged to dryness.

Prior to and immediately following collection of groundwater samples, field measurements for pH, specific conductance, temperature, DO, ORP, turbidity, and water level as well as visual and olfactory field observations will be recorded. Groundwater samples will be placed in pre-cleaned, pre-preserved laboratory provided sample bottles, cooled to 4°C in the field, and transported under chain-of-custody command to a NYSDOH-approved laboratory for analysis.

3.4.4 Groundwater Sample Analyses

As summarized on Table 3, groundwater samples will be sampled for TCL plus CP-51 List VOCs plus TICs, TCL SVOCs plus TICs, TAL metals, PCBs, pesticides, herbicides, 1,4-dioxane, and PFAS. Groundwater samples will be collected and analyzed in accordance with USEPA SW 846 methodology with equivalent NYSDEC Category B deliverables to allow for independent third-party data usability assessment.

Samples collected for 1,4-dioxane will be analyzed via EPA Method 8270 Selective Ion Monitoring (SIM) mode and samples collected for PFAS analysis will be analyzed via EPA Method 537.1 to achieve reporting limits of 2 nanograms per liter (ng/l).

3.5 Soil Vapor Investigation

Soil vapor will be investigated at three (3) locations to evaluate the potential for soil vapor intrusion (SVI) for future on-site buildings, and to complete a qualitative exposure assessment. Planned SV sample locations are located within the footprint of the planned new building. Sampling equipment will be advanced to a target depth of 6 fbgs to approximate foundation depth of future buildings (depending on depth to groundwater observed during the soil borings). Soil vapor sample locations are shown on Figure 4. One (1) ambient outdoor air sample will also be collected concurrent with the soil vapor samples. Soil vapor sampling probes will be installed in general conformance with the NYSDOH Soil Vapor Intrusion Guidance.

Each soil vapor sampling probe will be installed using specialized stainless steel soil probes. Sampling equipment includes stainless steel sampling screens, ¼-inch inside diameter inert sample tubing and dedicated Summa canisters. Soil boreholes will be advanced to a depth up to 5-6 fbgs. The steel rod will be equipped with an anchor point at the driving end of the rod. The anchor point will be connected to the sampling screen and tubing on the inside of the steel rod. Once the steel rod is advanced to the target depth, the steel rod will be retracted, leaving the anchor point, sampling screen and sampling tubing within the borehole annulus. Glass beads (or equivalent) will be poured around the sampling screen in a manner to cover the entire length of the sampling screen. Bentonite or bentonite/soil mixture will be placed above the glass beads to the ground surface to create a seal to prohibit infiltration of ambient air into the sampling area.

Once the sample probes are installed, the probe and tubing will be purged (three volumes) using a syringe and helium tracer gas will be used during the purging phase (in the same manner as recommended for soil vapor intrusion probes) to ensure that the probes are well sealed. Samples will be collected over an approximate 4-hour period. All soil vapor samples will be collected and analyzed for VOCs by EPA Method TO-15.

Each canister will be fitted with a sampling valve that uses a critical orifice and mass flow controller to regulate the air flow into the canister for the selected sampling period. The mass flow controller will maintain a relative constant air flow rate throughout the sampling period. Summa canister valves will remain closed until the sample holes are complete and all of the canisters are in their respective positions. The valves will then be opened for the designated collection period.

3.5.1 Soil Vapor Sample Analysis

Samples will be collected in laboratory supplied Summa® canisters, and once filled will be transported under chain-of-custody command to a NYSDOH-approved laboratory for analysis of USEPA TCL VOCs in accordance with USEPA Method TO-15. Samples will be analyzed in accordance with the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006, and subsequent revisions). Field documentation of soil vapor investigation sampling activities will be recorded.

3.6 Field Specific Quality Assurance/Quality Control Sampling

In addition to the soil/fill and groundwater samples described above, field-specific quality assurance/quality control (QA/QC) samples will be collected and analyzed to ensure the reliability of the generated data as described in the QAPP (see Section 4.0) and to support the required third-party data usability assessment effort. Site-specific QA/QC samples will include matrix spikes, matrix spike duplicates, blind duplicates, and trip blanks.

3.7 Decontamination & Investigation-Derived Waste Management

Every attempt will be made to utilize dedicated sampling equipment during the RI, however if non-dedicated equipment is required and/or used, the equipment will be decontaminated, at a minimum, with a non-phosphate detergent (i.e., Alconox®) and potable water mixture, rinsed with distilled water, and air-dried before each use in accordance with Benchmark's field operating procedures presented in Appendix D. Decontaminated sampling equipment will be kept in a clean environment prior to sample collection. Heavy equipment, such as an excavator (if used) and drilling tools, will be decontaminated by the subcontractor, as necessary.

RI generated spoils (soil-fill) not exhibiting gross contamination (i.e., visible product, odor, sheen, etc.) will be returned to the borehole from which it was removed (soil/fill). RI generated groundwater and drilling equipment decontamination rinse water will be containerized. RI and/or subsequent waste characterization analytical results of investigation-derived waste (IDW) material will be used to determine if spoils/water can be returned to the ground surface, utilized on-Site, or require treatment and/or off-Site disposal.

IDW materials exhibiting gross contamination will be segregated, stockpiled, and/or containerized for subsequent characterization and disposal based on the RI results.

All generated IDW containers/drums will be labeled alpha-numerically with regard to contents, origin, and date of generation using a paint stick marker on two (2) sides and the top of each drum. Drums will be securely staged on-site pending analyses and remedial measures assessment. Field personnel will coordinate the on-site handling and temporary storage of IDW drums, including transportation, characterization sampling, and offsite disposal arrangements, as necessary.

Discarded personal protective equipment (PPE) (i.e., latex gloves, Tyvek, paper towels, etc.) and disposable sampling equipment (i.e., bailers or stainless steel spoons) will be placed in sealed plastic garbage bags and disposed of as municipal solid waste.

3.8 Site Mapping & Survey

A Site map showing sample points and relevant Site features will be developed during the field investigation. Benchmark personnel will employ a handheld GPS unit to identify the locations of the test pits, and soil borings/monitoring wells relative to State planar grid coordinates. Monitoring well elevations will be measured by Benchmark's surveyor. An isopotential map showing the general direction of groundwater flow will be prepared based on water level measurements relative to USGS vertical datum.

3.9 Field Documentation and Reporting

RI field activities will be documented in a Field Activity Daily Log (FADLs) to provide a record of activities conducted at the Site. Entries will be signed and dated at the end of each day of fieldwork (or as produced) by the Field Team Leader. Field notes will include, at a minimum, the: date and time of all entries, names of personnel on site, weather conditions (temperature, precipitation, etc.), location of activity, and description of activity. Sampling activities will be logged and photographed as necessary to document the activities at the Site. Progress photographs from a set location will be collected to document development activities and intrusive construction activities. Field personnel will, at a minimum, complete the following standard field forms, as necessary (see Appendix C):

- Equipment Calibration Log
- Field Activity Daily Log (FADLs)
- Field Borehole/Monitoring Well Log
- Groundwater Field Form
- Photographic Log
- Real-Time Air Monitoring Log
- Tailgate Safety Meeting Form
- Test Pit Excavation Log
- Soil Vapor Sample Collection Log
- Problem Identification Report (as necessary)
- Corrective Measures Report (as necessary)

Weekly field summary logs will be prepared and provided to the Department, including CAMP data during intrusive RI and IRM activities. Additionally, the Department will be notified within 24-hrs of a remedial and/or CAMP event requiring corrective actions.

4.0 INTERIM REMEDIAL MEASURES

Interim Remedial Measures (IRMs) will be completed to address known environmental concerns and to expedite the remedial activities and overall project schedule. This Work Plan includes planned IRM activities based on current information and may be modified based on the results of the RI, subject to Department approval.

The planned IRMs include (see Figure 5):

- Building demolition
- Excavation and removal of potential subgrade petroleum distribution piping
- Excavation and offsite disposal of GCPS soil-fill
- Collection of post-excavation confirmatory samples; and,
- Backfilling excavations.

The Applicant intends to discuss the RI results with the Department prior to start of IRM excavation activities. If other impacted soil areas are identified during the RI, the Applicant intends to address those areas as additional IRM(s) in consultation with the Department.

The final remedy for the Site will be recommended in the Alternatives Analysis Report (AAR) and selection in the Department's Decision Document for the Site.

4.1 Utility Clearance

Prior to any intrusive activities, Dig Safely New York (Call 811) will be contacted by the site contractor a minimum of three (3) business days in advance of the work and informed of the intent to perform excavation work at the Site. If underground utilities are present on the property and are anticipated to interfere with intrusive activities, the Applicant and the NYSDEC will be contacted to discuss mitigating measures. The location of identified subgrade utilities will be recorded and included on base drawings as part of the report.

4.2 Waste Characterization

Waste characterization samples will be collected in accordance with the disposal facilities requirements. Pre-characterization of the soil/fill will allow for direct loading and off-site transportation at the time of the excavation. Based on the waste characterization sampling results, impacted soil will be managed according to all federal, state, and local waste disposal regulations.

4.3 Building Demolition

Demolition of the building floor slabs and subgrade foundations will be completed during IRM activities to allow for removal of GCPS and any appurtenant historic fuel system components (e.g., piping) underlying the building. Concrete slabs and foundations will be cleaned of residual soils and inspected for evidence of staining and/or contamination. If no evidence of staining is noted the concrete will be recycled off-Site at a registered recycling facility. If evidence of contamination is present on concrete, those pieces will be segregated and disposed offsite with the GCPS, per the disposal facility requirements.

4.4 Removal of Petroleum Impacted Soil/Fill

Immediately following removal of the building slabs, GCPS will be excavated and transported off-Site for disposal at a licensed disposal facility. Based on the previous investigations GCPS is present approximately 8-10 feet horizontally surrounding the exterior of the existing building, and beneath the existing building based on the presence of former petroleum related piping. Any petroleum related piping and or USTs discovered during GPSC excavation will be removed from the subsurface, cleaned of residual soils and/or product, and characterized for proper offsite recycling and/or disposal. Based on the previous removal depth, approximately 6,500 tons of GPSC will be excavated and properly disposed offsite.

The planned IRM excavation work will be overseen by an experienced Benchmark-TurnKey professional. A PID and visual/olfactory observations will be used to screen soil/fill materials and assist in verifying removal of impacted soil/fill. Lateral and vertical excavation will continue until GCPS are removed, sustained PID readings of less than 10 ppm, and/or post-excavation soil confirmatory samples have achieved a minimum Restricted Residential Use SCOs for petroleum related compounds, and the Protection of Water SCOs for chlorinated compounds. These criteria will be satisfied unless the excavation has reached the property boundary, or the Department approves that no further excavation is required. Appropriate disposal application(s) will be prepared for disposal facility review and approval. Waste facility approvals will be received prior to removal activities to allow for direct loading and/or limit time period that temporary storage container(s) are on-Site. All disposal activities will be in accordance with applicable local, state and federal waste disposal regulations.

4.5 Post-Excavation Confirmation Sampling

Post excavation confirmatory samples will be collected from the excavation sidewalls and bottom in accordance with DER-10. A minimum of one sample per 30 linear feet of sidewall and one sample for each 900 square feet of excavation bottom will be collected in accordance with DER-10. If excavation is completed to bedrock, no bottom samples will be collected. Post-excavation confirmatory samples for GCPS areas will be analyzed for TCL plus CP-51 List VOCs and CP-51 List SVOCs. If additional COPCs are identified during the RI, additional post-excavation analysis will be discussed with the Department.

Expedited turnaround times may be requested for the analytical results to minimize the time that the excavation(s) remains open.

4.6 Groundwater Management

Groundwater or surface water run-in encountered during soil/fill removal will be handled on-Site prior to approved temporary discharge to the municipal sewer, if necessary. A copy of any approved sewer discharge permit will be provided to the Department prior to discharge. In general, water removed from excavations will be stored/settled in a portable storage tank, and if deemed necessary, will be pumped through a bag or cartridge filter prior to pre-treatment using granular activated carbon (GAC). Following completion of excavation work, settled solids remaining in the tank will be properly characterized and disposed of off-Site. Any associated spent GAC will be characterized, and either regenerated and/or disposed of off-Site at a permitted facility in accordance with applicable regulations.

4.7 Excavation Backfill

Following Department concurrence that the remedial excavation is complete, the excavation will be backfilled with either approved on-Site compliant backfill material and/or off-site structural stone, based on the location relative to the planned redevelopment.

4.8 Off-Site – 31 Howell Street

A portion of the existing building (northwest corner) is constructed over the 1 Howell Street parcel boundary and is located on the adjacent 31 Howell Street parcel. Though not part of the BCP, this portion of the building will be removed during demolition activities. If petroleum-related contamination is identified, the associated petroleum contamination will be handled in accordance with NYSDEC Spills requirements. Any activities completed off-site will be tracked separately from the BCP.

5.0 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been prepared in support of the RI activities. The QAPP dictates implementation of the investigation tasks delineated in this Work Plan. A Sampling and Analysis Plan (SAP) identifying methods for sample collection, decontamination, handling, and shipping, is provided below.

The QAPP will assure the accuracy and precision of data collection during the Site characterization and data interpretation periods. The QAPP identifies procedures for sample collection to mitigate the potential for cross-contamination, as well as analytical requirements necessary to allow for independent data validation. The QAPP has been prepared in accordance with NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation).

5.1 Scope of the QAPP

This QAPP was prepared to provide quality assurance (QA) guidelines to be implemented during the RI activities. This document may be modified for subsequent phases of investigative work, as necessary. The QAPP provides:

- A means to communicate to the persons executing the various activities exactly what is to be done, by whom, and when.
- A culmination to the planning process that ensures that the program includes provisions for obtaining quality data (e.g., suitable methods of field operations).
- A historical record that documents the investigation in terms of the methods used, calibration standards, and frequencies planned, and auditing planned.
- A document that can be used by the Project Manager's and QA Officer to assess if the activities planned are being implemented and their importance for accomplishing the goal of quality data.
- A plan to document and track project data and results.
- Detailed descriptions of the data documentation materials and procedures, project files, and tabular and graphical reports.

The QAPP is primarily concerned with the QA/QC aspects of the procedures involved in the collection, preservation, packaging, and transportation of samples; field testing; record keeping; data management; chain-of-custody procedures; laboratory analyses;

and other necessary matters to assure that the RI/AA activities, once completed, will yield data whose integrity can be defended.

QA refers to the conduct of planned and systematic actions necessary to perform satisfactorily task-specific activities and to provide information and data confidence as a result of such activities. The QA for task-specific activities includes the development of procedures, auditing, monitoring, and surveillance of the performance.

QC refers to the activity performed to determine if the work activities conform to the requirements. This includes activities such as inspections of the work activities in the field (e.g., verification that the items and materials installed conform to applicable codes and design specifications).

5.2 QAPP Organization and Responsibility

The principal organizations involved in verifying achievement of data collection goals for the 1 Howell Street Site include: NYSDEC; NYSDOH; Howell Street Venture LLC (Volunteer Applicant); Benchmark (Volunteers' BCP Engineering and Environmental Consultant); drilling subcontractor(s); excavation subcontractor(s); independent environmental laboratory; and independent third-party data validator. Roles, responsibilities, and required qualifications of these organizations are discussed in the following subsections. Resumes are included in Appendix A.

5.2.1 NYSDEC and NYSDOH

It is the responsibility of the NYSDEC, in conjunction with the NYSDOH, to review Work Plans, Reports, and supporting documents for completeness and conformance with the site-specific cleanup objectives and to make a decision to accept or reject these documents based on this review. The NYSDEC also has the responsibility and authority to review and approve QA documentation collected during brownfield cleanup construction and to confirm that the QA Plan was followed.

5.2.2 BCP Entity

Howell Street Venture LLC ("Volunteer") will be responsible for complying with the QA requirements as specified herein and for monitoring and controlling the quality of the Brownfield cleanup construction either directly or through their designated developer and/or environmental consultant. The Volunteer will also have the authority to select

Remedial Action Contractor(s) to assist them in fulfilling these responsibilities. The designated Project Manager is responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements.

5.2.3 Environmental Consultant

Benchmark Civil/Environmental Engineering and Geology, PLLC is the primary BCP environmental engineering consultant on this project and is responsible for the implementation of the RI/IRM Work Plan, including, but not limited to, field operations, laboratory testing, data management, data analysis and reporting. Any one member of Benchmark's staff may fill more than one of the identified project positions (e.g., field team leader and site safety and health officer). The various quality assurances, field, laboratory, and management responsibilities of key project personnel are defined below.

- *BCP Principal Engineer/Project Officer (PO):* *Thomas H. Forbes, P.E.*

The PO has the responsibility for ensuring conformance with the BCP program requirements. The PO will report directly to the Applicant and the NYSDEC/NYSDOH Project Coordinators and is responsible for project oversight. The PO will:

  - Define project objectives and develop a detailed work plan schedule.
  - Acquire and apply technical and corporate resources as needed to assure performance within budget and schedule constraints.
  - Review the work performed on the project to assure its quality, responsiveness, and timeliness.
  - Certify deliverables before their submission to NYSDEC.

- *Project Manager (PM):* *Nathan Munley*

The PM has the responsibility for ensuring that the project meets the Work Plan objectives. The PM will report directly to the Applicant Project Coordinator and the NYSDEC/NYSDOH Project Coordinators and is responsible for technical and project oversight. The PM will:

  - Define project objectives and develop a detailed work plan schedule.

- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- Review the work performed on each task to assure its quality, responsiveness, and timeliness.
- Review and analyze overall task performance with respect to planned requirements and authorizations.
- Review all deliverables before their submission to NYSDEC.
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- Ultimately be responsible for the preparation and quality of interim and final reports.
- Represent the project team at meetings.

- FTL/SSHO: *Nathan Munley*

The Field Team Leader (FTL) has the responsibility for implementation of specific project tasks identified at the Site, and is responsible for the supervision of project field personnel, subconsultants, and subcontractors. The FTL reports directly to the Project Manager. The FTL will:

- Define daily work activities.
- Orient field staff concerning the project's special considerations.
- Monitor and direct subcontractor personnel.
- Review the work performed on each task to ensure its quality, responsiveness, and timeliness.
- Assure that field activities, including sample collection and handling, are carried out in accordance with this QAPP.

For this project the FTL will also serve as the Site Safety and Health Officer (SSHO). As such, he is responsible for implementing the procedures and required components of the Site Health and Safety Plan (HASP), determining levels of protection needed during field tasks, controlling site entry/exit, briefing the field team and subcontractors on site-specific health and safety issues, and all other responsibilities as identified in the HASP.

5.3 Quality Assurance (QA) Responsibilities

The QA Officer will have direct access to corporate executive staff as necessary, to resolve any QA dispute, and is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations and Benchmark policies, and NYSDEC requirements.

The QA Officer has sufficient authority to stop work on the investigation as deemed necessary in the event of serious QA issues.

- *Project QA Officer:* *Chris Boron, P.G.*

  Specific function and duties include:
  - Performing QA audits on various phases of the field operations
  - Reviewing and approving QA plans and procedures
  - Providing QA technical assistance to project staff
  - Reporting on the adequacy, status, and effectiveness of the QA program on a regular basis to the Project Manager for technical operations
  - Responsible for assuring third party data review of sample results from the analytical laboratory.

5.4 Field Responsibilities

Benchmark field staff for this project is drawn from a pool of qualified resources. The Project Manager will use staff to gather and analyze data, and to prepare various task reports and support materials. The designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to perform the required work effectively and efficiently.

5.5 Quality Assurance Objectives for Measurement Data

The overall objectives and criteria for assuring quality for this effort are discussed below. This QAPP addresses how the acquisition and handling of samples and the review and reporting of data will be documented. The objectives of this QAPP are to address the following:

- The procedures to be used to collect, preserve, package, and transport groundwater samples.
- Field data collection
- Record keeping
- Data management
- Chain-of-custody procedures
- Precision, accuracy, completeness, representativeness, decision rules, comparability, and level of quality control effort conformance for sample analysis and data management by the laboratory under EPA analytical methods.

5.6 Level of QC Effort for Sample Parameters

Field blank, method blank, trip blank, field duplicate, laboratory duplicate, laboratory control, standard reference materials (SRM) and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. QC samples are discussed below.

- Field and trip blanks consisting of distilled water will be submitted to the analytical laboratories to provide the means to assess the quality of the data resulting from the field sampling program. Field (equipment) blank samples are analyzed to check for procedural chemical constituents at the facility that may cause sample contamination. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- MS/MSD and MS/Duplicate samples provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD or MS/Duplicate should be collected for every 20 or fewer investigative samples to be analyzed for organic and inorganic chemicals of a given matrix (see Table 3).

The general level of QC effort will consist of one field (blind) duplicate and one field blank (when non-dedicated equipment is used) for every 20 or fewer investigative samples of a given matrix. Additional sample volume will also be provided to the laboratory to allow one (1) site-specific MS/MSD or MS/Duplicate for every 20 or fewer investigative samples of a given matrix. One (1) trip blank consisting of distilled, deionized water will be included along with each sample delivery group of aqueous VOC samples.

5.7 Sampling and Analysis Plan

The number and types of environmental samples to be collected is summarized on Table 3. Sample parameter lists, holding times and sample container requirements are summarized on Table 4. The sampling program and related site activities are discussed below. Methods and protocol to be used to collect environmental samples (i.e., soil, groundwater, and sub-slab vapor) for this investigation are described in the Benchmark FOPs, summarized and presented electronically in Appendix D.

To the extent allowed by existing physical conditions at the facility, sample collection efforts will adhere to the specific methods presented herein. If alternative sampling locations or procedures are implemented in response to facility specific constraints, each will be selected on the basis of meeting data objectives. Such alternatives will be approved by NYSDEC before implementation and subsequently documented for inclusion in the project file.

5.7.1 Custody Procedures

Sample custody is controlled and maintained through the chain-of-custody procedures. Chain of custody is the means by which the possession and handling of samples will be tracked from the source (field) to their final disposition (laboratory). A sample is considered to be in a person’s custody if it is in the person’s possession or it is in the person’s view after being in his or her possession or it was in that person’s possession and that person has locked it in a vehicle or room. Sample containers will be cleaned and preserved at the laboratory before shipment to the Site. The following sections describe procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory. Appendix D includes the FOPs for Sampling, Labeling, Storage, and Shipment.

5.7.2 Sample Storage

Samples are stored in secure limited-access areas. Walk-in coolers or refrigerators are maintained at 4°C ± 2°C, or as required by the applicable regulatory program. The temperatures of the refrigerated storage areas are monitored and recorded a minimum of once per day. Deviations of temperature from the applicable range require corrective action, including moving samples to another storage location if necessary.

5.7.3 Sample Custody

Sample custody is defined by this document as when any of the following occur:

- It is in someone's actual possession.
- It is in someone's view after being in his or her physical possession.
- It was in someone's possession and then locked, sealed, or secured in a manner that prevents unsuspected tampering.
- It is placed in a designated and secured area.

Samples are removed from storage areas by the sample custodian or analysts and transported to secure laboratory areas for analysis. Access to the laboratory and sample storage areas is restricted to laboratory personnel and escorted visitors only; all areas of the laboratory are therefore considered secure. If required by the applicable regulatory program, internal chain-of-custody is documented in a log by the person moving the samples between laboratory and storage areas.

Laboratory documentation used to establish chain of custody (COC) and sample identification may include the following:

- Field COC forms or other paperwork that arrives with the sample.
- The laboratory COC.
- Sample labels or tags are attached to each sample container.
- Sample custody seals.
- Sample preparation logs (i.e., extraction and digestion information) recorded in hardbound laboratory books that are filled out in legible handwriting and signed and dated by the chemist.

- Sample analysis logs (e.g., metals, GC/MS, etc.) information recorded in hardbound laboratory books that are filled out in legible handwriting and signed and dated by the chemist.
- Sample storage log (same as the laboratory COC).
- Sample disposition log, which documents sample disposal by a contracted waste disposal company.

5.7.4 Sample Tracking

The samples are maintained in the appropriate coolers prior to and after analysis. The analysts remove and return their samples as needed. Samples that require internal COC are relinquished to the analysts by the sample custodians. The analyst and sample custodian must sign the original COC relinquishing custody of the samples from the sample custodian to the analyst. When the samples are returned, the analyst will sign the original COC returning sample custody to the sample custodian. Sample extracts are relinquished to the instrumentation analysts by the preparatory analysts. Each preparation department tracks internal COC through their logbooks/spreadsheets.

Any change in the sample during the time of custody will be noted on the COC (e.g., sample breakage or depletion).

5.7.5 Split Sampling

During the RI, the NYSDEC may split any soil/fill or groundwater samples at the NYSDEC's expense. Benchmark personnel will cooperate with the NYSDEC to facilitate split sampling, as requested.

5.8 Calibration Procedures and Frequency

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

5.8.1 Field Instrument Calibration

Quantitative field data to be obtained during groundwater sampling include pH, turbidity, specific conductance, temperature, and depth to groundwater. Quantitative water level measurements will be obtained with an electronic sounder or steel tape, which require no calibration. Quantitative field data to be obtained during soil sampling include screening for the presence of volatile organic constituents using a PID.

Appendix D includes FOPs that describe the field instruments used to monitor for these parameters and the calibration methods, standards, and frequency requirements for each instrument. Calibration results will be recorded on the appropriate field forms and in the Project Field Book.

5.9 Analytical Procedures

Samples collected during this investigation field sampling activities will be analyzed by a NYSDOH approved laboratory.

5.9.1 Field Analytical Procedures

Field procedures for collecting and preserving groundwater and soil samples are described in the FOPs located in Appendix D. As indicated, RI soil/fill samples for VOC analysis will be collected using EnCore® samplers per recent NYSDOH requirements for VOC analytical method certification.

5.10 Data Usability Evaluation

Data usability evaluation procedures shall be performed for both field and laboratory operations as described below.

5.10.1 Procedures Used to Evaluate Field Data Usability

Procedures to validate field data for this project will be facilitated by adherence to the FOPs in Appendix D. The performance of field activities, calibration checks on field instruments at the beginning of each day of use, manual checks of field calculations, checking for transcription errors and review of field logbooks is the responsibility of the Field Team Leader.

5.10.2 Procedures Used to Evaluate Laboratory Data Usability

Data evaluation will be performed by the third-party data validator using the most current methods and quality control criteria (DER-10). 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. Also, results of blanks, surrogate spikes, MS/MSDs, and laboratory control samples will be reviewed/evaluated by the data validator. Sample analytical data for each sample matrix shall be evaluated. The third-party data validation expert will also evaluate the overall completeness of the data package. Completeness checks will be administered on the data to determine whether deliverables specified in this QAPP are present. The reviewer will determine whether required items are present and request copies of missing deliverables.

6.0 INVESTIGATION SUPPORT DOCUMENTS

6.1 Health and Safety Protocols

Benchmark has prepared a Site-Specific Health and Safety Plan (HASP) for use by Benchmark employees in accordance with 40 CFR 300.150 of the NCP and 29 CFR 1910.120. The HASP, provided in Appendix E, includes the following site-specific information:

- A hazard assessment
- Training requirements
- Definition of exclusion, contaminant reduction, and other work zones
- Monitoring procedures for site operations
- Safety procedures
- Personal protective clothing and equipment requirements for various field operations
- Disposal and decontamination procedures

The HASP also includes a contingency plan that addresses potential site-specific emergencies, and a Community Air Monitoring Plan that describes required particulate and vapor monitoring to protect the neighboring community during intrusive site investigation and remediation activities.

Health and safety activities will be monitored throughout the field investigation by the SSHO. The HASP will be subject to revision as necessary, based on new information that is discovered during the field investigation and/or remedial activities.

6.1.1 Community Air Monitoring

Real-time community air monitoring will be performed during ground intrusive RI activities at the Site. A CAMP is included within Benchmark's HASP (see Appendix E). Particulate and VOC monitoring will be performed along the downwind perimeter of the work area during subgrade excavation, grading, and soil handling activities in accordance with this plan. The CAMP is consistent with the requirements for community air monitoring at remediation sites as established by the NYSDOH and NYSDEC. Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10;

specifically, NYSDOH's Generic Community Air Monitoring Plan and Fugitive Dust and Particulate Monitoring included in Appendix E.

6.2 Citizen Participation Activities

NYSDEC will coordinate and lead community relations throughout the course of the project. Benchmark will support NYSDEC's community relations activities, as necessary. A Citizen Participation Plan will be prepared by Benchmark and submitted to NYSDEC under separate cover upon acceptance into the BCP and execution of the Brownfield Cleanup Agreement. The Citizen Participation Plan will follow NYSDEC's Citizen Participation Plans template for Brownfield Cleanup Program sites entering the BCP at the point of site investigation per NYSDEC DER-23.

7.0 REPORTING AND SCHEDULE

Upon completion of the RI fieldwork, a comprehensive Remedial Investigation/ Alternatives Analysis (RI/AA) Report will be completed as described below.

7.1 Remedial Investigation Reporting

The RI section of the RI/AA Report will include the following information and documentation, consistent with the NYSDEC's DER-10.

- Introduction and background.
- A description of the Site and the investigation areas.
- A description of the field procedures and methods used during the RI.
- A discussion of the nature and rationale for any significant variances from the scope of work described in this RI Work Plan.
- The data obtained during the RI and historical data considered by Benchmark to be of useable quality. This will include geochemical data, field measurements, etc.
- Comparative criteria that may be used to calculate cleanup levels during the alternatives analysis process, such as NYSDEC Soil Cleanup Objectives (SCOs) and other pertinent regulatory standards or criteria.
- A discussion of contaminant fate and transport. This will provide a description of the hydrologic parameters of the Site, and an evaluation of the lateral and vertical movement of groundwater.
- Conclusions regarding the extent and character of environmental impact in the media being investigated.
- The conclusions of the qualitative exposure assessment for both human health and/or fish and wildlife resources (performed in accordance with DER-10 3.3(c)(4), including any recommendations for more detailed assessments, if applicable.
- Supporting materials for RI data. These will include boring logs, monitoring well construction diagrams, laboratory analytical reports, and similar information.

In addition, 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 May 2010 DER-10 guidance. The DUSR and any necessary qualifications to the data will be appended to the RI report.

Benchmark will provide submittals to the NYSDEC in accordance with EDD requirements.

7.2 IRM Reporting

Benchmark personnel will be on-Site to document the IRM activities. Such documentation will include, at minimum, daily reports of IRM activities, community air monitoring results, photographs and corrective measures report, if necessary.

A summary of the IRM activities will be included in the RI/IRM/AAR submitted to the NYSDEC, with full details of the IRM activities included in the Final Engineering Report. At a minimum, the IRM section of the report will include:

- A Site or area planimetric map showing the parcel(s) remediated;
- A map showing the lateral limits of excavation/treatment areas;
- Summaries of unit quantities, including: volume of soil/fill excavated; disposition of excavated soil/fill and collected ground/surface water; volume/type/source of backfill; and volume of ground/surface water pumped and treated;
- Planimetric map showing location of verification and other sampling locations with sample identification labels/codes;
- Tabular comparison of verification and other sample analytical results to SCOs. An explanation shall be provided for all results exceeding acceptance criteria; and
- Text describing that the excavation activities were performed in accordance with this Work Plan.
- Text describing any interim site management requirements.

7.3 Alternatives Analysis Report

An alternatives analysis report (AAR) will be completed to provide a forum for evaluating and selecting a recommended remedial approach. Based on the findings of the RI, a list of remedial action objectives (RAOs) will be developed with the requirement for the selected remedial measures to be protective of human health and the environment under the proposed future use scenario. Proposed SCOs for the property will also be presented based on the proposed future use of the Site. SCOs will be based on published standards, criteria, and guidance (SCGs) and other NYSDEC and NYSDOH accepted values.

Based on the RAOs and SCOs, volumes and areas of media potentially requiring additional remediation will be calculated. General response actions will then be delineated to address each of the Site problem areas. These general response actions will form the foundation for the development and screening of applicable remedial alternatives against the following criteria as described in 6NYCRR 375-1.10:

- Overall Protection of Public Health and the Environment
- Compliance with Standards, Criteria, & Guidance (SCGs)
- Long-Term Effectiveness & Permanence
- Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment
- Short-Term Impacts & Effectiveness
- Implementability
- Cost-Effectiveness
- Land Use

In addition, the criteria of community acceptance will be considered based on public comments on the AAR and proposed remedial actions. Following the screening of alternatives, a comparative analysis will be performed against the above criteria. The comparative analysis will allow for better understanding of the relative advantages and disadvantages of each of the alternatives and will facilitate identification of a recommended remedial approach.

7.4 Project Schedule

A tentative project schedule for the major tasks to be performed in support of the RI/IRM/AAR is presented as Figure 6.

8.0 REFERENCES

1. New York State Department of Environmental Conservation. *DER-10; Technical Guidance for Site Investigation and Remediation*. May 2010.

2. *6 NYCRR Part 375 Environmental Remediation Programs*. December 2006.

3. New York State Department of Environmental Conservation Division of Water Technical and Operation Guidance (TOGS). *1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*. June 1998.

4. NYS Department of Health. *The Guidance for Evaluating Soil Vapor Intrusion in the State of New York*. October 2006, and subsequent updates.

5. United States Department of Agriculture (USDA), Soil Conservation Service. *Soil Survey of Erie County, New York*. December 1986.

6. New York State Department of Environmental Conservation. *Sampling, Analysis, and Assessment of Per- And Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs*. January 2021.

7. New York State Department of Environmental Conservation. *DER-23; Citizen Participation Handbook for Remedial Programs*. January 2010.

8. Benchmark Environmental Engineering and Science, PLLC. *Ltd. Phase II Environmental Investigation Repot, 1 Howell Street Site, Buffalo New York*. May 2022.

TABLES

TABLE 1
SUMMARY OF SUBSURFACE SOIL-FILL ANALYTICAL RESULTS
LIMITED PHASE II ENVIRONMENTAL INVESTIGATION
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Parameter [1]	**Unrestricted Use SCOs**[2]	**Protection of GW SCOs**[2]	**Restricted-Residential Use SCOs**[2]	**Commerical Use SCOs**[2]	**Industrial Use SCOs**[2]	**Sample Location**					
						TP-1 (3-4') 2/15/2022	**TP-3 (1-2') 2/15/2022**	**TP-6 (3-4') 2/15/2022**	**TP-7 (3-5') 2/15/2022**	**TP-8 (3-4') 2/15/2022**	**TP-10 (1-3') 2/15/2022**
Volatile Organic Compounds (VOCs) - mg/kg [3]											
Benzene	**0.06**	**--**	**4.8**	**44**	**89**	ND	ND	ND	ND	**0.810**	**0.130 J**
cis-1,2-Dichloroethene	**0.25**	**0.25**	**100**	**500**	**1,000**	ND	ND	**56**	ND	ND	ND
Cyclohexane	**--**	**--**	**--**	**--**	**--**	ND	ND	1.0 J	ND	ND	2.3
Isopropylbenzene (Cumene)	**100**	**--**	**100**	**100**	**100**	ND	ND	2.8	0.620 J	ND	0.150 J
Tetrachloroethene	**1.3**	**1.3**	**19**	**150**	**300**	ND	ND	**27**	ND	ND	ND
Trichloroethene	**0.47**	**0.47**	**21**	**200**	**400**	ND	ND	**2**	ND	ND	ND
Vinyl chloride	**0.02**	**0.02**	**0.9**	**13**	**27**	ND	ND	**9.8**	ND	ND	ND
Total Xylene	**0.26**	**--**	**100**	**500**	**1,000**	ND	ND	**12**	ND	ND	**0.800 J**
Toluene	**0.7**	**--**	**100**	**500**	**1,000**	ND	ND	**6.2**	ND	ND	ND
Ethylbenzene	**1**	**--**	**41**	**390**	**780**	ND	ND	**6.8**	ND	ND	ND
Semi-Volatile Organic Compounds (SVOCs) - mg/kg [3]											
Acenaphthene	**20**	**--**	**100**	**500**	**1,000**	0.39	0.500 J	0.190 J	0.28	0.960 J	0.520 J
Acenaphthylene	**100**	**--**	**100**	**500**	**1,000**	0.35	0.540 J	ND	ND	ND	0.290 J
Anthracene	**100**	**--**	**100**	**500**	**1,000**	0.46	1.1	0.170 J	0.29	0.650 J	0.810 J
Benzo(a)anthracene	**1**	**--**	**1**	**5.6**	**11**	**1.10**	**3.30**	0.30	0.49	0.710 J	**2.3**
Benzo(a)pyrene	**1**	**--**	**1**	**1**	**1.1**	**1.10**	**3.10**	0.25	0.51	0.470 J	**2.4**
Benzo(b)fluoranthene	**1**	**--**	**1**	**5.6**	**11**	**1.30**	**3.90**	0.39	0.96	0.750 J	**2.9**
Benzo(g,h,i)perylene	**100**	**--**	**100**	**500**	**1,000**	0.56	1.90	0.170 J F2	0.170 J	0.260 J	1.6
Benzo(k)fluoranthene	**0.8**	**--**	**3.9**	**56**	**110**	0.55	**1.7**	0.150 J	ND	0.170 J	**1.2**
Chrysene	**1**	**--**	**3.9**	**56**	**110**	**1.20**	**3.5**	0.44	0.65	0.720 J	**2.5**
Dibenzo(a,h)anthracene	**0.33**	**--**	**0.33**	**0.56**	**1.1**	0.150 J	**0.570 J**	0.069 J F2	**0.740 J**	ND	**0.430 J**
Fluoranthene	**100**	**--**	**100**	**500**	**1,000**	2.7	7.5	0.76	1.3	2.1	4.7
Fluorene	**30**	**--**	**100**	**500**	**1,000**	0.67	0.950 J	0.43	0.39	1.3	0.740 J
Indeno(1,2,3-cd)pyrene	**0.5**	**--**	**0.5**	**5.6**	**11**	**0.52**	**1.8**	0.150 J F2	0.18	0.250 J	ND
Phenanthrene	**100**	**--**	**100**	**500**	**1,000**	1.1	4.1	0.63	0.44	1.8	2.9
Pyrene	**100**	**--**	**100**	**500**	**1,000**	2.1	6.0	0.63	0.91	1.7	4.0
Naphthalene	**12**	**--**	**100**	**500**	**1,000**	0.23	0.41	0.46	0.23	0.260 J	0.93
Total PAHs	**--**	**--**	**100**	**500**	**--**	14.480	40.87 J	5.189 J	7.54	6.9 J	24.5 J
Metals - mg/kg											
Arsenic	**13**	**--**	**16**	**16**	**16**	5.70	10.2	7.9	9.7	5.9	**16.1**
Barium	**350**	**--**	**400**	**400**	**10,000**	123.0 F1	349	131	107	122	97.1
Cadmium	**2.5**	**--**	**4.3**	**9.3**	**60.0**	0.260	1.5	0.84	0.28	0.26	0.53
Chromium [4]	**30**	**--**	**180**	**1,500**	**6,800**	14.90	17.5	18.6	18.7	24.3	17.9
Lead	**63**	**--**	**400**	**1,000**	**3,900**	**63.7 F1**	**320**	**197**	**83.2**	40.0	**726**
Mercury	**0.18**	**--**	**0.81**	**2.8**	**5.7**	0.048	0.13	0.06	0.063	0.062	0.076

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 6NYCRR Part 375 Soil Cleanup Objectives (SCOs).
3. Sample results were reported by the laboratory in micograms per kilogram (ug/kg) and converted to milligram per kilogram (mg/kg) for comparison to SCOs.
4. SCOs provided for trivalent chromium

Definitions:

mg/kg = milligrams per kilogram
ND = Parameter not detected above laboratory detection limit
-- = No SCO available, or parameter not tested for.
J = Result is less than the RL but greater or equal to the MDL and the concentration is an approximate value, indicates estimated value for TICs.
F1= MS and/or MSD Recovery is outside acceptance limits.
F2= MS/MSD RPD exceeds control limits.

🟩 **BOLD**	= Result exceeds Residential Use SCOs
🟦 **BOLD**	= Result exceeds Restricted Residential Use SCOs
🟨 **BOLD**	= Result exceeds Commercial Use SCOs
🟥 **BOLD**	= Result exceeds Industrial Use SCOs

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

TURNKEY ENVIRONMENTAL RESTORATION, LLC

TABLE 2

SUMMARY OF RI SAMPLING AND ANALYTICAL PROGRAM

REMEDIAL INVESTIGATION/INTERIM REMEDIAL MEASURES WORK PLAN

1 HOWELL STREET SITE

BUFFALO, NEW YORK

Matrix	Investigation Location		TCL+CP-51 VOCs + TICs^{1,2}	TCL SVOCs + TICs^{2,3}	TAL Metals	PCBs	Pesticides	Herbicides	PFAS
Surface Soil	SS-1	Shallow Surface Soil-Fill (0-0.5 ft)	--	1	1	--	--	--	--
	SS-2		--	1	1	1	1	1	1
	SS-3		--	1	1	--	--	--	--
Subsurface Soil/Fill	TP-12	RI Test Pits Soil-Fill (0.5-11 fbgs)	1	1	1	--	--	--	--
	TP-13		TBD	1	1	1	1	1	1
	TP-14		TBD	1	1	1	--	--	--
	TP-15		1	1	1	1	--	--	--
	TP-16		1	1	1	1	--	--	--
	TP-17		1	1	1	1	1	1	1
	TP-18		1	1	1	1	--	--	--
	TP-19		1	1	1	--	--	--	--
	TP-20		TBD	1	1	1	1	1	1
	TP-21		1	1	1	--	--	--	--
	TP-22		TBD	1	1	--	--	--	--
	TP-23		1	1	1	--	--	--	--
	MW-1	RI Soil Borings Native Soil (>11 fbgs)	1	1	1	--	--	--	--
	MW-2		1	1	1	--	--	--	--
	MW-3		1	1	1	1	--	--	--
	MW-4		1	1	1	1	1	1	1
QA/QC	Soil	MS	1	1	1	1	1	1	1
		MSD	1	1	1	1	1	1	1
		Blind Dup	1	1	1	1	1	1	1
		TOTAL SOIL SAMPLES:	**15**	**22**	**22**	**13**	**8**	**8**	**8**
Groundwater	MW-1	Monitroing Wells	1	1	1	1	1	1	1
	MW-2		1	1	1	1	1	1	1
	MW-3		1	1	1	1	1	1	1
	MW-4		1	1	1	1	1	1	1
QA/QC	Groundwater	MS	1	1	1	1	1	1	1
		MSD	1	1	1	1	1	1	1
		Blind Dup	1	1	1	1	1	1	1
		Trip/Field Blank	1	--	--	--	--	--	--
		Equipment Blank	--	--	--	--	--	--	1
		'ATER SAMPLES:	**8**	**7**	**7**	**7**	**7**	**7**	**8**
Soil Vapor (TO-15 Method)	SV-1	Soil Vapor	1	--	--	--	--	--	--
	SV-2		1	--	--	--	--	--	--
	SV-3		1	--	--	--	--	--	--
	Ambient - OU		1	--	--	--	--	--	--
		TOTAL AIR SAMPLES:	**4**	**0**	**0**	**0**	**0**	**0**	**0**

Notes:

1. Full List VOCs = TCL plus CP-51 List VOCs via Method 8260. TBD - Additional soil/fill samples may be collected for analysis if evidenc (odor or elevated PID readings) are detected in the field.
2. Tentatively Identified Compounds (TICs) will be analyzed per DER-10 for the RI samples.
3. 1,4-Dioxane will be analyzed in soil and groundwater samples; soil will be analyzed using Method 8270 and groundwater will be analyzed using Method 8270 SIM per NYSDEC guidelines.

PFAS = Perfluoroalkyl Acids
SVOCs = Semi-Volatile Organic Compounds
TCL = Target Compound List
TICs = Tentatively Identified Compounds.
TAL = Target Analyte List
PCBs = Polychlorinated Biphenyls
TBD = To be determined.

TABLE 3

SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS
RI/IRM WORK PLAN
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Matrix	Parameter [1]	Method [1]	Container Type	Minimum Volume	Preservation (Cool to 2-4 °C for all samples)	Holding Time from Sample Date
Soil	TCL + CP-51 VOCs	8260B	EnCore/WMG	5 gm / 4 oz.	Cool to 2-4 °C, Zero Headspace	48 - hours / 14 days
	TCL SVOCs	8270C	WMG	16 oz.	Cool to 2-4 °C	14 days extrac./40 days
	TAL Metals [2]	6010	WMG	4 oz.	Cool to 2-4 °C	6 months/Hg 28 days
	Pesticides	8081	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	Herbicides	8151	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	PCBs	8082	WMG	4 oz.	Cool to 2-4 °C	14 days extrac./40 days
	PFAS	537.1	HDPE/Polypropylene	4-8 oz.	Cool to 2-4 °C	14 days extrac./40 days
Groundwater	TCL + CP-51 VOCs	8260B	glass vial	3 - 4 oz.	HCl to pH<2, Zero Headspace, Cool to 2-4 °C	14 days
	TCL SVOCs	8270C	amber glass	1000 ml	Cool to 2-4 °C	7 days extrac/40 days
	TAL Metals [2]	6010	plastic	600 ml	HNO_3 to pH<2, Cool to 2-4 °C	6 months/Hg 28 days
	Pesticides	8081B	amber glass	1000 ml	Cool to 2-4 °C	14 days extrac./40 days
	Herbicides	8151A	amber glass	1000 ml	Cool to 2-4 °C	14 days extrac./40 days
	PCBs	8082	amber glass	1000 ml	Cool to 2-4 °C	7 days extrac/40 days
	PFAS	537.1	HDPE/Polypropylene	2 - 500 mL	Trizma, Cool to 2-4 °C	14 days
	1,4-dioxane	8270 SIM mode	amber glass	2 - 500 mL	Cool to 2-4 °C	7 days extrac./40 days

References:
1. Test Methods for Evaluating Solid Wastes, USEPA SW-846, Update III, 1991.

Notes:
1. EPA-approved methods published in Reference 1 above may be used. The list of analytes, laboratory method and the method detection limit for each parameter are included in Tables 1 and 2 of the QAPP.
2. Mercury sampling in soil/groundwater via EPA methods 7471/7470 respectively.

Acronyms:
VOCs = Volatile Organic Compounds
PFAS = Per- and Polyfluoroalkyl Substances
SVOCs = Semi-Volatile Organic Compounds
TCL = Target Compound List
TAL = Target Analyte List
WMG = Wide Mouth Glass
PCBs = Polychlorinated Biphenyls

TABLE 4

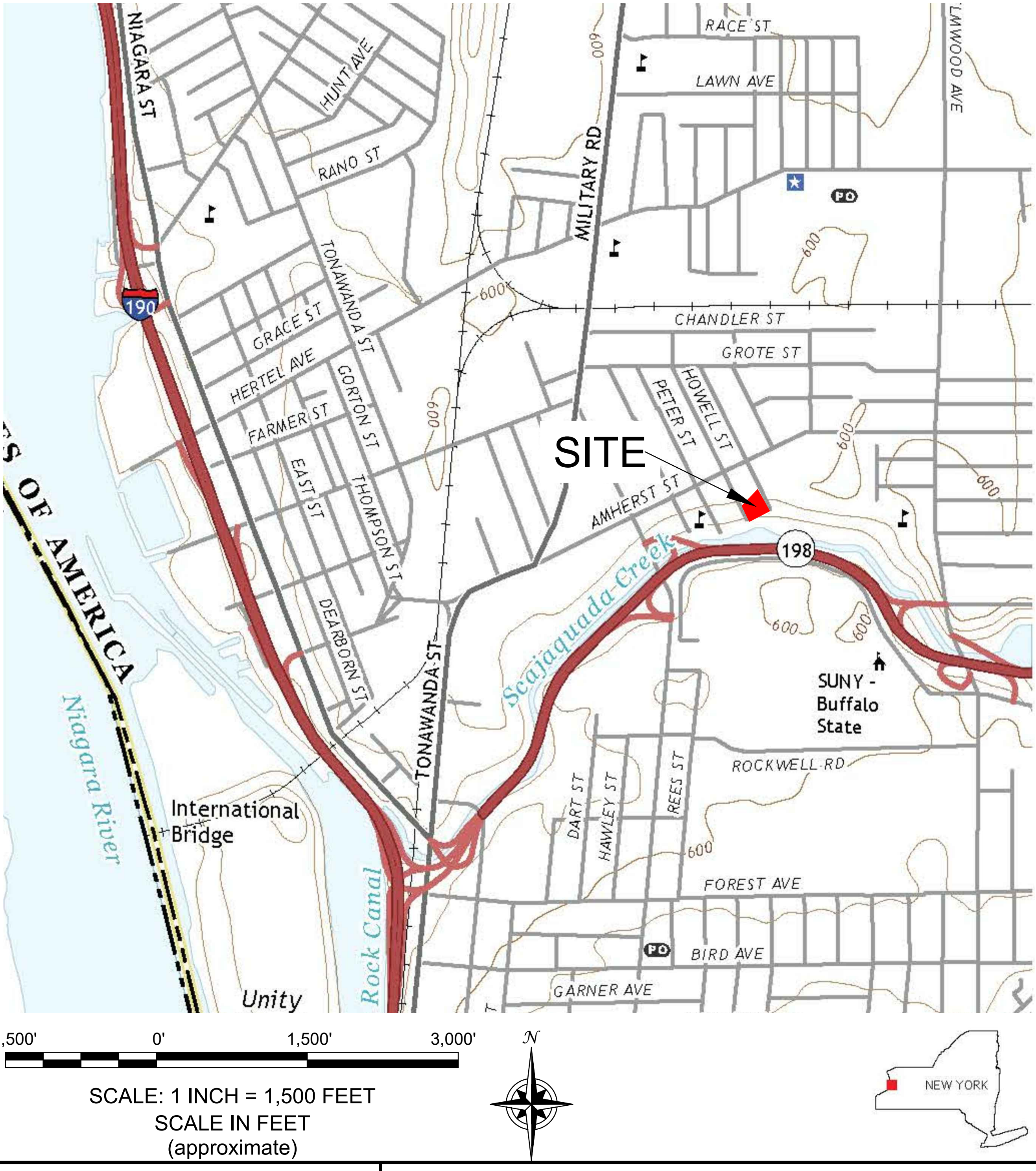
SUMMARY OF FIELD OPERATING PROCEDURES
RI/IRM WORK PLAN
1 HOWELL STREET SITE
BUFFALO, NEW YORK

FOP Number	Description	No. of Attachments	Total Pages	FOPs Referenced
001.1	Abandonment of Borehole Procedures	1	4	--
002.0	Abandonment of Monitoring Wells Procedure	1	5	018, 032
004.6	Soil Vapor Sample Collection Procedure	8	44	--
007.0	Calibration and Maintenance of Portable Dissolved Oxygen Meter	1	3	--
008.0	Calibration and Maintenance of Portable Field pH/Eh Meter	1	4	--
009.0	Calibration and Maintenance of Portable Field Turbidity Meter	1	7	--
011.1	Calibration and Maintenance of Portable Photoionization Detector	3	31	--
012.0	Calibration and Maintenance of Portable Specific Conductance Meter	1	5	--
013.0	Composite Sample Collection Procedure for Non-Volatile Organic Analysis	1	3	040, 046
015.0	Documentation Requirements for Drilling and Well Installation	6	11	--
017.0	Drill Site Selection Procedure	0	1	--
018.0	Drilling and Excavation Equipment Decontamination Procedures	0	2	--
021.0	Establishing Horizontal and Vertical Control	0	2	--
022.0	Groundwater Level Measurement	1	3	040
023.1	Groundwater Purging Procedures Prior to Sample Collection	2	8	011, 022, 024, 040
024.1	Groundwater Sample Collection Procedures	1	10	007, 008, 009, 011, 012, 022, 023, 031, 040, 046
024.3	Groundwater Sample Collection Procedures for PFAS	2	7	023, 036, 064
025.0	Hand Augering Procedure	1	3	013, 017, 040, 046, 054, 057
026.1	Hollow Stem Auger (HSA) Drilling Procedures	2	6	001, 010, 011, 017, 018, 058
031.2	Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure	1	7	007, 008, 009, 011, 012, 022, 024, 040, 046
032.1	Management of Investigation-Derived Waste (IDW)	2	5	--
033.0	Monitoring Well Construction for Hollow Stem Auger Boreholes	2	6	015, 026, 032, 036
036.0	Monitoring Well Development Procedures	1	3	015, 040
039.1	NAPL Detection and Sample Collection Procedure	1	7	011, 040, 046
040.1	Non-Disposable and Non-Dedicated Sampling Equipment Decontamination	0	4	032
041.0	Overburden Casing Installation Procedure	3	7	018
046.0	Sample Labeling, Storage and Shipment Procedures	5	9	--
047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities	2	4	010, 011, 015, 058
048.0	Screening of Soil Samples for Organic Vapors During UST Removal Activities	1	4	010, 011, 073, 074
054.2	Soil Description Procedures Using The Visual-Manual Method	5	22	010, 011, 015, 025, 032, 046, 047, 058, 065
057.0	Soil Sample Collection for VOC Analysis - EnCore Sampling	1	6	046
058.0	Split-Spoon Sampling Procedures	0	3	015, 046, 047, 054
063.2	Surface and Subsurface Soil Sampling Procedures	3	7	006, 010, 011, 040, 046, 073
065.1	Test Pit Excavation and Logging Procedures	3	7	006, 010, 011, 018, 063
070.0	Well/Piezometer Construction Materials and Design	0	2	--
073.2	Real-Time Air Monitoring During Intrusive Activities	1	12	006, 010, 011, 084
074.0	Underground Storage Tank Excavation & Removal Procedures	4	11	006, 010, 011, 018, 032, 048, 054, 063, 073
076.0	"Before Going Into the Field" Procedure	0	4	--
078.0	Geoprobe Drilling Procedures	2	6	001, 017, 018, 054, 077
079.0	Stockpile Sampling Procedures for Chemical Analysis	0	3	046
080.0	Stockpile-Borrow Source Sampling Procedures for Physical Analysis	1	5	--
082.0	Waste Sampling Procedures	1	15	011, 046
084.0	Calibration and Maintenance of Portable Particulate Meter	0	8	--
085.0	Field Quality Control Procedures	0	3	040
088.0	Underground Piping Decommissioning Procedures	2	5	006, 010, 011, 065
090.0	Outdoor Ambient Air VOC Sample Collection Procedure	1	6	--

Notes:

1. FOPs are identified by the sequential FOP number and revision number. For example, FOP number 011.1 indicates FOP 11, revision 1.

FIGURES



SCALE: 1 INCH = 1,500 FEET
SCALE IN FEET
(approximate)

BENCHMARK IN ASSOCIATION WITH TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

SITE LOCATION AND VICINITY MAP

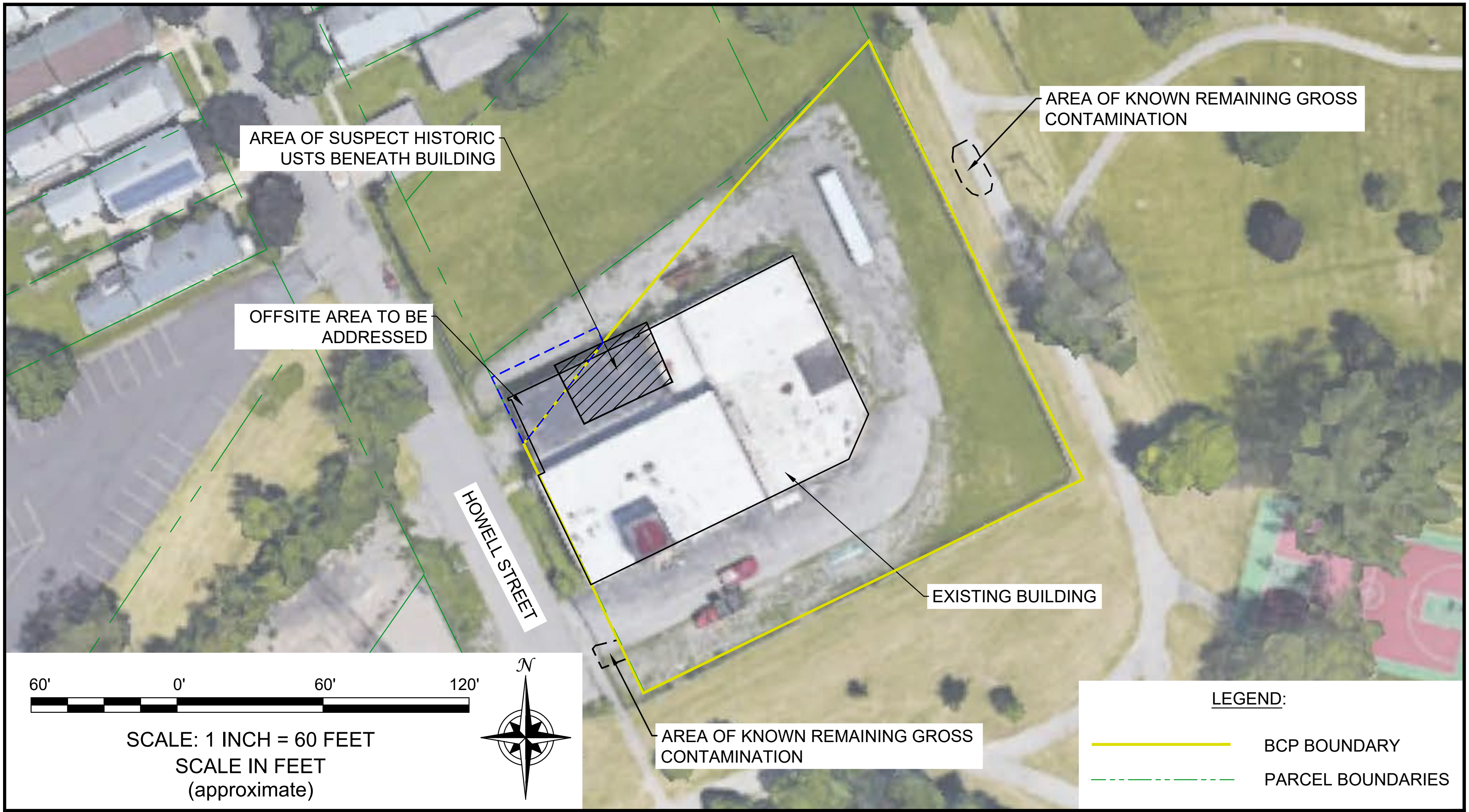
REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

1 HOWELL STREET SITE

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC



BENCHMARK IN ASSOCIATION WITH TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

SITE PLAN (AERIAL)

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

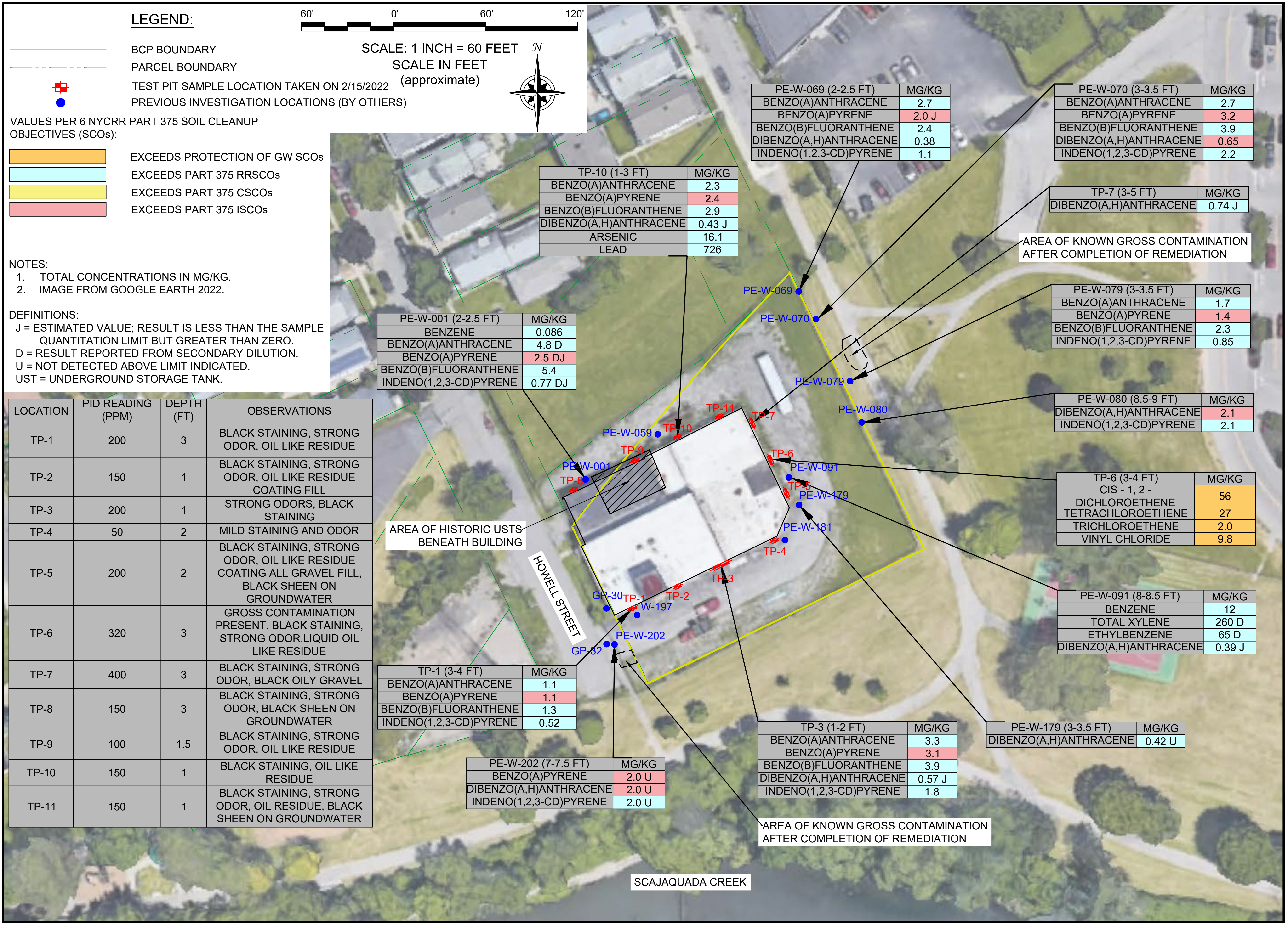
1 HOWELL STREET SITE

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 2



LEGEND:

- BCP BOUNDARY
- PARCEL BOUNDARY
- TEST PIT SAMPLE LOCATION TAKEN ON 2/15/2022
- ● PREVIOUS INVESTIGATION LOCATIONS (BY OTHERS)

VALUES PER 6 NYCRR PART 375 SOIL CLEANUP OBJECTIVES (SCOs):

- 🟧 EXCEEDS PROTECTION OF GW SCOs
- 🟦 EXCEEDS PART 375 RRSCOs
- 🟨 EXCEEDS PART 375 CSCOs
- 🟥 EXCEEDS PART 375 ISCOs

NOTES:
1. TOTAL CONCENTRATIONS IN MG/KG.
2. IMAGE FROM GOOGLE EARTH 2022.

DEFINITIONS:
J = ESTIMATED VALUE; RESULT IS LESS THAN THE SAMPLE QUANTITATION LIMIT BUT GREATER THAN ZERO.
D = RESULT REPORTED FROM SECONDARY DILUTION.
U = NOT DETECTED ABOVE LIMIT INDICATED.
UST = UNDERGROUND STORAGE TANK.

LOCATION	PID READING (PPM)	DEPTH (FT)	OBSERVATIONS
TP-1	200	3	BLACK STAINING, STRONG ODOR, OIL LIKE RESIDUE
TP-2	150	1	BLACK STAINING, STRONG ODOR, OIL LIKE RESIDUE COATING FILL
TP-3	200	1	STRONG ODORS, BLACK STAINING
TP-4	50	2	MILD STAINING AND ODOR
TP-5	200	2	BLACK STAINING, STRONG ODOR, OIL LIKE RESIDUE COATING ALL GRAVEL FILL, BLACK SHEEN ON GROUNDWATER
TP-6	320	3	GROSS CONTAMINATION PRESENT. BLACK STAINING, STRONG ODOR,LIQUID OIL LIKE RESIDUE
TP-7	400	3	BLACK STAINING, STRONG ODOR, BLACK OILY GRAVEL
TP-8	150	3	BLACK STAINING, STRONG ODOR, BLACK SHEEN ON GROUNDWATER
TP-9	100	1.5	BLACK STAINING, STRONG ODOR, OIL LIKE RESIDUE
TP-10	150	1	BLACK STAINING, OIL LIKE RESIDUE
TP-11	150	1	BLACK STAINING, STRONG ODOR, OIL RESIDUE, BLACK SHEEN ON GROUNDWATER

PE-W-069 (2-2.5 FT)	MG/KG
BENZO(A)ANTHRACENE	2.7
BENZO(A)PYRENE	2.0 J
BENZO(B)FLUORANTHENE	2.4
DIBENZO(A,H)ANTHRACENE	0.38
INDENO(1,2,3-CD)PYRENE	1.1

PE-W-070 (3-3.5 FT)	MG/KG
BENZO(A)ANTHRACENE	2.7
BENZO(A)PYRENE	3.2
BENZO(B)FLUORANTHENE	3.9
DIBENZO(A,H)ANTHRACENE	0.65
INDENO(1,2,3-CD)PYRENE	2.2

TP-10 (1-3 FT)	MG/KG
BENZO(A)ANTHRACENE	2.3
BENZO(A)PYRENE	2.4
BENZO(B)FLUORANTHENE	2.9
DIBENZO(A,H)ANTHRACENE	0.43 J
ARSENIC	16.1
LEAD	726

TP-7 (3-5 FT)	MG/KG
DIBENZO(A,H)ANTHRACENE	0.74 J

AREA OF KNOWN GROSS CONTAMINATION AFTER COMPLETION OF REMEDIATION

PE-W-079 (3-3.5 FT)	MG/KG
BENZO(A)ANTHRACENE	1.7
BENZO(A)PYRENE	1.4
BENZO(B)FLUORANTHENE	2.3
INDENO(1,2,3-CD)PYRENE	0.85

PE-W-001 (2-2.5 FT)	MG/KG
BENZENE	0.086
BENZO(A)ANTHRACENE	4.8 D
BENZO(A)PYRENE	2.5 DJ
BENZO(B)FLUORANTHENE	5.4
INDENO(1,2,3-CD)PYRENE	0.77 DJ

PE-W-080 (8.5-9 FT)	MG/KG
DIBENZO(A,H)ANTHRACENE	2.1
INDENO(1,2,3-CD)PYRENE	2.1

TP-6 (3-4 FT)	MG/KG
CIS - 1, 2 - DICHLOROETHENE	56
TETRACHLOROETHENE	27
TRICHLOROETHENE	2.0
VINYL CHLORIDE	9.8

AREA OF HISTORIC USTS BENEATH BUILDING

PE-W-091 (8-8.5 FT)	MG/KG
BENZENE	12
TOTAL XYLENE	260 D
ETHYLBENZENE	65 D
DIBENZO(A,H)ANTHRACENE	0.39 J

TP-1 (3-4 FT)	MG/KG
BENZO(A)ANTHRACENE	1.1
BENZO(A)PYRENE	1.1
BENZO(B)FLUORANTHENE	1.3
INDENO(1,2,3-CD)PYRENE	0.52

TP-3 (1-2 FT)	MG/KG
BENZO(A)ANTHRACENE	3.3
BENZO(A)PYRENE	3.1
BENZO(B)FLUORANTHENE	3.9
DIBENZO(A,H)ANTHRACENE	0.57 J
INDENO(1,2,3-CD)PYRENE	1.8

PE-W-179 (3-3.5 FT)	MG/KG
DIBENZO(A,H)ANTHRACENE	0.42 U

PE-W-202 (7-7.5 FT)	MG/KG
BENZO(A)PYRENE	2.0 U
DIBENZO(A,H)ANTHRACENE	2.0 U
INDENO(1,2,3-CD)PYRENE	2.0 U

AREA OF KNOWN GROSS CONTAMINATION AFTER COMPLETION OF REMEDIATION

DATE: MAY 2022
DRAFTED BY: CEH

BENCHMARK
IN ASSOCIATION WITH
TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: T0258-022-002

PREVIOUS INVESTIGATION LOCATIONS AND AREAS OF CONCERN

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

1 HOWELL STREET SITE

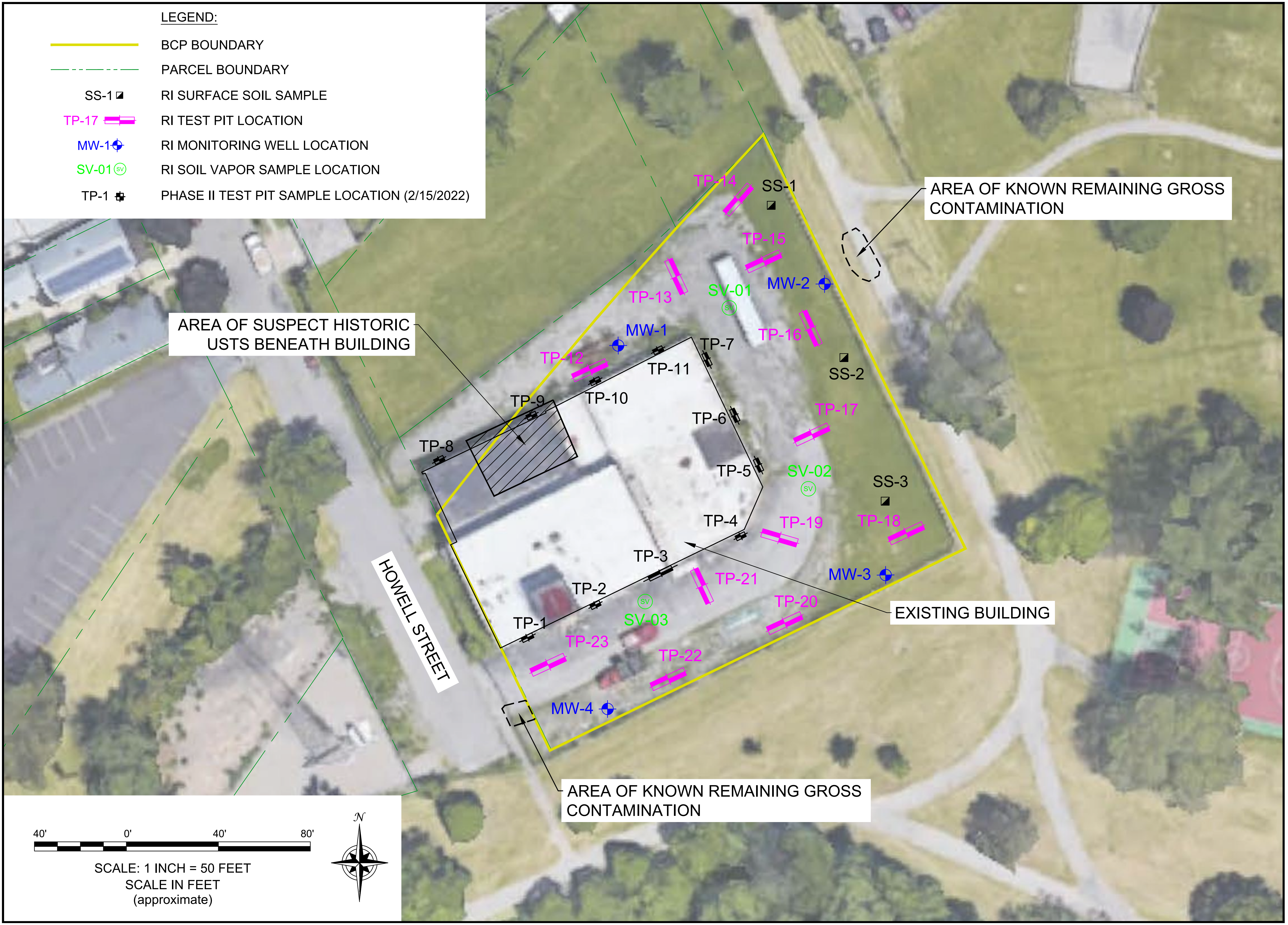
BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 3

DISCLAIMER: PROPERTY OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC. & TURNKEY ENVIRONMENTAL RESTORATION, LLC *IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS & SUPPLIERS WITHOUT THE WRITTEN CONSENT OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC & TURNKEY ENVIRONMENTAL RESTORATION, LLC.*



DATE: MAY 2022
DRAFTED BY: CEH

PROPOSED REMEDIAL INVESTIGATION LOCATIONS

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

1 HOWELL STREET SITE

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

BENCHMARK

IN ASSOCIATION WITH

TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: T0258-022-002

FIGURE 4

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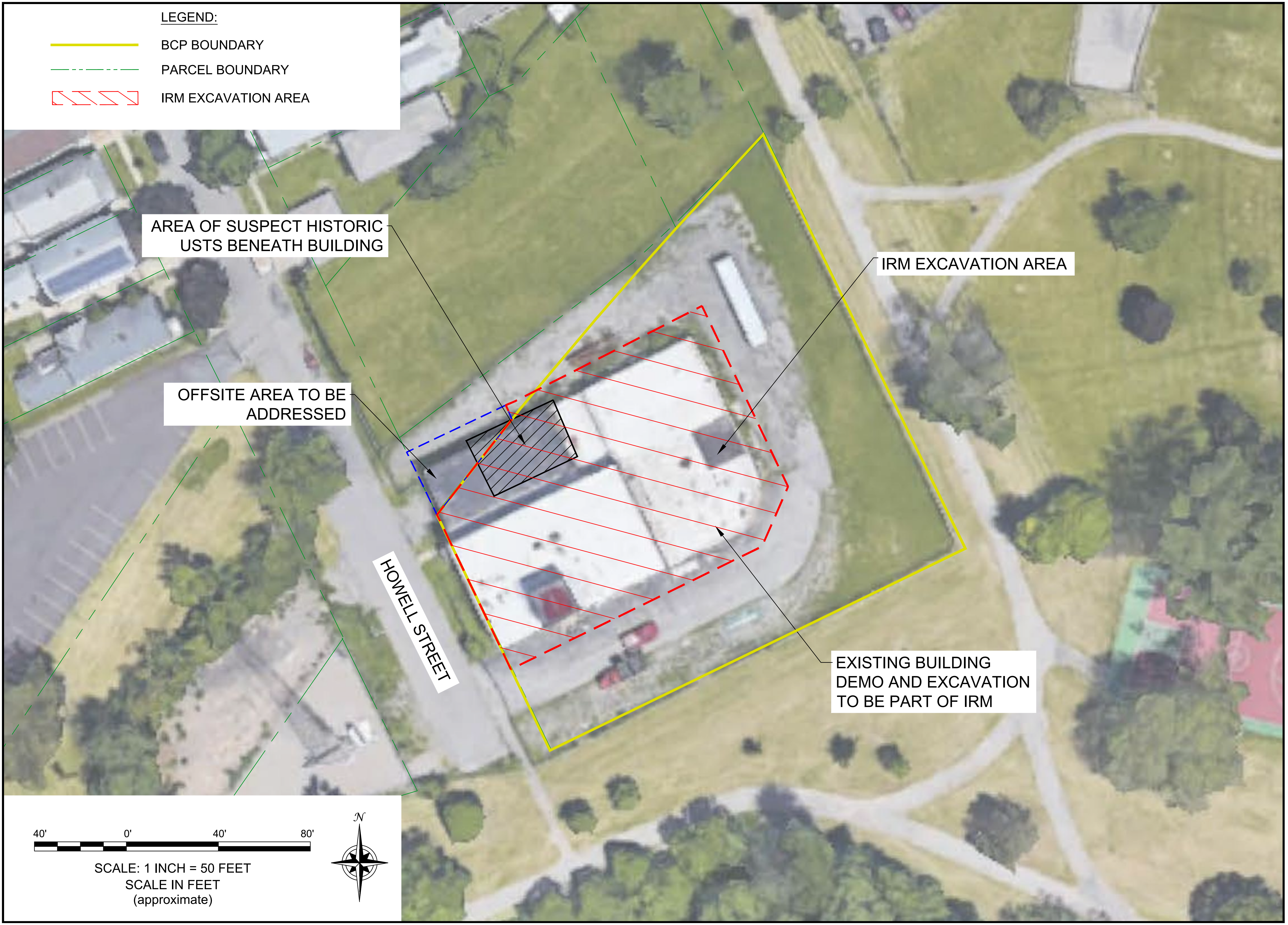

DATE: MARCH 2022
DRAFTED BY: TJM

PLANNED INTERIM REMEDIAL MEASURES

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

1 HOWELL STREET SITE

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

BENCHMARK IN ASSOCIATION WITH TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: T0258-022-002

FIGURE 5

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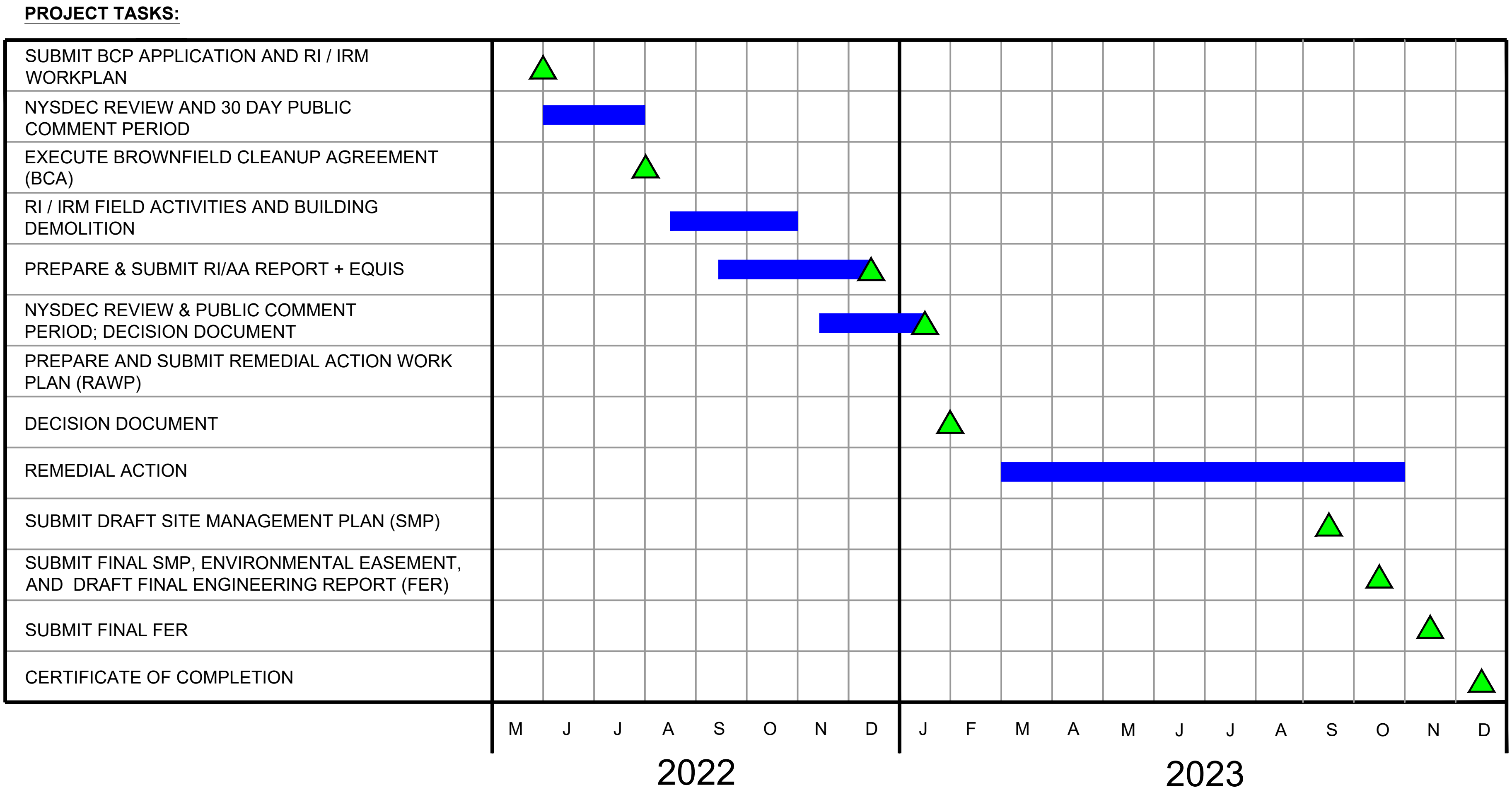

BENCHMARK

IN ASSOCIATION WITH

TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

PRELIMINARY PROJECT SCHEDULE

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORKPLAN

1 HOWELL STREET SITE

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 6

APPENDIX A

RESUMES

EDUCATION

BS (Chemical Engineering) 1988; State University of New York at Buffalo
Graduate of State University of New York at Buffalo School of Management Center for Entrepreneurial Leadership; 2002
Graduate-level courses in Biological Principles of Engineering and Hazardous Waste Management through the State University of New York at Buffalo Department of Environmental Engineering

REGISTRATION AND AFFILIATIONS

Professional Engineer, New York
Professional Engineer, Ohio
ISO 14000 Certified Lead Auditor - April 1998
Member - American Institute of Chemical Engineers
Member – New York Water Environment Association, Inc.

SUMMARY OF EXPERIENCE

Mr. Forbes has over 26 years of environmental engineering experience, with a particular focus on brownfield and hazardous waste site investigation and remediation; petroleum-impacted site remediation; due diligence for environmentally-impaired properties; groundwater and industrial wastewater treatment; and environmental regulatory compliance. Investigations and cleanups Mr. Forbes has directed have included well over 100 sites contaminated with a wide range of materials, including chlorinated solvents, PCBs, dioxins, heavy metals, cyanide, radioactive isotopes, and petroleum contamination. He has evaluated and successfully implemented on a conventional and design-build basis cost-saving and innovative treatment technologies (e.g. in-situ and ex-situ physical-chemical, thermal, and biological treatment) as well as removal and containment methods for remediation.

REPRESENTATIVE PROJECT EXPERIENCE

June 1998 to Present: **Benchmark Environmental Engineering & Science, PLLC**

- Served as project manager for the investigation and hydrogeological assessment of the 2001 Webster Block site on behalf of the City of Buffalo. Work included a Phase II Site investigation, underground storage tank removal, groundwater pump test, and utility capacity evaluation performed under USEPA Pilot grant.

- Currently serving as Project Officer for NYSDEC Brownfield Cleanup Program (BCP) investigation and remediation of the former Millard Fillmore Gates Circle hospital complex in Buffalo, NY.

- Project officer for NYSDEC BCP investigation and cleanup of 154 South Ogden Street in concert with construction of the South Buffalo Charter School.

- Serving as project manager for remedial investigation, alternatives analysis, and remedial construction to facilitate redevelopment of over 450-acres of former steel manufacturing site property encompassing 33 separate BCP sub-parcel sites in Lackawanna, New York. Contaminants of concern primarily include petroleum organics/solvents and heavy metals.

- Project manager for RI/FS, remedial design and remedial construction at the Sycamore Village Site, a 4-acre NY State Environmental Restoration Program (ERP) site in Buffalo, NY. Responsible for all technical and administrative aspects of the project, involving removal of over 18,000 cubic yards of soil from an impacted residential neighborhood and site restoration.

- Assisted western NY client's legal counsel prepare legal defense related to a multi-PRP suit by Orange County Water District, Fullerton, CA for primary drinking water aquifer contamination by chlorinated solvents and emergent organic contaminants. Served as technical consultant during mediation and settlement discussions; prepared expert report and lead technical arguments on behalf of defendant to support bankruptcy claim dismissal.

- Served as project manager and supervising contractor for design-build remedial activities at the Markhams National Priority List (NPL) site in Dayton, NY. Successfully implemented remedial measures leading to USEPA-designated Preliminary Site Closeout status in October 2008 and delisting in 2009.

- Served as project manager representing multiple potential responsible party (PRP)-led remedial construction activities to address heavy metal and chlorinated solvent impacts at the Peter Cooper Landfill NPL site. Responsible for oversight and coordination of RI/FS planning and implementation activities, lead technical contact with USEPA, and remedial measures design and construction. Achieved site closeout in 2011.

- Served as project manager for design-build cleanup of the Urbana Landfill Site, a Class 2 Hazardous Waste Landfill Site. Designed and successfully implemented a Soil Vapor Extraction system to address source area chlorinated organics in soils, achieving soil cleanup goals with 12 months, Also responsible for design, startup and continued operation of a downgradient perimeter groundwater extraction well system and groundwater remediation utilizing advanced oxidation treatment.

- Assisted in the development of a voluntary cleanup plan for remediation of a 120-acre former steel manufacturing site in Buffalo, NY which was contaminated with volatile organic compounds, heavy metals, poly-nuclear aromatic hydrocarbons. Specific assistance involved design of a soil vapor extraction (SVE) system to address VOC and SVOC source area impacts proximate to a residential neighborhood and development and implementation of a Community Air Monitoring Plan involving quantitative monitoring (Summa Canister and respirable particulate analysis) and qualitative monitoring (field instruments).

- Served as Project Manager for RI/FS and cleanup activities related to solvent releases from a former paint and specialty coatings manufacturing facility in Buffalo, NY. The work, carried out under NY State Superfund program, included insitu treatment of soils and groundwater impacted by chlorinated and non-chlorinated volatile organics and heavy metals.

- Assisted confidential client's legal counsel negotiate a consent decree with New Mexico Environment Department related to cleanup of chlorinated solvent releases to the fractured bedrock aquifer from a former manufacturing operation in Albuquerque, NM. Presently managing insitu groundwater cleanup and monitoring work.

- Currently serving as Project Manager for NY State Voluntary Cleanup efforts for chlorinated solvent cleanup at a former degreasing and electroplating facility in Rochester, NY. Designed and implemented interim remedial measures involving low-profile air stripping and insitu hydrogen infusion.

- Served as Project Manager for multiple EPA Pilot-Grant funded investigations for City of Buffalo Department of Strategic Planning.

- Project manager for remedial investigation, alternatives analysis, and remedial construction to facilitate redevelopment of over 450-acres of former steel manufacturing site property in Lackawanna, New York. Contaminants of concern primarily include petroleum organics and heavy metals.

- Managed design-build cleanup of former New 7th Street Brownfield Cleanup Program Site in Buffalo, New York. The project involved design-build removal of several hundred tons of petroleum-impacted soil and fill material and preparation of related engineering reports resulting in Certificate of Completion issuance.

- Led remedial efforts for petroleum releases at a Western New York refinery and major oil storage facility, achieving site inactivation within 3 months of the release.

- Managed spill site investigation and cleanup work including underground storage tank removal work at numerous petroleum and chemical spill sites in Western New York.

- Led design-build construction of a 5 MGD capacity cooling water pH adjustment system for PVS Chemical Corporation. The project included design of feed forward pH control system, adjustment tank and mixer construction, process and chemical feed piping modifications to neutralize sulfuric acid discharges. Successfully implemented startup and demonstration testing.

- Designed a 75 gpm groundwater treatment system and served as quality assurance officer for remedial efforts at the Steelfields site (former LTV Steel/Hanna Furnace Site), Buffalo, NY. The treatment system removes petroleum-based volatile organic and semi-volatile organic compounds prior to discharge to the Buffalo Sewer Authority.

June 1988 to June 1998 Malcolm Pirnie, Inc.

- Assisted the City of Buffalo Department of Community Development in implementing an emergency PCB-contaminated soil removal effort from a residential neighborhood in Buffalo, NY. Responsibilities included coordination of hazmat excavation contractor and secure landfill, preparation of an emergency excavation and confirmatory sampling plan, and oversight of community air monitoring during the removal work.

- Designed and successfully implemented an innovative groundwater treatment system for the Mercury Aircraft, Inc. Class 2 hazardous waste site in Dresden, New York. Responsibilities included preparation of design plans and specifications for an advanced oxidation process and low profile air stripper, construction oversight and treatment system start-up.

- Performed a Feasibility Study and prepared an Engineering Design Report for remediation of PCB-contaminated soils and sediments at the Columbus McKinnon Corporation, Tonawanda, New York. Responsibilities included detailed evaluation of several remedial processes, completion of design calculations and remedial cost estimates, and preparation of a final report for submission to NYSDEC.

- Assisted in performance of a Feasibility Study for the West Valley Nuclear Demonstration Site. The Feasibility Study evaluated alternatives for remediation of groundwater contaminated with radioactive isotopes from a former containment area release.

- Assisted in the design and performed start-up of a groundwater remediation system for Moog, Inc., an aerospace parts manufacturer. The project, performed on a design-build basis, involved preparation of design plans, securing contractor bids for construction, and start-up of the remediation system, which incorporates filtration and air stripping to remove chlorinated volatile organic contaminants from groundwater.

- Designed and implemented groundwater monitoring well decommissioning procedures for the Love Canal site, Niagara Falls NY. The project was performed on behalf of NYSDEC and included abandoning of monitoring wells no longer used in the Love Canal landfill or in adjoining neighborhoods.

- Prepared an environmental monitoring plan for remediation of PCB-contaminated sediments in the St. Lawrence River along the General Motors, Inc. Powertrain Division facility in Massena, New York.

- Assisted in the performance of a Feasibility Study for remediation of volatile organic, PCB and heavy metal-contaminated soils and ground water at the Rochester Fire Academy, Rochester, New York.

PUBLICATIONS/PRESENTATIONS

Forbes, Thomas H. and Frappa, Richard H. "Innovative Remedial Measures for the Mercury Aircraft Site" Proceedings of the Purdue University 50th Annual Industrial Waste Conference, May 1995.

Frappa, Richard H., Forbes, Thomas H. and McManus, Anne Marie "A Blast to Remediate” Industrial Wastewater, July/August 1996.

Forbes, Thomas H. and McManus, Anne Marie "Advanced Oxidation Technology and Application” Proceedings of the University at Buffalo 28th Mid-Atlantic Industrial and Hazardous Waste Conference, July 1996.

Forbes, Thomas H. et al - "Pay to Throw in Buffalo" Proceedings of 1997 Solid Waste Association of North America annual conference.

Forbes, T.H. & Werthman, P.H. "Development of Site-Specific Cleanup Levels for Commercial Redevelopment of a Large Former Steel Works," presented at the Brownfields 2000 Conference, Atlantic City NJ, October 2000.

Forbes, Thomas H. and Frappa, Richard H. "Innovative Remedial Measures Almost 10 Years Later at the Former Mercury Aircraft Site" Proceedings of the National Groundwater Association Northeast Conference, October 2002.

Forbes, Thomas H. "Ins and Outs of the New York State Brownfield Cleanup Program" Air & Waste Management Association, Niagara Frontier Section, Annual Environmental Seminar (presentation), April 2006.

Forbes, Thomas H. "Brownfield Redevelopment" Proceedings of Half Moon Seminar’s “New York Environmental Compliance for Design Professionals” conference, September 2008.

Forbes, Thomas H. “New York State Brownfield Cleanup Program Update" Air & Waste Management Association Annual Environmental Seminar (presentation), April 2009.

APPENDIX B

PREVIOUS INVESTIGATIONS

LIMITED PHASE II ENVIRONMENTAL INVESTIGATION REPORT

1 Howell Street Site
Buffalo, New York

March 2022 0258-022-002

Prepared for:

Howell Street Venture, LLC

Prepared by:

TurnKey Environmental Restoration, LLC
2558 Hamburg Turnpike, Suite 300
Buffalo, New York 14218

LTD. PHASE II ENVIRONMENTAL INVESTIGATION REPORT

1 Howell Street Site
Buffalo, New York

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1.0 INTRODUCTION

1.1 Background and Site Description

TurnKey Environmental Restoration, LLC (TurnKey) completed a Limited Phase II Environmental Investigation for Howell Street Venture, LLC at the property addressed at 1 Howell Street, City of Buffalo, Erie County, New York (Site; see Figure 1).

The Site consists of a single 0.73-acre tax parcel (SBL No. 88.36-2-6), addressed at 1 Howell Street, Buffalo, New York (see Figures 1 and 2). The Site is located in a highly developed mixed use residential and commercial area of the City of Buffalo and is currently vacant. The Site includes the existing building, asphalt and gravel covered parking areas, and grass covered areas.

The Site was used as a robe manufacturing facility including dye house operations and has a history of petroleum storage and distribution as early as 1915. Historic records indicate robe production including animal hide robe manufacturing. A petroleum service station was located on-Site in the early 1930s, and petroleum terminal bulk storage and distribution operated on-Site from the late 1930s through the 1970s. Multiple commercial operations including window and door repair and manufacturing, roofing contractor, and construction operations have occupied the site.

A portion of the Site, and surrounding off-Site areas, were previously remediated under NYS Spill No. 9507939. NYSDEC Spill documents indicate that gross petroleum contaminated soils remain around the existing building, and in select areas along the property boundary of the Site. Additionally, remedial measures were completed related to elevated polychlorinated biphenyls (PCBs) in sludges that were improperly handled from on-Site aboveground storage tank (AST) removal in accordance with the Resource Conservation and Recovery Act (RCRA) listing 915173. Records indicated the presence of remaining gross contamination along the property boundary in several locations, as well as surrounding and beneath the existing building. The specific RECs identified for the Site included the following:

- Historic operations including robe manufacturing with dye house operations, petroleum bulk storage and distribution, window manufacturing, and other commercial operations. Multiple underground storage tanks (USTs) and aboveground storage tanks (ASTs) were once present on Site, including distribution piping.

- Historic records indicate potential tanks beneath a portion of the building – removal records are not available. Records also indicate subgrade petroleum piping assumed to exist below the southern, eastern, and northern portions of the building.
- NYSDEC Spill No. 950939 indicates grossly contaminated petroleum soils (GCPS) remain on Site post-Spill closure activities. Gross contamination is present along the Site boundary in two (2) locations, including Howell Street, post-Spill closure.
- PCB contamination associated with former AST sludge removal (915173) completed in 2001.

The purpose of this investigation was to assess recognized environmental conditions (RECs) identified for the Site in New York State Department of Environmental Conservation (NYSDEC) records.

2.0 SITE INVESTIGATION ACTIVITIES

2.1 Test Pit Investigation

On February 15, 2022, TurnKey mobilized an excavator to the Site to complete test pits and assess the subsurface conditions. Eleven (11) test pits designated as TP-1 through TP-11 were completed on-Site (see Figure 2). TPs ranged in depth from 4 to 8 feet below ground surface (fbgs).

TurnKey field staff inspected the test pits and excavated spoils for field characterization of the subsurface conditions, screening of the soil/fill using a photoionization detector (PID) and documenting visual and/or olfactory observations. Details of the field findings are provided on Table 1. Findings of the investigation are described in Section 3.

Based on the field evidence, including the presence of Grossly Contaminated Petroleum Soils (GCPS), the NYS Spill hotline was notified, and Spill No. 2109702 was assigned to the Site.

2.2 Laboratory Analysis

A total of six (6) TP locations were selected for laboratory analysis based on the field findings of investigation. Certain soil samples were analyzed for NYSDEC CP-51 List volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs), and Resource Conservation and Recovery Act (RCRA) list metals. Laboratory analytical results are presented below.

3.0 INVESTIGATION FINDINGS

3.1 Qualitative Soil Screening

GCPS was identified in all 11 TP locations, including stained black soils, strong odors, elevated PID readings as high as 400 ppm, product in soils, and product sheen on water in the TP(s).

The overburden material observed during the investigation is generally described as fill materials overlying sand and clay to at least eight (8) fbgs. Fill materials consisted of ash, cinders/black fines, brick and glass fragments, sand, gravel, and household debris (e.g., glass, metal, roofing, siding, wood etc). Fill was encountered across the Site at all TP locations at depths up to 5-8 fbgs. It should be noted that petroleum impacts were identified in the apparent backfill material. Elevated PID readings from the TPs ranged from 200-400 ppm, with the highest readings found at TP-6 and TP-7.

Assumed native clays were identified beneath the fill unit, and showed evidence of black staining, suspected product, and odors. Details of the investigation are provided on Table 1 and on the attached photolog within Appendix A.

3.2 Soil Analytical Results

Laboratory analytical results are summarized on Table 2 with comparison to applicable 6NYCRR Part 375 Soil Cleanup Objectives (SCOs). The laboratory report is provided in Appendix B.

Elevated VOCs, including benzene, ethylbenzene, toluene, and xylene (BTEX compounds) were detected exceeding their CP-51 Soil Cleanup Levels, and associated Part 375 Unrestricted SCOs (USCOs). Elevated chlorinated VOCs, including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC) were detected exceeding their Protection of Water SCO (PWSCO), and Restricted Residential Use SCOs (RRSCOs).

Elevated PAHs were detected exceeding their Industrial Use SCOs (ISCOs), RRSCOs, and USCOs, selectively.

Elevated metals, including arsenic and lead were detected exceeding their ISCO and RRSCO, respectively.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the Ltd. Phase II investigation at the Site, TurnKey offers the following conclusions and recommendations:

- Grossly Contaminated Petroleum Soils (GCPS) were identified at all 11 TP locations surrounding the vacant building. Visual, olfactory, and elevated PID readings as high as 400 ppm were detected.
- Based on the field evidence NYSDEC Spill 2109702 was issued for the Site.
- Elevated PAHs exceeding RRSCOs and ISCOs were detected.
- Elevated metals, arsenic and lead, were detected above ISCOs and RRSCOs respectively.
- Based on the findings of this investigation, additional Site investigation and remediation would be required to address the Spill and associated elevated fill materials prior to Site redevelopment. We understand that Howell Street Venture, LLC, or related entity, is considering redeveloping the property for residential use, and based on the environmental impacts noted above, the Site may be eligible for the NYS Brownfield Cleanup Program.

5.0 LIMITATIONS

This report has been prepared for the exclusive use of Howell Street Venture, LLC. The contents of this report are limited to information available at the time of the Site investigation activities and to data referenced herein and assume all referenced historic information sources to be true and accurate. The findings herein may be relied upon only at the discretion of Howell Street Venture, LLC. Use of or reliance on this report or its findings by any other person or entity is prohibited without written permission of TurnKey Environmental Restoration, LLC.

TABLES

TurnKey Environmental Restoration, LLC

TABLE 1

SUMMARY OF SUBSURFACE FIELD OBSERVATIONS
LIMITED PHASE II ENVIRONMENTAL INVESTIGATION
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Location	Date	Urban Fill Present	Odors	Water Present	Depth of Test Pit (fbgs)	Length of Test Pits (ft)	Test Pit Width (ft)	PID Measurements	Sample Depth (ft)	Depth (fbgs) and Soil Description
TP-1	02/15/22	Yes	Yes	Yes	6	7	3	0 ppm		**0-2 ft:** Gray, crusher run limestone (parking lot subbase)
								150-200 ppm		**2-3 ft:** Black, ashy fill, oily residue, strong odor.
								150-200 ppm	3-4 ft	**3-6 ft:** Red/brown lean, sandy clay. Black staining, strong odor, oil like residue.
TP-2	02/15/22	Yes	Yes	Yes	7	6	3	0 ppm		**0-1 ft**: Gray, crusher run limestone (parking lot subbase)
								50-150 ppm		**1-3 ft:** Black, gravelly fill. Cinders/ash strewn throughout. Oil like residue coating fill. Definite odor and staining.
								10-20 ppm		**3-7 ft:** Red/brown lean, sandy clay. Black staining evident in the 3-4 ft range. Strong odor. All of the noted observations of fill come from the north side of the test pit (building side). South side of test pit wall consists of crusher run limestone backfill.
TP-3	02/15/22	Yes	Yes	Yes	8	15	3	0 ppm		**0-1 ft:** Gray, crusher run limestone (parking lot subbase)
								150-200 ppm	1-2 ft	**1-2 ft:** Black, gravelly fill mixed with sandy clay. Strong odor.
								50-100 ppm		**2-4 ft:** Red/brown lean, sandy clay. Moist, strong odors, black staining.
								50 ppm		**4-8 ft:** Red/ brown lean, sandy clay. Less impacted than above, impacts decrease with increasing depth.
TP-4	2/15/2022	Yes	Yes	No	7	6	3	0 ppm		**0-1 ft:** Gray, crusher run limestone (parking lot subbase)
								20 ppm		**1-1.5 ft:** Black, gravelly fill with ash strewn throughout. Some sand, slight odor, staining.
								20 ppm		**1.5-2 ft:** Gray, ashy fill. Cinders strewn throughout.
								50 ppm		**2-7 ft:** Red/brown clay. Mild staining/odor. PID signature from 2-3 ft range.
TP-5	02/15/22	Yes	Yes	Yes	6	8	3	0 ppm		**0-2 ft:** Brown, gravelly soil below grass. Fabric encountered at 2 ft.
								50 ppm		**2-2.5 ft:** Red/brown clay. Slight odor, black staining.
								100-200 ppm		**2-6 ft:** Black stained gravel with silt and sand strewn throughout. Contains wood, ash, cinders. Clay encountered at appx. 6 fbgs. Strong odor, black staining, oil like residue coating all gravel fill. Black sheen develops atop groundwater from gravel unit.

TurnKey Environmental Restoration, LLC

TABLE 1

SUMMARY OF SUBSURFACE FIELD OBSERVATIONS
LIMITED PHASE II ENVIRONMENTAL INVESTIGATION
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Location	Date	Urban Fill Present	Odors	Water Present	Depth of Test Pit (fbgs)	Length of Test Pits (ft)	Test Pit Width (ft)	PID Measurements	Sample Depth (ft)	Depth (fbgs) and Soil Description
TP-6	02/15/22	Yes	Yes	No	8	8	3	0 ppm		**0-1 ft:** Brown, gravelly soil below grass.
								150 ppm		**1-3 ft:** Red/brown ashy fill. Evidence of cinders, some slag, gravel strewn throughout. Oil like residue seeping from western sidewall (building side).
								320 ppm	3-4 ft	**3-4 ft:** Black stained fill. Oil like residue coating material. Oil like liquid seaping from west side of test pit (building side). Strong odors and evidence of gross contamination.
								50 ppm		**4-8 ft:** Red/brown clay. Highly impacted (staining/odor) in shallower range. Impacts decrease with depth.
TP-7	02/15/22	Yes	Yes	No	5	8	3	0 ppm		**0-0.5 ft:** Brown, gravelly soil below grass.
								0 ppm		**0.5-1 ft:** Gray/brown sandy silt. Some clay.
								250-300 ppm		**1-3 ft:** Red/brown clay. Wood, brick, gravel strewn throughout. Black staining, odor.
								400 ppm	3-5 ft	**3-5 ft:** Black, oily gravel followed immediately by heavily impacted clay (black staining, strong odor) Impacts decrease with depth. High PID signature in 3-4 ft range.
TP-8	02/15/22	Yes	Yes	Yes	4	6	3	0 ppm		**0-1 ft:** Brown, gravelly soil below grass.
								50 ppm		**1-3 ft:** Black stained gravelly fill, strong odor. Immediate groundwater intrusion at appx. 2 fbgs.
								150 ppm	3-4 ft	**3-4 ft:** Black stained clay, strong odor. Above noted water develops black sheen due to the impacted fill.
TP-9	02/15/22	Yes	Yes	No	6	6	3	0 ppm		**0-0.5 ft:** Brown, gravelly soil
								20 ppm		**0.5-1.5:** Red/brown clay with fill material strewn throughout.
								50-100 ppm		**1.5-3 ft:** Gravelly fill with sand, wood, brick strewn throughout. Oil like residue coating material, strong odor.
								50 ppm		**3-6 ft:** Red/brown clay. Black staining evident in the 3-4 ft range. Impacts decrease with depth.
TP-10	02/15/22	Yes	Yes	Yes	5	6	3	0 ppm		**0-1 ft:** Gray/brown gravelly soil.
								150 ppm	1-3 ft	**1-3 ft:** Red/brown clay on eastern side of TP. Black stained fill on west, oil like residue (Photo).
								30-50 ppm		**3-5 ft:** Gray/brown clay. Some black staining.
TP-11	02/15/22	Yes	Yes	Yes	5	6	3	0 ppm		**0-1 ft:** Gray/brown gravelly soil.
								150 ppm		**1-3 ft:** Red/brown sandy soil. Some gravel. Thin unit of oil impacted fill at 3 fbgs.
								100 ppm		**3-5 ft:** Red/brown clay. Black staining and strong odors. Groundwater developing black sheen from above impacts.

Notes:

1. Urban Fill: varying combinations of concrete, orange brick, and cinders.

2. Ground surface elevation data based on survey information by Millard, MacKay & Delles Land Surveyors, LLP dated 2/20/20 utilizing GPS datum: NAD83 (2011) Epoch 2010.0 datum.

Definitions:

fbgs = feet below ground surface

PID = photoionization detector

ppm = parts per million

DTW = Depth to water.

N/A = Non applicable

TABLE 2
SUMMARY OF SUBSURFACE SOIL-FILL ANALYTICAL RESULTS
LIMITED PHASE II ENVIRONMENTAL INVESTIGATION
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Parameter [1]	**Unrestricted Use SCOs[2]**	**Protection of GW SCOs[2]**	**Restricted-Residential Use SCOs[2]**	**Commerical Use SCOs[2]**	**Industrial Use SCOs[2]**	**Sample Location**					
						TP-1 (3-4') 2/15/2022	**TP-3 (1-2') 2/15/2022**	**TP-6 (3-4') 2/15/2022**	**TP-7 (3-5') 2/15/2022**	**TP-8 (3-4') 2/15/2022**	**TP-10 (1-3') 2/15/2022**
Volatile Organic Compounds (VOCs) - mg/kg[3]											
Benzene	**0.06**	**--**	**4.8**	**44**	**89**	ND	ND	ND	ND	**0.810**	**0.130 J**
cis-1,2-Dichloroethene	**0.25**	**0.25**	**100**	**500**	**1,000**	ND	ND	**56**	ND	ND	ND
Cyclohexane	**--**	**--**	**--**	**--**	**--**	ND	ND	1.0 J	ND	ND	2.3
Isopropylbenzene (Cumene)	**100**	**--**	**100**	**100**	**100**	ND	ND	2.8	0.620 J	ND	0.150 J
Tetrachloroethene	**1.3**	**1.3**	**19**	**150**	**300**	ND	ND	**27**	ND	ND	ND
Trichloroethene	**0.47**	**0.47**	**21**	**200**	**400**	ND	ND	**2**	ND	ND	ND
Vinyl chloride	**0.02**	**0.02**	**0.9**	**13**	**27**	ND	ND	**9.8**	ND	ND	ND
Total Xylene	**0.26**	**--**	**100**	**500**	**1,000**	ND	ND	**12**	ND	ND	**0.800 J**
Toluene	**0.7**	**--**	**100**	**500**	**1,000**	ND	ND	**6.2**	ND	ND	ND
Ethylbenzene	**1**	**--**	**41**	**390**	**780**	ND	ND	**6.8**	ND	ND	ND
Semi-Volatile Organic Compounds (SVOCs) - mg/kg[3]											
Acenaphthene	**20**	**--**	**100**	**500**	**1,000**	0.39	0.500 J	0.190 J	0.28	0.960 J	0.520 J
Acenaphthylene	**100**	**--**	**100**	**500**	**1,000**	0.35	0.540 J	ND	ND	ND	0.290 J
Anthracene	**100**	**--**	**100**	**500**	**1,000**	0.46	1.1	0.170 J	0.29	0.650 J	0.810 J
Benzo(a)anthracene	**1**	**--**	**1**	**5.6**	**11**	**1.10**	**3.30**	0.30	0.49	0.710 J	**2.3**
Benzo(a)pyrene	**1**	**--**	**1**	**1**	**1.1**	**1.10**	**3.10**	0.25	0.51	0.470 J	**2.4**
Benzo(b)fluoranthene	**1**	**--**	**1**	**5.6**	**11**	**1.30**	**3.90**	0.39	0.96	0.750 J	**2.9**
Benzo(g,h,i)perylene	**100**	**--**	**100**	**500**	**1,000**	0.56	1.90	0.170 J F2	0.170 J	0.260 J	1.6
Benzo(k)fluoranthene	**0.8**	**--**	**3.9**	**56**	**110**	0.55	**1.7**	0.150 J	ND	0.170 J	**1.2**
Chrysene	**1**	**--**	**3.9**	**56**	**110**	**1.20**	**3.5**	0.44	0.65	0.720 J	**2.5**
Dibenzo(a,h)anthracene	**0.33**	**--**	**0.33**	**0.56**	**1.1**	0.150 J	**0.570 J**	0.069 J F2	**0.740 J**	ND	**0.430 J**
Fluoranthene	**100**	**--**	**100**	**500**	**1,000**	2.7	7.5	0.76	1.3	2.1	4.7
Fluorene	**30**	**--**	**100**	**500**	**1,000**	0.67	0.950 J	0.43	0.39	1.3	0.740 J
Indeno(1,2,3-cd)pyrene	**0.5**	**--**	**0.5**	**5.6**	**11**	**0.52**	**1.8**	0.150 J F2	0.18	0.250 J	ND
Phenanthrene	**100**	**--**	**100**	**500**	**1,000**	1.1	4.1	0.63	0.44	1.8	2.9
Pyrene	**100**	**--**	**100**	**500**	**1,000**	2.1	6.0	0.63	0.91	1.7	4.0
Naphthalene	**12**	**--**	**100**	**500**	**1,000**	0.23	0.41	0.46	0.23	0.260 J	0.93
Total PAHs	**--**	**--**	**100**	**500**	**--**	14.480	40.87 J	5.189 J	7.54	6.9 J	24.5 J
Metals - mg/kg											
Arsenic	**13**	**--**	**16**	**16**	**16**	5.70	10.2	7.9	9.7	5.9	**16.1**
Barium	**350**	**--**	**400**	**400**	**10,000**	123.0 F1	349	131	107	122	97.1
Cadmium	**2.5**	**--**	**4.3**	**9.3**	**60.0**	0.260	1.5	0.84	0.28	0.26	0.53
Chromium [4]	**30**	**--**	**180**	**1,500**	**6,800**	14.90	17.5	18.6	18.7	24.3	17.9
Lead	**63**	**--**	**400**	**1,000**	**3,900**	**63.7 F1**	**320**	**197**	**83.2**	40.0	**726**
Mercury	**0.18**	**--**	**0.81**	**2.8**	**5.7**	0.048	0.13	0.06	0.063	0.062	0.076

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 6NYCRR Part 375 Soil Cleanup Objectives (SCOs).
3. Sample results were reported by the laboratory in micograms per kilogram (ug/kg) and converted to milligram per kilogram (mg/kg) for comparison to SCOs.
4. SCOs provided for trivalent chromium

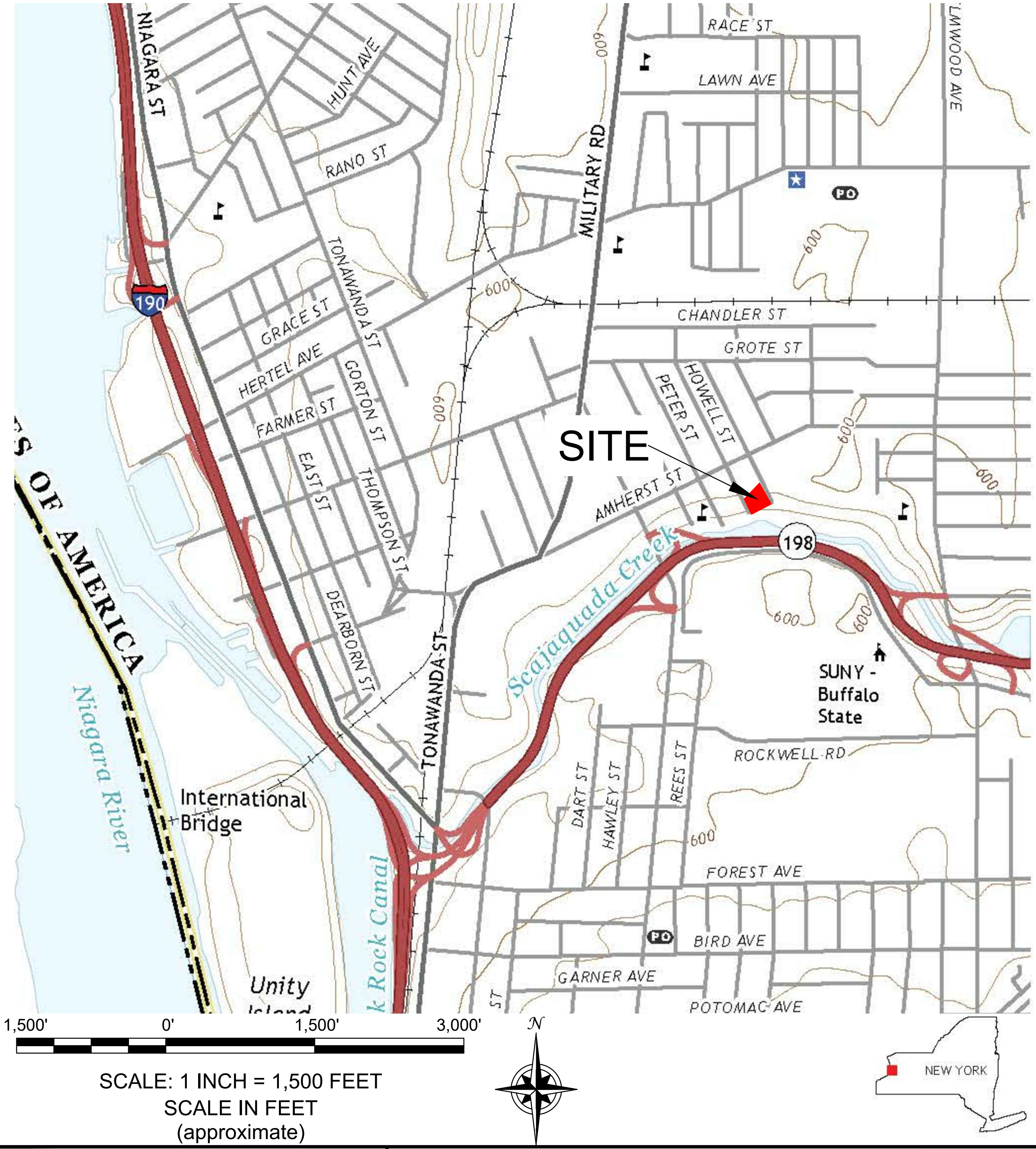
Definitions:

mg/kg = milligrams per kilogram
ND = Parameter not detected above laboratory detection limit
-- = No SCO available, or parameter not tested for.
J = Result is less than the RL but greater or equal to the MDL and the concentration is an approximate value, indicates estimated value for TICs.
F1= MS and/or MSD Recovery is outside acceptance limits.
F2= MS/MSD RPD exceeds control limits.

🟩 **BOLD** = Result exceeds Residential Use SCOs
🟦 **BOLD** = Result exceeds Restricted Residential Use SCOs
🟨 **BOLD** = Result exceeds Commercial Use SCOs
🟥 **BOLD** = Result exceeds Industrial Use SCOs

FIGURES

FIGURE 1



TurnKey
Environmental
Restoration, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MARCH 2022

DRAFTED BY: TJM

SITE LOCATION AND VICINITY MAP

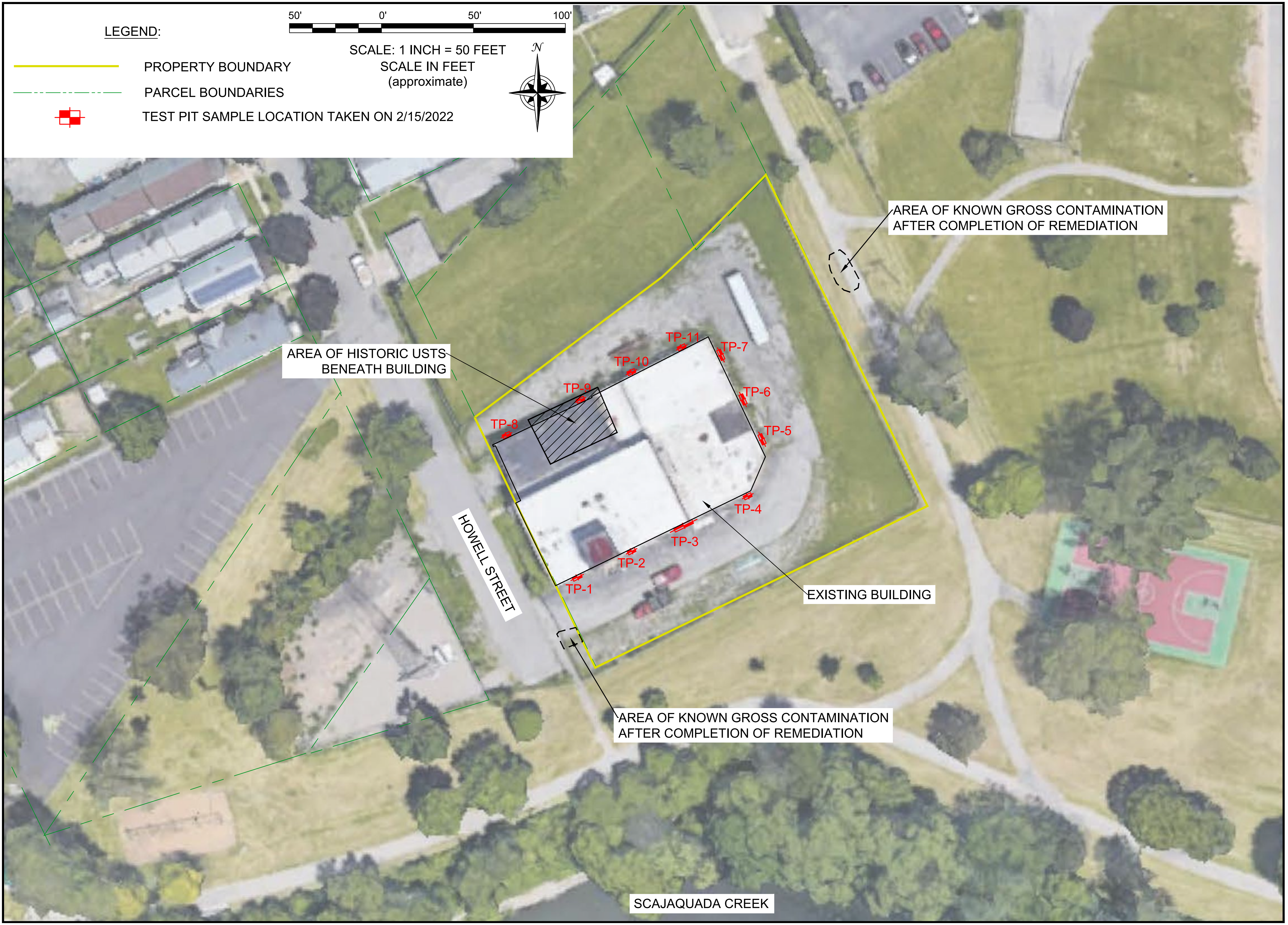
LIMITED PHASE II INVESTIGATION

1 HOWELL STREET
BUFFALO, NEW YORK

PREPARED FOR
HOWELL STREET VENTURE, LLC

F:\CAD\TurnKey\Savarino\1 Howell Street\Limited Phase II\Figure 1; Site Location and Vicinity Map.dwg, 3/28/2022 4:03:34 PM, DWG To PDF.pc3

F:\CAD\TurnKey\Savarino\1 Howell Street\Limited Phase II\Figure 2; Investigation Locations.dwg, 3/28/2022 3:51:08 PM, DWG To PDF.pc3



DATE: MARCH 2022
DRAFTED BY: TJM

TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218,
(716) 856-0599

JOB NO.: T0258-022-002

INVESTIGATION LOCATIONS

LIMITED PHASE II INVESTIGATION

1 HOWELL STREET
BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 2

DISCLAIMER:
PROPERTY OF TURNKEY ENVIRONMENTAL RESTORATION, LLC. IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS & SUPPLIERS WITHOUT THE WRITTEN CONSENT OF TURNKEY ENVIRONMENTAL RESTORATION, LLC.

APPENDIX A

PHOTO LOG

SITE PHOTOGRAPHS

Photo 1:

Photo 2:

Photo 3:

Photo 4:

Photo 1:	View of heavily impacted gravel backfill at TP-5. The gravel, found below fabric, is coated in an oil like residue.
Photo 2:	View of the groundwater intrusion at TP-5, and a black sheen developing atop the water looking north.
Photo 3:	View of product seeping from the western sidewall (building side) of TP-6.
Photo 4:	View of the black stained fill material present within TP-7. Note the black stained wood within the fill.

SITE PHOTOGRAPHS

Photo 5:

Photo 6:

Photo 7:

Photo 8:

Photo 5: View of the groundwater intrusion at TP-8 due, most likely, to perched water within backfill. Note the black sheen developing atop the water from impacted fill that is coated in product.

Photo 6: View of the impacted clay found within TP-8. Note the black product coating the material.

Photo 7: View of the black stained fill found within TP-10. Note the fill is coated with product and a sheen is beginning to develop atop the groundwater.

Photo 8: View of the black stained clay within TP-11 and the fill material coated in product. Note the coated fill on the south side of the test pit (building side) creating a sheen atop the groundwater.

APPENDIX B

LABORATORY ANALYTICAL DATA SUMMARY PACKAGE

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ANALYTICAL REPORT

Eurofins Buffalo
10 Hazelwood Drive
Amherst, NY 14228-2298
Tel: (716)691-2600

Laboratory Job ID: 480-195030-1
Client Project/Site: Benchmark - Howell Street

For:
Benchmark Env. Eng. & Science, PLLC
2558 Hamburg Turnpike
Lackawanna, New York 14218

Attn: Bryan Mayback

Authorized for release by:
2/22/2022 4:45:38 PM
Rebecca Jones, Project Management Assistant I
Rebecca.Jones@Eurofinset.com

Designee for

Brian Fischer, Manager of Project Management
(716)504-9835
Brian.Fischer@Eurofinset.com

The test results in this report meet all 2003 NELAC, 2009 TNI, and 2016 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
*+	LCS and/or LCSD is outside acceptance limits, high biased.
*1	LCS/LCSD RPD exceeds control limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
F2	MS/MSD RPD exceeds control limits
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
S1+	Surrogate recovery exceeds control limits, high biased.

Metals

Qualifier	Qualifier Description
F1	MS and/or MSD recovery exceeds control limits.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: Benchmark Env. Eng. & Science, PLLC
Project/Site: Benchmark - Howell Street

Job ID: 480-195030-1

Job ID: 480-195030-1

Laboratory: Eurofins Buffalo

Narrative

Job Narrative
480-195030-1

Comments
No additional comments.

Receipt
The samples were received on 2/15/2022 5:05 PM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 5.2º C.

GC/MS VOA
Method 8260C: The laboratory control sample duplicate (LCSD) for preparation batch 480-615092 and analytical batch 480-615137 recovered outside control limits for the following analyte: Acetone. This analyte was biased high in the LCSD and were not detected in the associated samples; therefore, the data have been reported. The associated samples are impacted: TP-1 3-4' (480-195030-1), TP-3 1-2' (480-195030-2), TP-6 3-4' (480-195030-3), TP-7 3-5' (480-195030-4), TP-8 3-4' (480-195030-5) and TP-10 1-3' (480-195030-6).

Method 8260C: The RPD of the laboratory control sample duplicate (LCSD) for preparation batch 480-615092 and analytical batch 480-615137 recovered outside control limits for the following analytes: Chloroethane, 2-Butanone (MEK) and Acetone. The associated samples are impacted: TP-1 3-4' (480-195030-1), TP-3 1-2' (480-195030-2), TP-6 3-4' (480-195030-3), TP-7 3-5' (480-195030-4), TP-8 3-4' (480-195030-5) and TP-10 1-3' (480-195030-6).

Method 8260C: The following sample was analyzed using medium level soil analysis and diluted to bring the concentration of target analytes within the calibration range: TP-6 3-4' (480-195030-3). Elevated reporting limits (RLs) are provided.

Method 8260C: The following samples were analyzed using medium level soil analysis and diluted due to the nature of the sample matrix: TP-1 3-4' (480-195030-1), TP-3 1-2' (480-195030-2), TP-7 3-5' (480-195030-4), TP-8 3-4' (480-195030-5) and TP-10 1-3' (480-195030-6). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
Method 8270D: The following samples were diluted due to color and appearance: TP-3 1-2' (480-195030-2) and TP-8 3-4' (480-195030-5). Elevated reporting limits (RL) are provided.

Method 8270D: Surrogate recovery was outside acceptance limits for the following matrix spike/matrix spike duplicate (MS/MSD) samples: (480-195030-A-3-A MS) and (480-195030-A-3-B MSD). The parent sample's surrogate recovery was within limits. The MS/MSD sample has been qualified and reported.

Method 8270D: The laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) for preparation batch 480-615141 and analytical batch 480-615423 recovered outside control limits for the following surrogate: 2,4,6-Tribromophenol. This surrogate is biased high and no detections were found for associated analytes in the following affected samples: TP-1 3-4' (480-195030-1), TP-3 1-2' (480-195030-2), TP-6 3-4' (480-195030-3) and TP-8 3-4' (480-195030-5). Therefore, the data has been reported.

Method 8270D: The following sample was diluted due to color and appearance: TP-10 1-3' (480-195030-6). Elevated reporting limits (RL) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Benchmark Env. Eng. & Science, PLLC
Job ID: 480-195030-1
Project/Site: Benchmark - Howell Street

Client Sample ID: TP-1 3-4'
Lab Sample ID: 480-195030-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acenaphthene	390		200	29	ug/Kg	1	☼	8270D	Total/NA
Acenaphthylene	350		200	26	ug/Kg	1	☼	8270D	Total/NA
Anthracene	460		200	49	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	1100		200	20	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	1100		200	29	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	1300		200	31	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	560		200	21	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	550		200	26	ug/Kg	1	☼	8270D	Total/NA
Chrysene	1200		200	44	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	150	J	200	35	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	2700		200	21	ug/Kg	1	☼	8270D	Total/NA
Fluorene	670		200	23	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	520		200	24	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	230		200	26	ug/Kg	1	☼	8270D	Total/NA
Pyrene	2100		200	23	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	1100		200	29	ug/Kg	1	☼	8270D	Total/NA
Arsenic	5.7		2.3		mg/Kg	1	☼	6010C	Total/NA
Barium	123	F1	0.56		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.26		0.23		mg/Kg	1	☼	6010C	Total/NA
Chromium	14.9		0.56		mg/Kg	1	☼	6010C	Total/NA
Lead	63.7	F1	1.1		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.048		0.025		mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: TP-3 1-2'
Lab Sample ID: 480-195030-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acenaphthene	500	J	1100	160	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	540	J	1100	140	ug/Kg	5	☼	8270D	Total/NA
Anthracene	1100		1100	260	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	3300		1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	3100		1100	160	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	3900		1100	170	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	1900		1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	1700		1100	140	ug/Kg	5	☼	8270D	Total/NA
Chrysene	3500		1100	240	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	570	J	1100	190	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	7500		1100	110	ug/Kg	5	☼	8270D	Total/NA
Fluorene	950	J	1100	130	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	1800		1100	130	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	410	J	1100	140	ug/Kg	5	☼	8270D	Total/NA
Pyrene	6000		1100	130	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	4100		1100	160	ug/Kg	5	☼	8270D	Total/NA
Arsenic	10.2		2.6		mg/Kg	1	☼	6010C	Total/NA
Barium	349		0.66		mg/Kg	1	☼	6010C	Total/NA
Cadmium	1.5		0.26		mg/Kg	1	☼	6010C	Total/NA
Chromium	17.5		0.66		mg/Kg	1	☼	6010C	Total/NA
Lead	320		1.3		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.13		0.024		mg/Kg	1	☼	7471B	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client Sample ID: TP-6 3-4'

Lab Sample ID: 480-195030-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
cis-1,2-Dichloroethene	56000		1600	430	ug/Kg	10	☼	8260C	Total/NA
Cyclohexane	1000	J	1600	340	ug/Kg	10	☼	8260C	Total/NA
Ethylbenzene	6800		1600	450	ug/Kg	10	☼	8260C	Total/NA
Isopropylbenzene	2800		1600	230	ug/Kg	10	☼	8260C	Total/NA
Methylcyclohexane	5000		1600	730	ug/Kg	10	☼	8260C	Total/NA
Tetrachloroethene	27000		1600	210	ug/Kg	10	☼	8260C	Total/NA
Toluene	6200		1600	420	ug/Kg	10	☼	8260C	Total/NA
Trichloroethene	2000		1600	430	ug/Kg	10	☼	8260C	Total/NA
Vinyl chloride	9800		1600	520	ug/Kg	10	☼	8260C	Total/NA
Xylenes, Total	12000		3100	860	ug/Kg	10	☼	8260C	Total/NA
Acenaphthene	190	J	230	34	ug/Kg	1	☼	8270D	Total/NA
Anthracene	170	J	230	57	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	300		230	23	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	250		230	34	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	390		230	37	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	170	J F2	230	24	ug/Kg	1	☼	8270D	Total/NA
Benzo[k]fluoranthene	150	J	230	30	ug/Kg	1	☼	8270D	Total/NA
Chrysene	440		230	51	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	69	J F2	230	41	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	760		230	24	ug/Kg	1	☼	8270D	Total/NA
Fluorene	430		230	27	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	150	J F2	230	28	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	460		230	30	ug/Kg	1	☼	8270D	Total/NA
Pyrene	630		230	27	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	630		230	34	ug/Kg	1	☼	8270D	Total/NA
Arsenic	7.9		2.7		mg/Kg	1	☼	6010C	Total/NA
Barium	131		0.66		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.84		0.27		mg/Kg	1	☼	6010C	Total/NA
Chromium	18.6		0.66		mg/Kg	1	☼	6010C	Total/NA
Lead	197		1.3		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.060		0.027		mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: TP-7 3-5'

Lab Sample ID: 480-195030-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Isopropylbenzene	620	J	2900	430	ug/Kg	20	☼	8260C	Total/NA
Acenaphthene	280		220	33	ug/Kg	1	☼	8270D	Total/NA
Anthracene	290		220	55	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]anthracene	490		220	22	ug/Kg	1	☼	8270D	Total/NA
Benzo[a]pyrene	510		220	33	ug/Kg	1	☼	8270D	Total/NA
Benzo[b]fluoranthene	960		220	35	ug/Kg	1	☼	8270D	Total/NA
Benzo[g,h,i]perylene	170	J	220	24	ug/Kg	1	☼	8270D	Total/NA
Chrysene	650		220	50	ug/Kg	1	☼	8270D	Total/NA
Dibenz(a,h)anthracene	74	J	220	39	ug/Kg	1	☼	8270D	Total/NA
Fluoranthene	1300		220	24	ug/Kg	1	☼	8270D	Total/NA
Fluorene	390		220	26	ug/Kg	1	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	180	J	220	28	ug/Kg	1	☼	8270D	Total/NA
Naphthalene	230		220	29	ug/Kg	1	☼	8270D	Total/NA
Pyrene	910		220	26	ug/Kg	1	☼	8270D	Total/NA
Phenanthrene	440		220	33	ug/Kg	1	☼	8270D	Total/NA
Arsenic	9.7		2.6		mg/Kg	1	☼	6010C	Total/NA

This Detection Summary does not include radiochemical test results.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Client Sample ID: TP-7 3-5' (Continued) Lab Sample ID: 480-195030-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	107		0.65		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.28		0.26		mg/Kg	1	☼	6010C	Total/NA
Chromium	18.7		0.65		mg/Kg	1	☼	6010C	Total/NA
Lead	83.2		1.3		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.063		0.027		mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: TP-8 3-4' Lab Sample ID: 480-195030-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzene	810	J	2800	530	ug/Kg	20	☼	8260C	Total/NA
Acenaphthene	960	J	1100	160	ug/Kg	5	☼	8270D	Total/NA
Anthracene	650	J	1100	260	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	710	J	1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	470	J	1100	160	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	750	J	1100	170	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	260	J	1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	170	J	1100	140	ug/Kg	5	☼	8270D	Total/NA
Chrysene	720	J	1100	240	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	2100		1100	110	ug/Kg	5	☼	8270D	Total/NA
Fluorene	1300		1100	130	ug/Kg	5	☼	8270D	Total/NA
Indeno[1,2,3-cd]pyrene	250	J	1100	130	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	260	J	1100	140	ug/Kg	5	☼	8270D	Total/NA
Pyrene	1700		1100	130	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	1800		1100	160	ug/Kg	5	☼	8270D	Total/NA
Arsenic	5.9		2.6		mg/Kg	1	☼	6010C	Total/NA
Barium	122		0.65		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.26		0.26		mg/Kg	1	☼	6010C	Total/NA
Chromium	24.3		0.65		mg/Kg	1	☼	6010C	Total/NA
Lead	40.0		1.3		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.062		0.027		mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: TP-10 1-3' Lab Sample ID: 480-195030-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzene	130	J	560	110	ug/Kg	4	☼	8260C	Total/NA
Cyclohexane	2300		560	120	ug/Kg	4	☼	8260C	Total/NA
Isopropylbenzene	150	J	560	83	ug/Kg	4	☼	8260C	Total/NA
Methylcyclohexane	4100		560	260	ug/Kg	4	☼	8260C	Total/NA
Xylenes, Total	800	J	1100	310	ug/Kg	4	☼	8260C	Total/NA
Acenaphthene	520	J	1100	160	ug/Kg	5	☼	8270D	Total/NA
Acenaphthylene	290	J	1100	140	ug/Kg	5	☼	8270D	Total/NA
Anthracene	810	J	1100	270	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]anthracene	2300		1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[a]pyrene	2400		1100	160	ug/Kg	5	☼	8270D	Total/NA
Benzo[b]fluoranthene	2900		1100	170	ug/Kg	5	☼	8270D	Total/NA
Benzo[g,h,i]perylene	1600		1100	110	ug/Kg	5	☼	8270D	Total/NA
Benzo[k]fluoranthene	1200		1100	140	ug/Kg	5	☼	8270D	Total/NA
Chrysene	2500		1100	240	ug/Kg	5	☼	8270D	Total/NA
Dibenz(a,h)anthracene	430	J	1100	190	ug/Kg	5	☼	8270D	Total/NA
Fluoranthene	4700		1100	110	ug/Kg	5	☼	8270D	Total/NA
Fluorene	740	J	1100	130	ug/Kg	5	☼	8270D	Total/NA
Naphthalene	930	J	1100	140	ug/Kg	5	☼	8270D	Total/NA

Client Sample ID: TP-10 1-3' (Continued)

Lab Sample ID: 480-195030-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Pyrene	4000		1100	130	ug/Kg	5	☼	8270D	Total/NA
Phenanthrene	2900		1100	160	ug/Kg	5	☼	8270D	Total/NA
Arsenic	16.1		2.4		mg/Kg	1	☼	6010C	Total/NA
Barium	97.1		0.61		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.53		0.24		mg/Kg	1	☼	6010C	Total/NA
Chromium	17.9		0.61		mg/Kg	1	☼	6010C	Total/NA
Lead	726		1.2		mg/Kg	1	☼	6010C	Total/NA
Mercury	0.076		0.026		mg/Kg	1	☼	7471B	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample Results

Client Sample ID: TP-1 3-4'
Lab Sample ID: 480-195030-1
Date Collected: 02/15/22 08:15
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 83.8

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		1100	300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,1,2,2-Tetrachloroethane	ND		1100	170	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,1,2-Trichloroethane	ND		1100	220	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		1100	530	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,1-Dichloroethane	ND		1100	330	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,1-Dichloroethene	ND		1100	370	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2,4-Trichlorobenzene	ND		1100	410	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2-Dibromo-3-Chloropropane	ND		1100	530	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2-Dichlorobenzene	ND		1100	270	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2-Dichloroethane	ND		1100	440	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2-Dichloropropane	ND		1100	170	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,3-Dichlorobenzene	ND		1100	290	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,4-Dichlorobenzene	ND		1100	150	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
2-Butanone (MEK)	ND	*1	5300	3200	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
2-Hexanone	ND		5300	2200	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
4-Methyl-2-pentanone (MIBK)	ND		5300	340	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Acetone	ND	*+ *1	5300	4400	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Benzene	ND		1100	200	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Bromodichloromethane	ND		1100	210	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Bromoform	ND		1100	530	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Bromomethane	ND		1100	240	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Carbon disulfide	ND		1100	490	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Carbon tetrachloride	ND		1100	270	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Chlorobenzene	ND		1100	140	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Dibromochloromethane	ND		1100	520	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Chloroethane	ND	*1	1100	220	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Chloroform	ND		1100	730	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Chloromethane	ND		1100	250	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
cis-1,2-Dichloroethene	ND		1100	300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
cis-1,3-Dichloropropene	ND		1100	260	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Cyclohexane	ND		1100	240	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Dichlorodifluoromethane	ND		1100	470	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Ethylbenzene	ND		1100	310	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
1,2-Dibromoethane	ND		1100	190	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Isopropylbenzene	ND		1100	160	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Methyl acetate	ND		5300	510	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Methyl tert-butyl ether	ND		1100	400	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Methylcyclohexane	ND		1100	500	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Methylene Chloride	ND		1100	210	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Styrene	ND		1100	260	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Tetrachloroethene	ND		1100	140	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Toluene	ND		1100	290	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
trans-1,2-Dichloroethene	ND		1100	250	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
trans-1,3-Dichloropropene	ND		1100	110	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Trichloroethene	ND		1100	300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Trichlorofluoromethane	ND		1100	500	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Vinyl chloride	ND		1100	360	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10
Xylenes, Total	ND		2100	590	ug/Kg	☼	02/16/22 17:28	02/17/22 13:18	10

Client Sample Results

Client Sample ID: TP-1 3-4'

Lab Sample ID: 480-195030-1

Date Collected: 02/15/22 08:15
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 83.8

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*98*		*50 - 149*	*02/16/22 17:28*	*02/17/22 13:18*	*10*
1,2-Dichloroethane-d4 (Surr)	*101*		*53 - 146*	*02/16/22 17:28*	*02/17/22 13:18*	*10*
4-Bromofluorobenzene (Surr)	*98*		*49 - 148*	*02/16/22 17:28*	*02/17/22 13:18*	*10*
Dibromofluoromethane (Surr)	*97*		*60 - 140*	*02/16/22 17:28*	*02/17/22 13:18*	*10*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**390**		200	29	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Acenaphthylene	**350**		200	26	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Anthracene	**460**		200	49	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Benzo[a]anthracene	**1100**		200	20	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Benzo[a]pyrene	**1100**		200	29	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Benzo[b]fluoranthene	**1300**		200	31	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Benzo[g,h,i]perylene	**560**		200	21	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Benzo[k]fluoranthene	**550**		200	26	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Chrysene	**1200**		200	44	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Dibenz(a,h)anthracene	**150**	**J**	200	35	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Fluoranthene	**2700**		200	21	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Fluorene	**670**		200	23	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Indeno[1,2,3-cd]pyrene	**520**		200	24	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Naphthalene	**230**		200	26	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Pyrene	**2100**		200	23	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1
Phenanthrene	**1100**		200	29	ug/Kg	☼	02/17/22 08:30	02/18/22 18:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*118*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:35*	*1*
2-Fluorobiphenyl	*112*		*60 - 120*	*02/17/22 08:30*	*02/18/22 18:35*	*1*
2-Fluorophenol (Surr)	*85*		*52 - 120*	*02/17/22 08:30*	*02/18/22 18:35*	*1*
Phenol-d5 (Surr)	*92*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:35*	*1*
p-Terphenyl-d14 (Surr)	*99*		*79 - 130*	*02/17/22 08:30*	*02/18/22 18:35*	*1*
Nitrobenzene-d5 (Surr)	*104*		*53 - 120*	*02/17/22 08:30*	*02/18/22 18:35*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.7**		2.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Barium	**123**	**F1**	0.56		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Cadmium	**0.26**		0.23		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Chromium	**14.9**		0.56		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Lead	**63.7**	**F1**	1.1		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Selenium	ND		4.5		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1
Silver	ND		0.68		mg/Kg	☼	02/16/22 15:41	02/17/22 17:15	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.048**		0.025		mg/Kg	☼	02/17/22 11:06	02/17/22 13:00	1

Client Sample Results

Client Sample ID: TP-3 1-2'
Lab Sample ID: 480-195030-2

Date Collected: 02/15/22 09:33
Matrix: Solid

Date Received: 02/15/22 17:05
Percent Solids: 78.4

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		2800	770	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,1,2,2-Tetrachloroethane	ND		2800	450	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,1,2-Trichloroethane	ND		2800	580	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,1-Dichloroethane	ND		2800	850	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,1-Dichloroethene	ND		2800	960	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2,4-Trichlorobenzene	ND		2800	1000	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2-Dibromo-3-Chloropropane	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2-Dichlorobenzene	ND		2800	710	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2-Dichloroethane	ND		2800	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2-Dichloropropane	ND		2800	450	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,3-Dichlorobenzene	ND		2800	740	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,4-Dichlorobenzene	ND		2800	390	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
2-Butanone (MEK)	ND	*1	14000	8200	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
2-Hexanone	ND		14000	5700	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
4-Methyl-2-pentanone (MIBK)	ND		14000	880	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Acetone	ND	*+ *1	14000	11000	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Benzene	ND		2800	530	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Bromodichloromethane	ND		2800	550	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Bromoform	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Bromomethane	ND		2800	610	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Carbon disulfide	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Carbon tetrachloride	ND		2800	710	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Chlorobenzene	ND		2800	360	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Dibromochloromethane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Chloroethane	ND	*1	2800	580	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Chloroform	ND		2800	1900	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Chloromethane	ND		2800	660	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
cis-1,2-Dichloroethene	ND		2800	760	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
cis-1,3-Dichloropropene	ND		2800	660	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Cyclohexane	ND		2800	610	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Dichlorodifluoromethane	ND		2800	1200	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Ethylbenzene	ND		2800	800	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
1,2-Dibromoethane	ND		2800	480	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Isopropylbenzene	ND		2800	410	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Methyl acetate	ND		14000	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Methyl tert-butyl ether	ND		2800	1000	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Methylcyclohexane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Methylene Chloride	ND		2800	550	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Styrene	ND		2800	670	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Tetrachloroethene	ND		2800	370	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Toluene	ND		2800	740	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
trans-1,2-Dichloroethene	ND		2800	650	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
trans-1,3-Dichloropropene	ND		2800	270	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Trichloroethene	ND		2800	770	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Trichlorofluoromethane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Vinyl chloride	ND		2800	930	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20
Xylenes, Total	ND		5500	1500	ug/Kg	☼	02/16/22 17:28	02/17/22 13:41	20

Client Sample Results

Client Sample ID: TP-3 1-2'

Lab Sample ID: 480-195030-2

Date Collected: 02/15/22 09:33
Date Received: 02/15/22 17:05

Matrix: Solid
Percent Solids: 78.4

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*102*		*50 - 149*	*02/16/22 17:28*	*02/17/22 13:41*	*20*
1,2-Dichloroethane-d4 (Surr)	*109*		*53 - 146*	*02/16/22 17:28*	*02/17/22 13:41*	*20*
4-Bromofluorobenzene (Surr)	*104*		*49 - 148*	*02/16/22 17:28*	*02/17/22 13:41*	*20*
Dibromofluoromethane (Surr)	*105*		*60 - 140*	*02/16/22 17:28*	*02/17/22 13:41*	*20*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**500**	**J**	1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Acenaphthylene	**540**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Anthracene	**1100**		1100	260	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Benzo[a]anthracene	**3300**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Benzo[a]pyrene	**3100**		1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Benzo[b]fluoranthene	**3900**		1100	170	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Benzo[g,h,i]perylene	**1900**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Benzo[k]fluoranthene	**1700**		1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Chrysene	**3500**		1100	240	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Dibenz(a,h)anthracene	**570**	**J**	1100	190	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Fluoranthene	**7500**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Fluorene	**950**	**J**	1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Indeno[1,2,3-cd]pyrene	**1800**		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Naphthalene	**410**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Pyrene	**6000**		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5
Phenanthrene	**4100**		1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 18:59	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*82*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:59*	*5*
2-Fluorobiphenyl	*94*		*60 - 120*	*02/17/22 08:30*	*02/18/22 18:59*	*5*
2-Fluorophenol (Surr)	*73*		*52 - 120*	*02/17/22 08:30*	*02/18/22 18:59*	*5*
Phenol-d5 (Surr)	*81*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:59*	*5*
p-Terphenyl-d14 (Surr)	*92*		*79 - 130*	*02/17/22 08:30*	*02/18/22 18:59*	*5*
Nitrobenzene-d5 (Surr)	*100*		*53 - 120*	*02/17/22 08:30*	*02/18/22 18:59*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**10.2**		2.6		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Barium	**349**		0.66		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Cadmium	**1.5**		0.26		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Chromium	**17.5**		0.66		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Lead	**320**		1.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Selenium	ND		5.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1
Silver	ND		0.79		mg/Kg	☼	02/16/22 15:41	02/17/22 17:33	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.13**		0.024		mg/Kg	☼	02/17/22 11:06	02/17/22 13:01	1

Client Sample ID: TP-6 3-4'

Lab Sample ID: 480-195030-3

Date Collected: 02/15/22 11:17

Matrix: Solid

Date Received: 02/15/22 17:05

Percent Solids: 72.3

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		1600	430	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,1,2,2-Tetrachloroethane	ND		1600	250	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,1,2-Trichloroethane	ND		1600	330	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		1600	780	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,1-Dichloroethane	ND		1600	480	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,1-Dichloroethene	ND		1600	540	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2,4-Trichlorobenzene	ND		1600	590	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2-Dibromo-3-Chloropropane	ND		1600	780	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2-Dichlorobenzene	ND		1600	400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2-Dichloroethane	ND		1600	630	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2-Dichloropropane	ND		1600	250	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,3-Dichlorobenzene	ND		1600	410	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,4-Dichlorobenzene	ND		1600	220	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
2-Butanone (MEK)	ND	*1	7800	4600	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
2-Hexanone	ND		7800	3200	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
4-Methyl-2-pentanone (MIBK)	ND		7800	500	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Acetone	ND	*+ *1	7800	6400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Benzene	ND		1600	290	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Bromodichloromethane	ND		1600	310	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Bromoform	ND		1600	780	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Bromomethane	ND		1600	340	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Carbon disulfide	ND		1600	710	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Carbon tetrachloride	ND		1600	400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Chlorobenzene	ND		1600	200	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Dibromochloromethane	ND		1600	750	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Chloroethane	ND	*1	1600	320	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Chloroform	ND		1600	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Chloromethane	ND		1600	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
cis-1,2-Dichloroethene	**56000**		1600	430	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
cis-1,3-Dichloropropene	ND		1600	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Cyclohexane	**1000**	**J**	1600	340	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Dichlorodifluoromethane	ND		1600	680	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Ethylbenzene	**6800**		1600	450	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
1,2-Dibromoethane	ND		1600	270	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Isopropylbenzene	**2800**		1600	230	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Methyl acetate	ND		7800	740	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Methyl tert-butyl ether	ND		1600	590	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Methylcyclohexane	**5000**		1600	730	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Methylene Chloride	ND		1600	310	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Styrene	ND		1600	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Tetrachloroethene	**27000**		1600	210	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Toluene	**6200**		1600	420	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
trans-1,2-Dichloroethene	ND		1600	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
trans-1,3-Dichloropropene	ND		1600	150	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Trichloroethene	**2000**		1600	430	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Trichlorofluoromethane	ND		1600	730	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Vinyl chloride	**9800**		1600	520	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10
Xylenes, Total	**12000**		3100	860	ug/Kg	☼	02/16/22 17:28	02/17/22 14:04	10

Client Sample Results

Client: Benchmark Env. Eng. & Science, PLLC
Job ID: 480-195030-1
Project/Site: Benchmark - Howell Street

Client Sample ID: TP-6 3-4'

Lab Sample ID: 480-195030-3
Date Collected: 02/15/22 11:17
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 72.3

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*99*		*50 - 149*	*02/16/22 17:28*	*02/17/22 14:04*	*10*
1,2-Dichloroethane-d4 (Surr)	*106*		*53 - 146*	*02/16/22 17:28*	*02/17/22 14:04*	*10*
4-Bromofluorobenzene (Surr)	*101*		*49 - 148*	*02/16/22 17:28*	*02/17/22 14:04*	*10*
Dibromofluoromethane (Surr)	*106*		*60 - 140*	*02/16/22 17:28*	*02/17/22 14:04*	*10*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**190**	**J**	230	34	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Acenaphthylene	ND		230	30	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Anthracene	**170**	**J**	230	57	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Benzo[a]anthracene	**300**		230	23	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Benzo[a]pyrene	**250**		230	34	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Benzo[b]fluoranthene	**390**		230	37	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Benzo[g,h,i]perylene	**170**	**J F2**	230	24	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Benzo[k]fluoranthene	**150**	**J**	230	30	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Chrysene	**440**		230	51	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Dibenz(a,h)anthracene	**69**	**J F2**	230	41	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Fluoranthene	**760**		230	24	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Fluorene	**430**		230	27	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Indeno[1,2,3-cd]pyrene	**150**	**J F2**	230	28	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Naphthalene	**460**		230	30	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Pyrene	**630**		230	27	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1
Phenanthrene	**630**		230	34	ug/Kg	☼	02/17/22 08:30	02/18/22 18:12	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*118*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:12*	*1*
2-Fluorobiphenyl	*98*		*60 - 120*	*02/17/22 08:30*	*02/18/22 18:12*	*1*
2-Fluorophenol (Surr)	*78*		*52 - 120*	*02/17/22 08:30*	*02/18/22 18:12*	*1*
Phenol-d5 (Surr)	*82*		*54 - 120*	*02/17/22 08:30*	*02/18/22 18:12*	*1*
p-Terphenyl-d14 (Surr)	*88*		*79 - 130*	*02/17/22 08:30*	*02/18/22 18:12*	*1*
Nitrobenzene-d5 (Surr)	*110*		*53 - 120*	*02/17/22 08:30*	*02/18/22 18:12*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.9**		2.7		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Barium	**131**		0.66		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Cadmium	**0.84**		0.27		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Chromium	**18.6**		0.66		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Lead	**197**		1.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Selenium	ND		5.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1
Silver	ND		0.80		mg/Kg	☼	02/16/22 15:41	02/17/22 17:37	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.060**		0.027		mg/Kg	☼	02/17/22 11:06	02/17/22 13:02	1

Client Sample ID: TP-7 3-5'
Lab Sample ID: 480-195030-4
Date Collected: 02/15/22 11:35
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 75.9

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		2900	800	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,1,2,2-Tetrachloroethane	ND		2900	470	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,1,2-Trichloroethane	ND		2900	600	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		2900	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,1-Dichloroethane	ND		2900	890	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,1-Dichloroethene	ND		2900	990	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2,4-Trichlorobenzene	ND		2900	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2-Dibromo-3-Chloropropane	ND		2900	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2-Dichlorobenzene	ND		2900	730	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2-Dichloroethane	ND		2900	1200	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2-Dichloropropane	ND		2900	470	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,3-Dichlorobenzene	ND		2900	770	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,4-Dichlorobenzene	ND		2900	400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
2-Butanone (MEK)	ND	*1	14000	8500	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
2-Hexanone	ND		14000	5900	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
4-Methyl-2-pentanone (MIBK)	ND		14000	920	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Acetone	ND	*+ *1	14000	12000	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Benzene	ND		2900	550	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Bromodichloromethane	ND		2900	570	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Bromoform	ND		2900	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Bromomethane	ND		2900	630	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Carbon disulfide	ND		2900	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Carbon tetrachloride	ND		2900	730	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Chlorobenzene	ND		2900	380	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Dibromochloromethane	ND		2900	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Chloroethane	ND	*1	2900	600	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Chloroform	ND		2900	2000	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Chloromethane	ND		2900	680	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
cis-1,2-Dichloroethene	ND		2900	790	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
cis-1,3-Dichloropropene	ND		2900	690	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Cyclohexane	ND		2900	640	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Dichlorodifluoromethane	ND		2900	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Ethylbenzene	ND		2900	840	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
1,2-Dibromoethane	ND		2900	500	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Isopropylbenzene	**620**	**J**	2900	430	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Methyl acetate	ND		14000	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Methyl tert-butyl ether	ND		2900	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Methylcyclohexane	ND		2900	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Methylene Chloride	ND		2900	570	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Styrene	ND		2900	690	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Tetrachloroethene	ND		2900	390	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Toluene	ND		2900	770	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
trans-1,2-Dichloroethene	ND		2900	680	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
trans-1,3-Dichloropropene	ND		2900	280	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Trichloroethene	ND		2900	800	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Trichlorofluoromethane	ND		2900	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Vinyl chloride	ND		2900	960	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20
Xylenes, Total	ND		5700	1600	ug/Kg	☼	02/16/22 17:28	02/17/22 14:27	20

Client Sample Results

Client: Benchmark Env. Eng. & Science, PLLC
Project/Site: Benchmark - Howell Street

Job ID: 480-195030-1

Client Sample ID: TP-7 3-5'
Date Collected: 02/15/22 11:35
Date Received: 02/15/22 17:05

Lab Sample ID: 480-195030-4
Matrix: Solid
Percent Solids: 75.9

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*102*		*50 - 149*	*02/16/22 17:28*	*02/17/22 14:27*	*20*
1,2-Dichloroethane-d4 (Surr)	*104*		*53 - 146*	*02/16/22 17:28*	*02/17/22 14:27*	*20*
4-Bromofluorobenzene (Surr)	*102*		*49 - 148*	*02/16/22 17:28*	*02/17/22 14:27*	*20*
Dibromofluoromethane (Surr)	*101*		*60 - 140*	*02/16/22 17:28*	*02/17/22 14:27*	*20*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**280**		220	33	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Acenaphthylene	ND		220	29	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Anthracene	**290**		220	55	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Benzo[a]anthracene	**490**		220	22	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Benzo[a]pyrene	**510**		220	33	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Benzo[b]fluoranthene	**960**		220	35	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Benzo[g,h,i]perylene	**170**	**J**	220	24	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Benzo[k]fluoranthene	ND		220	29	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Chrysene	**650**		220	50	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Dibenz(a,h)anthracene	**74**	**J**	220	39	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Fluoranthene	**1300**		220	24	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Fluorene	**390**		220	26	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Indeno[1,2,3-cd]pyrene	**180**	**J**	220	28	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Naphthalene	**230**		220	29	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Pyrene	**910**		220	26	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1
Phenanthrene	**440**		220	33	ug/Kg	☼	02/17/22 08:30	02/18/22 19:23	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*109*		*54 - 120*	*02/17/22 08:30*	*02/18/22 19:23*	*1*
2-Fluorobiphenyl	*106*		*60 - 120*	*02/17/22 08:30*	*02/18/22 19:23*	*1*
2-Fluorophenol (Surr)	*84*		*52 - 120*	*02/17/22 08:30*	*02/18/22 19:23*	*1*
Phenol-d5 (Surr)	*87*		*54 - 120*	*02/17/22 08:30*	*02/18/22 19:23*	*1*
p-Terphenyl-d14 (Surr)	*81*		*79 - 130*	*02/17/22 08:30*	*02/18/22 19:23*	*1*
Nitrobenzene-d5 (Surr)	*99*		*53 - 120*	*02/17/22 08:30*	*02/18/22 19:23*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**9.7**		2.6		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Barium	**107**		0.65		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Cadmium	**0.28**		0.26		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Chromium	**18.7**		0.65		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Lead	**83.2**		1.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Selenium	ND		5.2		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1
Silver	ND		0.78		mg/Kg	☼	02/16/22 15:41	02/17/22 17:52	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.063**		0.027		mg/Kg	☼	02/17/22 11:06	02/17/22 13:03	1

Client Sample ID: TP-8 3-4'
Lab Sample ID: 480-195030-5
Date Collected: 02/15/22 12:00
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.6

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		2800	770	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,1,2,2-Tetrachloroethane	ND		2800	450	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,1,2-Trichloroethane	ND		2800	580	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,1-Dichloroethane	ND		2800	860	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,1-Dichloroethene	ND		2800	960	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2,4-Trichlorobenzene	ND		2800	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2-Dibromo-3-Chloropropane	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2-Dichlorobenzene	ND		2800	710	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2-Dichloroethane	ND		2800	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2-Dichloropropane	ND		2800	450	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,3-Dichlorobenzene	ND		2800	740	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,4-Dichlorobenzene	ND		2800	390	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
2-Butanone (MEK)	ND	*1	14000	8200	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
2-Hexanone	ND		14000	5700	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
4-Methyl-2-pentanone (MIBK)	ND		14000	890	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Acetone	ND	*+ *1	14000	11000	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Benzene	**810**	**J**	2800	530	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Bromodichloromethane	ND		2800	550	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Bromoform	ND		2800	1400	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Bromomethane	ND		2800	610	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Carbon disulfide	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Carbon tetrachloride	ND		2800	710	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Chlorobenzene	ND		2800	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Dibromochloromethane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Chloroethane	ND	*1	2800	580	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Chloroform	ND		2800	1900	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Chloromethane	ND		2800	660	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
cis-1,2-Dichloroethene	ND		2800	760	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
cis-1,3-Dichloropropene	ND		2800	660	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Cyclohexane	ND		2800	620	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Dichlorodifluoromethane	ND		2800	1200	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Ethylbenzene	ND		2800	810	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
1,2-Dibromoethane	ND		2800	480	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Isopropylbenzene	ND		2800	420	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Methyl acetate	ND		14000	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Methyl tert-butyl ether	ND		2800	1000	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Methylcyclohexane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Methylene Chloride	ND		2800	550	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Styrene	ND		2800	670	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Tetrachloroethene	ND		2800	370	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Toluene	ND		2800	740	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
trans-1,2-Dichloroethene	ND		2800	650	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
trans-1,3-Dichloropropene	ND		2800	270	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Trichloroethene	ND		2800	770	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Trichlorofluoromethane	ND		2800	1300	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Vinyl chloride	ND		2800	930	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20
Xylenes, Total	ND		5500	1500	ug/Kg	☼	02/16/22 17:28	02/17/22 14:50	20

Client Sample Results

Client Sample ID: TP-8 3-4'

Lab Sample ID: 480-195030-5

Date Collected: 02/15/22 12:00
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.6

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*98*		*50 - 149*	*02/16/22 17:28*	*02/17/22 14:50*	*20*
1,2-Dichloroethane-d4 (Surr)	*101*		*53 - 146*	*02/16/22 17:28*	*02/17/22 14:50*	*20*
4-Bromofluorobenzene (Surr)	*97*		*49 - 148*	*02/16/22 17:28*	*02/17/22 14:50*	*20*
Dibromofluoromethane (Surr)	*100*		*60 - 140*	*02/16/22 17:28*	*02/17/22 14:50*	*20*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**960**	**J**	1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Acenaphthylene	ND		1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Anthracene	**650**	**J**	1100	260	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Benzo[a]anthracene	**710**	**J**	1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Benzo[a]pyrene	**470**	**J**	1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Benzo[b]fluoranthene	**750**	**J**	1100	170	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Benzo[g,h,i]perylene	**260**	**J**	1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Benzo[k]fluoranthene	**170**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Chrysene	**720**	**J**	1100	240	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Dibenz(a,h)anthracene	ND		1100	190	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Fluoranthene	**2100**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Fluorene	**1300**		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Indeno[1,2,3-cd]pyrene	**250**	**J**	1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Naphthalene	**260**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Pyrene	**1700**		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5
Phenanthrene	**1800**		1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 19:47	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*77*		*54 - 120*	*02/17/22 08:30*	*02/18/22 19:47*	*5*
2-Fluorobiphenyl	*96*		*60 - 120*	*02/17/22 08:30*	*02/18/22 19:47*	*5*
2-Fluorophenol (Surr)	*71*		*52 - 120*	*02/17/22 08:30*	*02/18/22 19:47*	*5*
Phenol-d5 (Surr)	*79*		*54 - 120*	*02/17/22 08:30*	*02/18/22 19:47*	*5*
p-Terphenyl-d14 (Surr)	*90*		*79 - 130*	*02/17/22 08:30*	*02/18/22 19:47*	*5*
Nitrobenzene-d5 (Surr)	*106*		*53 - 120*	*02/17/22 08:30*	*02/18/22 19:47*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.9**		2.6		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Barium	**122**		0.65		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Cadmium	**0.26**		0.26		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Chromium	**24.3**		0.65		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Lead	**40.0**		1.3		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Selenium	ND		5.2		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1
Silver	ND		0.78		mg/Kg	☼	02/16/22 15:41	02/17/22 17:55	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.062**		0.027		mg/Kg	☼	02/17/22 11:06	02/17/22 13:05	1

Client Sample ID: TP-10 1-3'

Lab Sample ID: 480-195030-6

Date Collected: 02/15/22 12:55
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.8

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		560	150	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,1,2,2-Tetrachloroethane	ND		560	90	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,1,2-Trichloroethane	ND		560	120	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		560	280	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,1-Dichloroethane	ND		560	170	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,1-Dichloroethene	ND		560	190	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2,4-Trichlorobenzene	ND		560	210	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2-Dibromo-3-Chloropropane	ND		560	280	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2-Dichlorobenzene	ND		560	140	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2-Dichloroethane	ND		560	230	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2-Dichloropropane	ND		560	90	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,3-Dichlorobenzene	ND		560	150	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,4-Dichlorobenzene	ND		560	78	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
2-Butanone (MEK)	ND	*1	2800	1600	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
2-Hexanone	ND		2800	1100	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
4-Methyl-2-pentanone (MIBK)	ND		2800	180	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Acetone	ND	*+ *1	2800	2300	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Benzene	**130**	**J**	560	110	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Bromodichloromethane	ND		560	110	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Bromoform	ND		560	280	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Bromomethane	ND		560	120	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Carbon disulfide	ND		560	250	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Carbon tetrachloride	ND		560	140	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Chlorobenzene	ND		560	73	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Dibromochloromethane	ND		560	270	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Chloroethane	ND	*1	560	120	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Chloroform	ND		560	380	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Chloromethane	ND		560	130	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
cis-1,2-Dichloroethene	ND		560	150	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
cis-1,3-Dichloropropene	ND		560	130	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Cyclohexane	**2300**		560	120	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Dichlorodifluoromethane	ND		560	240	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Ethylbenzene	ND		560	160	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
1,2-Dibromoethane	ND		560	97	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Isopropylbenzene	**150**	**J**	560	83	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Methyl acetate	ND		2800	260	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Methyl tert-butyl ether	ND		560	210	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Methylcyclohexane	**4100**		560	260	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Methylene Chloride	ND		560	110	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Styrene	ND		560	130	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Tetrachloroethene	ND		560	75	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Toluene	ND		560	150	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
trans-1,2-Dichloroethene	ND		560	130	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
trans-1,3-Dichloropropene	ND		560	55	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Trichloroethene	ND		560	150	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Trichlorofluoromethane	ND		560	260	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Vinyl chloride	ND		560	190	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4
Xylenes, Total	**800**	**J**	1100	310	ug/Kg	☼	02/16/22 17:28	02/17/22 15:13	4

Client Sample Results

Client: Benchmark Env. Eng. & Science, PLLC
Project/Site: Benchmark - Howell Street

Job ID: 480-195030-1

Client Sample ID: TP-10 1-3'

Date Collected: 02/15/22 12:55
Date Received: 02/15/22 17:05

Lab Sample ID: 480-195030-6
Matrix: Solid
Percent Solids: 77.8

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*99*		*50 - 149*	*02/16/22 17:28*	*02/17/22 15:13*	*4*
1,2-Dichloroethane-d4 (Surr)	*102*		*53 - 146*	*02/16/22 17:28*	*02/17/22 15:13*	*4*
4-Bromofluorobenzene (Surr)	*96*		*49 - 148*	*02/16/22 17:28*	*02/17/22 15:13*	*4*
Dibromofluoromethane (Surr)	*99*		*60 - 140*	*02/16/22 17:28*	*02/17/22 15:13*	*4*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**520**	**J**	1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Acenaphthylene	**290**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Anthracene	**810**	**J**	1100	270	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Benzo[a]anthracene	**2300**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Benzo[a]pyrene	**2400**		1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Benzo[b]fluoranthene	**2900**		1100	170	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Benzo[g,h,i]perylene	**1600**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Benzo[k]fluoranthene	**1200**		1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Chrysene	**2500**		1100	240	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Dibenz(a,h)anthracene	**430**	**J**	1100	190	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Fluoranthene	**4700**		1100	110	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Fluorene	**740**	**J**	1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Indeno[1,2,3-cd]pyrene	ND		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Naphthalene	**930**	**J**	1100	140	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Pyrene	**4000**		1100	130	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5
Phenanthrene	**2900**		1100	160	ug/Kg	☼	02/17/22 08:30	02/18/22 20:11	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*76*		*54 - 120*	*02/17/22 08:30*	*02/18/22 20:11*	*5*
2-Fluorobiphenyl	*99*		*60 - 120*	*02/17/22 08:30*	*02/18/22 20:11*	*5*
2-Fluorophenol (Surr)	*77*		*52 - 120*	*02/17/22 08:30*	*02/18/22 20:11*	*5*
Phenol-d5 (Surr)	*82*		*54 - 120*	*02/17/22 08:30*	*02/18/22 20:11*	*5*
p-Terphenyl-d14 (Surr)	*88*		*79 - 130*	*02/17/22 08:30*	*02/18/22 20:11*	*5*
Nitrobenzene-d5 (Surr)	*98*		*53 - 120*	*02/17/22 08:30*	*02/18/22 20:11*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**16.1**		2.4		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Barium	**97.1**		0.61		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Cadmium	**0.53**		0.24		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Chromium	**17.9**		0.61		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Lead	**726**		1.2		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Selenium	ND		4.9		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1
Silver	ND		0.73		mg/Kg	☼	02/16/22 15:41	02/17/22 17:59	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.076**		0.026		mg/Kg	☼	02/17/22 11:06	02/17/22 13:06	1

Surrogate Summary

Method: 8260C - Volatile Organic Compounds by GC/MS

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)			
		TOL	**DCA**	**BFB**	**DBFM**
Lab Sample ID	**Client Sample ID**	**(50-149)**	**(53-146)**	**(49-148)**	**(60-140)**
480-195030-1	TP-1 3-4'	98	101	98	97
480-195030-2	TP-3 1-2'	102	109	104	105
480-195030-3	TP-6 3-4'	99	106	101	106
480-195030-4	TP-7 3-5'	102	104	102	101
480-195030-5	TP-8 3-4'	98	101	97	100
480-195030-6	TP-10 1-3'	99	102	96	99
LCS 480-615092/1-A	Lab Control Sample	97	102	100	103
LCSD 480-615092/2-A	Lab Control Sample Dup	97	99	100	99
MB 480-615092/3-A	Method Blank	104	105	104	103

Surrogate Legend

TOL = Toluene-d8 (Surr)
DCA = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Solid **Prep Type: Total/NA**

		Percent Surrogate Recovery (Acceptance Limits)					
		TBP	**FBP**	**2FP**	**PHL**	**TPHd14**	**NBZ**
Lab Sample ID	**Client Sample ID**	**(54-120)**	**(60-120)**	**(52-120)**	**(54-120)**	**(79-130)**	**(53-120)**
480-195030-1	TP-1 3-4'	118	112	85	92	99	104
480-195030-2	TP-3 1-2'	82	94	73	81	92	100
480-195030-3	TP-6 3-4'	118	98	78	82	88	110
480-195030-3 MS	TP-6 3-4'	133 S1+	115	93	95	103	111
480-195030-3 MSD	TP-6 3-4'	122 S1+	98	83	88	92	98
480-195030-4	TP-7 3-5'	109	106	84	87	81	99
480-195030-5	TP-8 3-4'	77	96	71	79	90	106
480-195030-6	TP-10 1-3'	76	99	77	82	88	98
LCS 480-615141/2-A	Lab Control Sample	128 S1+	113	95	96	123	100
MB 480-615141/1-A	Method Blank	103	108	91	91	127	94

Surrogate Legend

TBP = 2,4,6-Tribromophenol (Surr)
FBP = 2-Fluorobiphenyl
2FP = 2-Fluorophenol (Surr)
PHL = Phenol-d5 (Surr)
TPHd14 = p-Terphenyl-d14 (Surr)
NBZ = Nitrobenzene-d5 (Surr)

QC Sample Results

Method: 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 480-615092/3-A
Matrix: Solid
Analysis Batch: 615137

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 615092

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		100	28	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,1,2,2-Tetrachloroethane	ND		100	16	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,1,2-Trichloroethane	ND		100	21	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		100	50	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,1-Dichloroethane	ND		100	31	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,1-Dichloroethene	ND		100	35	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2,4-Trichlorobenzene	ND		100	38	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2-Dibromo-3-Chloropropane	ND		100	50	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2-Dichlorobenzene	ND		100	26	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2-Dichloroethane	ND		100	41	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2-Dichloropropane	ND		100	16	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,3-Dichlorobenzene	ND		100	27	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,4-Dichlorobenzene	ND		100	14	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
2-Butanone (MEK)	ND		500	300	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
2-Hexanone	ND		500	210	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
4-Methyl-2-pentanone (MIBK)	ND		500	32	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Acetone	ND		500	410	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Benzene	ND		100	19	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Bromodichloromethane	ND		100	20	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Bromoform	ND		100	50	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Bromomethane	ND		100	22	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Carbon disulfide	ND		100	46	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Carbon tetrachloride	ND		100	26	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Chlorobenzene	ND		100	13	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Dibromochloromethane	ND		100	48	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Chloroethane	ND		100	21	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Chloroform	ND		100	69	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Chloromethane	ND		100	24	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
cis-1,2-Dichloroethene	ND		100	28	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
cis-1,3-Dichloropropene	ND		100	24	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Cyclohexane	ND		100	22	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Dichlorodifluoromethane	ND		100	44	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Ethylbenzene	ND		100	29	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
1,2-Dibromoethane	ND		100	18	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Isopropylbenzene	ND		100	15	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Methyl acetate	ND		500	48	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Methyl tert-butyl ether	ND		100	38	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Methylcyclohexane	ND		100	47	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Methylene Chloride	ND		100	20	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Styrene	ND		100	24	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Tetrachloroethene	ND		100	13	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Toluene	ND		100	27	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
trans-1,2-Dichloroethene	ND		100	24	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
trans-1,3-Dichloropropene	ND		100	9.8	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Trichloroethene	ND		100	28	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Trichlorofluoromethane	ND		100	47	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Vinyl chloride	ND		100	34	ug/Kg		02/16/22 14:31	02/17/22 12:18	1
Xylenes, Total	ND		200	55	ug/Kg		02/16/22 14:31	02/17/22 12:18	1

QC Sample Results

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: MB 480-615092/3-A
Matrix: Solid
Analysis Batch: 615137

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 615092

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
Toluene-d8 (Surr)	*104*		*50 - 149*	*02/16/22 14:31*	*02/17/22 12:18*	*1*
1,2-Dichloroethane-d4 (Surr)	*105*		*53 - 146*	*02/16/22 14:31*	*02/17/22 12:18*	*1*
4-Bromofluorobenzene (Surr)	*104*		*49 - 148*	*02/16/22 14:31*	*02/17/22 12:18*	*1*
Dibromofluoromethane (Surr)	*103*		*60 - 140*	*02/16/22 14:31*	*02/17/22 12:18*	*1*

Lab Sample ID: LCS 480-615092/1-A
Matrix: Solid
Analysis Batch: 615137

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 615092

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	2500	2760		ug/Kg		110	68 - 130
1,1,2,2-Tetrachloroethane	2500	2730		ug/Kg		109	73 - 120
1,1,2-Trichloroethane	2500	2800		ug/Kg		112	80 - 120
1,1,2-Trichloro-1,2,2-trifluoroethane	2500	2800		ug/Kg		112	10 - 179
1,1-Dichloroethane	2500	2790		ug/Kg		112	78 - 121
1,1-Dichloroethene	2500	2780		ug/Kg		111	48 - 133
1,2,4-Trichlorobenzene	2500	2770		ug/Kg		111	70 - 140
1,2-Dibromo-3-Chloropropane	2500	2700		ug/Kg		108	56 - 122
1,2-Dichlorobenzene	2500	2670		ug/Kg		107	78 - 125
1,2-Dichloroethane	2500	2740		ug/Kg		110	74 - 127
1,2-Dichloropropane	2500	2810		ug/Kg		112	80 - 120
1,3-Dichlorobenzene	2500	2750		ug/Kg		110	80 - 120
1,4-Dichlorobenzene	2500	2720		ug/Kg		109	80 - 120
2-Butanone (MEK)	12500	11000		ug/Kg		88	54 - 149
2-Hexanone	12500	14400		ug/Kg		115	59 - 127
4-Methyl-2-pentanone (MIBK)	12500	14600		ug/Kg		117	74 - 120
Acetone	12500	12100		ug/Kg		97	47 - 141
Benzene	2500	2810		ug/Kg		112	77 - 125
Bromodichloromethane	2500	2770		ug/Kg		111	71 - 121
Bromoform	2500	2630		ug/Kg		105	48 - 125
Bromomethane	2500	1970		ug/Kg		79	39 - 149
Carbon disulfide	2500	2740		ug/Kg		109	40 - 136
Carbon tetrachloride	2500	2770		ug/Kg		111	54 - 135
Chlorobenzene	2500	2690		ug/Kg		108	76 - 126
Dibromochloromethane	2500	2760		ug/Kg		111	64 - 120
Chloroethane	2500	2050		ug/Kg		82	23 - 150
Chloroform	2500	2680		ug/Kg		107	78 - 120
Chloromethane	2500	2690		ug/Kg		108	61 - 124
cis-1,2-Dichloroethene	2500	2770		ug/Kg		111	79 - 124
cis-1,3-Dichloropropene	2500	2940		ug/Kg		118	75 - 121
Cyclohexane	2500	2630		ug/Kg		105	49 - 129
Dichlorodifluoromethane	2500	3060		ug/Kg		122	10 - 150
Ethylbenzene	2500	2790		ug/Kg		112	78 - 124
1,2-Dibromoethane	2500	2750		ug/Kg		110	80 - 120
Isopropylbenzene	2500	2670		ug/Kg		107	76 - 120
Methyl acetate	5000	5470		ug/Kg		109	71 - 123
Methyl tert-butyl ether	2500	2690		ug/Kg		108	67 - 137
Methylcyclohexane	2500	2650		ug/Kg		106	50 - 130

QC Sample Results

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCS 480-615092/1-A
Matrix: Solid
Analysis Batch: 615137

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 615092

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Methylene Chloride	2500	2780		ug/Kg		111	75 - 118
Styrene	2500	2830		ug/Kg		113	80 - 120
Tetrachloroethene	2500	2690		ug/Kg		107	73 - 133
Toluene	2500	2730		ug/Kg		109	75 - 124
trans-1,2-Dichloroethene	2500	2710		ug/Kg		109	74 - 129
trans-1,3-Dichloropropene	2500	2850		ug/Kg		114	73 - 120
Trichloroethene	2500	2850		ug/Kg		114	75 - 131
Trichlorofluoromethane	2500	2880		ug/Kg		115	29 - 158
Vinyl chloride	2500	2950		ug/Kg		118	59 - 124

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*97*		*50 - 149*
1,2-Dichloroethane-d4 (Surr)	*102*		*53 - 146*
4-Bromofluorobenzene (Surr)	*100*		*49 - 148*
Dibromofluoromethane (Surr)	*103*		*60 - 140*

Lab Sample ID: LCSD 480-615092/2-A
Matrix: Solid
Analysis Batch: 615137

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 615092

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1,1-Trichloroethane	2500	2470		ug/Kg		99	68 - 130	11	20
1,1,2,2-Tetrachloroethane	2500	2670		ug/Kg		107	73 - 120	3	20
1,1,2-Trichloroethane	2500	2730		ug/Kg		109	80 - 120	2	20
1,1,2-Trichloro-1,2,2-trifluoroethane	2500	2600		ug/Kg		104	10 - 179	7	20
1,1-Dichloroethane	2500	2500		ug/Kg		100	78 - 121	11	20
1,1-Dichloroethene	2500	2510		ug/Kg		101	48 - 133	10	20
1,2,4-Trichlorobenzene	2500	2770		ug/Kg		111	70 - 140	0	20
1,2-Dibromo-3-Chloropropane	2500	2860		ug/Kg		115	56 - 122	6	20
1,2-Dichlorobenzene	2500	2660		ug/Kg		106	78 - 125	1	20
1,2-Dichloroethane	2500	2620		ug/Kg		105	74 - 127	5	20
1,2-Dichloropropane	2500	2600		ug/Kg		104	80 - 120	8	20
1,3-Dichlorobenzene	2500	2660		ug/Kg		107	80 - 120	3	20
1,4-Dichlorobenzene	2500	2570		ug/Kg		103	80 - 120	5	20
2-Butanone (MEK)	12500	15500	*1	ug/Kg		124	54 - 149	34	20
2-Hexanone	12500	14600		ug/Kg		117	59 - 127	2	20
4-Methyl-2-pentanone (MIBK)	12500	14800		ug/Kg		118	74 - 120	1	20
Acetone	12500	20200	*+ *1	ug/Kg		161	47 - 141	50	20
Benzene	2500	2540		ug/Kg		102	77 - 125	10	20
Bromodichloromethane	2500	2690		ug/Kg		108	71 - 121	3	20
Bromoform	2500	2640		ug/Kg		106	48 - 125	0	20
Bromomethane	2500	1830		ug/Kg		73	39 - 149	7	20
Carbon disulfide	2500	2490		ug/Kg		100	40 - 136	9	20
Carbon tetrachloride	2500	2500		ug/Kg		100	54 - 135	10	20
Chlorobenzene	2500	2620		ug/Kg		105	76 - 126	3	20
Dibromochloromethane	2500	2630		ug/Kg		105	64 - 120	5	20
Chloroethane	2500	1630	*1	ug/Kg		65	23 - 150	22	20
Chloroform	2500	2490		ug/Kg		100	78 - 120	7	20

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCSD 480-615092/2-A
Client Sample ID: Lab Control Sample Dup
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615137
Prep Batch: 615092

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chloromethane	2500	2460		ug/Kg		99	61 - 124	9	20
cis-1,2-Dichloroethene	2500	2600		ug/Kg		104	79 - 124	6	20
cis-1,3-Dichloropropene	2500	2690		ug/Kg		108	75 - 121	9	20
Cyclohexane	2500	2440		ug/Kg		98	49 - 129	7	20
Dichlorodifluoromethane	2500	2870		ug/Kg		115	10 - 150	7	20
Ethylbenzene	2500	2670		ug/Kg		107	78 - 124	4	20
1,2-Dibromoethane	2500	2730		ug/Kg		109	80 - 120	1	20
Isopropylbenzene	2500	2570		ug/Kg		103	76 - 120	4	20
Methyl acetate	5000	5850		ug/Kg		117	71 - 123	7	20
Methyl tert-butyl ether	2500	2710		ug/Kg		109	67 - 137	1	20
Methylcyclohexane	2500	2540		ug/Kg		101	50 - 130	4	20
Methylene Chloride	2500	2580		ug/Kg		103	75 - 118	8	20
Styrene	2500	2730		ug/Kg		109	80 - 120	4	20
Tetrachloroethene	2500	2610		ug/Kg		104	73 - 133	3	20
Toluene	2500	2650		ug/Kg		106	75 - 124	3	20
trans-1,2-Dichloroethene	2500	2430		ug/Kg		97	74 - 129	11	20
trans-1,3-Dichloropropene	2500	2760		ug/Kg		111	73 - 120	3	20
Trichloroethene	2500	2610		ug/Kg		104	75 - 131	9	20
Trichlorofluoromethane	2500	2450		ug/Kg		98	29 - 158	16	20
Vinyl chloride	2500	2770		ug/Kg		111	59 - 124	6	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*97*		*50 - 149*
1,2-Dichloroethane-d4 (Surr)	*99*		*53 - 146*
4-Bromofluorobenzene (Surr)	*100*		*49 - 148*
Dibromofluoromethane (Surr)	*99*		*60 - 140*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 480-615141/1-A
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615423
Prep Batch: 615141

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		170	24	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Acenaphthylene	ND		170	21	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Anthracene	ND		170	41	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Benzo[a]anthracene	ND		170	17	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Benzo[a]pyrene	ND		170	24	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Benzo[b]fluoranthene	ND		170	26	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Benzo[g,h,i]perylene	ND		170	18	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Benzo[k]fluoranthene	ND		170	21	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Chrysene	ND		170	37	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Dibenz(a,h)anthracene	ND		170	29	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Fluoranthene	ND		170	18	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Fluorene	ND		170	20	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Indeno[1,2,3-cd]pyrene	ND		170	20	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Naphthalene	ND		170	21	ug/Kg		02/17/22 08:30	02/18/22 16:37	1
Pyrene	ND		170	20	ug/Kg		02/17/22 08:30	02/18/22 16:37	1

QC Sample Results

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 480-615141/1-A
Matrix: Solid
Analysis Batch: 615423

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 615141

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phenanthrene	ND		170	24	ug/Kg		02/17/22 08:30	02/18/22 16:37	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2,4,6-Tribromophenol (Surr)	*103*		*54 - 120*	*02/17/22 08:30*	*02/18/22 16:37*	*1*
2-Fluorobiphenyl	*108*		*60 - 120*	*02/17/22 08:30*	*02/18/22 16:37*	*1*
2-Fluorophenol (Surr)	*91*		*52 - 120*	*02/17/22 08:30*	*02/18/22 16:37*	*1*
Phenol-d5 (Surr)	*91*		*54 - 120*	*02/17/22 08:30*	*02/18/22 16:37*	*1*
p-Terphenyl-d14 (Surr)	*127*		*79 - 130*	*02/17/22 08:30*	*02/18/22 16:37*	*1*
Nitrobenzene-d5 (Surr)	*94*		*53 - 120*	*02/17/22 08:30*	*02/18/22 16:37*	*1*

Lab Sample ID: LCS 480-615141/2-A
Matrix: Solid
Analysis Batch: 615423

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 615141

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	1640	1810		ug/Kg		111	62 - 120
Acenaphthylene	1640	1730		ug/Kg		106	58 - 121
Anthracene	1640	1890		ug/Kg		116	62 - 120
Benzo[a]anthracene	1640	1850		ug/Kg		113	65 - 120
Benzo[a]pyrene	1640	1690		ug/Kg		104	64 - 120
Benzo[b]fluoranthene	1640	1870		ug/Kg		115	64 - 120
Benzo[g,h,i]perylene	1640	2000		ug/Kg		123	45 - 145
Benzo[k]fluoranthene	1640	1910		ug/Kg		117	65 - 120
Chrysene	1640	1830		ug/Kg		112	64 - 120
Dibenz(a,h)anthracene	1640	1950		ug/Kg		119	54 - 132
Fluoranthene	1640	1860		ug/Kg		113	62 - 120
Fluorene	1640	1840		ug/Kg		113	63 - 120
Indeno[1,2,3-cd]pyrene	1640	1960		ug/Kg		120	56 - 134
Naphthalene	1640	1640		ug/Kg		100	55 - 120
Pyrene	1640	1940		ug/Kg		119	61 - 133
Phenanthrene	1640	1830		ug/Kg		112	60 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2,4,6-Tribromophenol (Surr)	*128*	*S1+*	*54 - 120*
2-Fluorobiphenyl	*113*		*60 - 120*
2-Fluorophenol (Surr)	*95*		*52 - 120*
Phenol-d5 (Surr)	*96*		*54 - 120*
p-Terphenyl-d14 (Surr)	*123*		*79 - 130*
Nitrobenzene-d5 (Surr)	*100*		*53 - 120*

Lab Sample ID: 480-195030-3 MS
Matrix: Solid
Analysis Batch: 615423

Client Sample ID: TP-6 3-4'
Prep Type: Total/NA
Prep Batch: 615141

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	190	J	2270	2700		ug/Kg	☼	110	60 - 120
Acenaphthylene	ND		2270	2440		ug/Kg	☼	108	58 - 121
Anthracene	170	J	2270	2650		ug/Kg	☼	109	62 - 120

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 480-195030-3 MS
Matrix: Solid
Analysis Batch: 615423

Client Sample ID: TP-6 3-4'
Prep Type: Total/NA
Prep Batch: 615141

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzo[a]anthracene	300		2270	2720		ug/Kg	☼	107	65 - 120
Benzo[a]pyrene	250		2270	2360		ug/Kg	☼	93	64 - 120
Benzo[b]fluoranthene	390		2270	2570		ug/Kg	☼	96	10 - 150
Benzo[g,h,i]perylene	170	J F2	2270	2610		ug/Kg	☼	108	45 - 145
Benzo[k]fluoranthene	150	J	2270	2440		ug/Kg	☼	101	23 - 150
Chrysene	440		2270	2820		ug/Kg	☼	105	64 - 120
Dibenz(a,h)anthracene	69	J F2	2270	2550		ug/Kg	☼	109	54 - 132
Fluoranthene	760		2270	3170		ug/Kg	☼	106	62 - 120
Fluorene	430		2270	3080		ug/Kg	☼	117	63 - 120
Indeno[1,2,3-cd]pyrene	150	J F2	2270	2690		ug/Kg	☼	112	56 - 134
Naphthalene	460		2270	2580		ug/Kg	☼	93	46 - 120
Pyrene	630		2270	2800		ug/Kg	☼	96	61 - 133
Phenanthrene	630		2270	2970		ug/Kg	☼	103	60 - 122

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
2,4,6-Tribromophenol (Surr)	*133*	*S1+*	*54 - 120*
2-Fluorobiphenyl	*115*		*60 - 120*
2-Fluorophenol (Surr)	*93*		*52 - 120*
Phenol-d5 (Surr)	*95*		*54 - 120*
p-Terphenyl-d14 (Surr)	*103*		*79 - 130*
Nitrobenzene-d5 (Surr)	*111*		*53 - 120*

Lab Sample ID: 480-195030-3 MSD
Matrix: Solid
Analysis Batch: 615423

Client Sample ID: TP-6 3-4'
Prep Type: Total/NA
Prep Batch: 615141

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Acenaphthene	190	J	2270	2450		ug/Kg	☼	99	60 - 120	10	35
Acenaphthylene	ND		2270	2210		ug/Kg	☼	97	58 - 121	10	18
Anthracene	170	J	2270	2410		ug/Kg	☼	99	62 - 120	9	15
Benzo[a]anthracene	300		2270	2550		ug/Kg	☼	99	65 - 120	7	15
Benzo[a]pyrene	250		2270	2240		ug/Kg	☼	88	64 - 120	5	15
Benzo[b]fluoranthene	390		2270	2440		ug/Kg	☼	90	10 - 150	5	15
Benzo[g,h,i]perylene	170	J F2	2270	2050	F2	ug/Kg	☼	82	45 - 145	24	15
Benzo[k]fluoranthene	150	J	2270	2260		ug/Kg	☼	93	23 - 150	8	22
Chrysene	440		2270	2730		ug/Kg	☼	101	64 - 120	3	15
Dibenz(a,h)anthracene	69	J F2	2270	2060	F2	ug/Kg	☼	88	54 - 132	21	15
Fluoranthene	760		2270	3050		ug/Kg	☼	101	62 - 120	4	15
Fluorene	430		2270	2700		ug/Kg	☼	100	63 - 120	13	15
Indeno[1,2,3-cd]pyrene	150	J F2	2270	2190	F2	ug/Kg	☼	90	56 - 134	21	15
Naphthalene	460		2270	2340		ug/Kg	☼	83	46 - 120	10	29
Pyrene	630		2270	2690		ug/Kg	☼	91	61 - 133	4	35
Phenanthrene	630		2270	2730		ug/Kg	☼	93	60 - 122	8	15

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
2,4,6-Tribromophenol (Surr)	*122*	*S1+*	*54 - 120*
2-Fluorobiphenyl	*98*		*60 - 120*
2-Fluorophenol (Surr)	*83*		*52 - 120*

QC Sample Results

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 480-195030-3 MSD
Client Sample ID: TP-6 3-4'
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615423
Prep Batch: 615141

Surrogate	MSD %Recovery	MSD Qualifier	Limits
Phenol-d5 (Surr)	*88*		*54 - 120*
p-Terphenyl-d14 (Surr)	*92*		*79 - 130*
Nitrobenzene-d5 (Surr)	*98*		*53 - 120*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 480-615099/1-A
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615358
Prep Batch: 615099

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		2.1		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Barium	ND		0.51		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Cadmium	ND		0.21		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Chromium	ND		0.51		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Lead	ND		1.0		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Selenium	ND		4.1		mg/Kg		02/16/22 15:41	02/17/22 16:45	1
Silver	ND		0.62		mg/Kg		02/16/22 15:41	02/17/22 16:45	1

Lab Sample ID: LCSSRM 480-615099/2-A
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615358
Prep Batch: 615099

Analyte	Spike Added	LCSSRM Result	LCSSRM Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	156	147.2		mg/Kg		94.4	69.9 - 130.1
Barium	239	231.3		mg/Kg		96.8	74.9 - 124.7
Cadmium	137	124.1		mg/Kg		90.6	75.2 - 124.8
Chromium	154	147.5		mg/Kg		95.8	70.1 - 129.9
Lead	130	145.5		mg/Kg		111.9	71.8 - 128.5
Selenium	167	153.1		mg/Kg		91.7	67.7 - 132.3
Silver	33.6	32.14		mg/Kg		95.6	68.5 - 131.3

Lab Sample ID: 480-195030-1 MS
Client Sample ID: TP-1 3-4'
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 615358
Prep Batch: 615099

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	5.7		49.5	53.10		mg/Kg	☼	96	75 - 125
Barium	123	F1	49.5	196.5	F1	mg/Kg	☼	148	75 - 125
Cadmium	0.26		49.5	46.33		mg/Kg	☼	93	75 - 125
Chromium	14.9		49.5	70.24		mg/Kg	☼	112	75 - 125
Lead	63.7	F1	49.5	130.8	F1	mg/Kg	☼	136	75 - 125
Selenium	ND		49.5	46.17		mg/Kg	☼	89	75 - 125
Silver	ND		12.4	11.79		mg/Kg	☼	95	75 - 125

QC Sample Results

Method: 6010C - Metals (ICP)

Lab Sample ID: 480-195030-1 MSD
Matrix: Solid
Analysis Batch: 615358

Client Sample ID: TP-1 3-4'
Prep Type: Total/NA
Prep Batch: 615099

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	5.7		50.2	51.51		mg/Kg	☼	91	75 - 125	3	20
Barium	123	F1	50.2	198.3	F1	mg/Kg	☼	150	75 - 125	1	20
Cadmium	0.26		50.2	46.06		mg/Kg	☼	91	75 - 125	1	20
Chromium	14.9		50.2	67.39		mg/Kg	☼	104	75 - 125	4	20
Lead	63.7	F1	50.2	130.3	F1	mg/Kg	☼	133	75 - 125	0	20
Selenium	ND		50.2	45.34		mg/Kg	☼	86	75 - 125	2	20
Silver	ND		12.6	11.80		mg/Kg	☼	94	75 - 125	0	20

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 480-615189/1-A
Matrix: Solid
Analysis Batch: 615267

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 615189

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.020		mg/Kg		02/17/22 11:06	02/17/22 12:43	1

Lab Sample ID: LCSSRM 480-615189/2-A ^10
Matrix: Solid
Analysis Batch: 615267

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 615189

Analyte	Spike Added	LCSSRM Result	LCSSRM Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	27.2	22.23		mg/Kg		81.7	59.9 - 140.1

QC Association Summary

Client: Benchmark Env. Eng. & Science, PLLC
Job ID: 480-195030-1
Project/Site: Benchmark - Howell Street

GC/MS VOA

Prep Batch: 615092

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	5035A_H	
480-195030-2	TP-3 1-2'	Total/NA	Solid	5035A_H	
480-195030-3	TP-6 3-4'	Total/NA	Solid	5035A_H	
480-195030-4	TP-7 3-5'	Total/NA	Solid	5035A_H	
480-195030-5	TP-8 3-4'	Total/NA	Solid	5035A_H	
480-195030-6	TP-10 1-3'	Total/NA	Solid	5035A_H	
MB 480-615092/3-A	Method Blank	Total/NA	Solid	5035A_H	
LCS 480-615092/1-A	Lab Control Sample	Total/NA	Solid	5035A_H	
LCSD 480-615092/2-A	Lab Control Sample Dup	Total/NA	Solid	5035A_H	

Analysis Batch: 615137

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	8260C	615092
480-195030-2	TP-3 1-2'	Total/NA	Solid	8260C	615092
480-195030-3	TP-6 3-4'	Total/NA	Solid	8260C	615092
480-195030-4	TP-7 3-5'	Total/NA	Solid	8260C	615092
480-195030-5	TP-8 3-4'	Total/NA	Solid	8260C	615092
480-195030-6	TP-10 1-3'	Total/NA	Solid	8260C	615092
MB 480-615092/3-A	Method Blank	Total/NA	Solid	8260C	615092
LCS 480-615092/1-A	Lab Control Sample	Total/NA	Solid	8260C	615092
LCSD 480-615092/2-A	Lab Control Sample Dup	Total/NA	Solid	8260C	615092

GC/MS Semi VOA

Prep Batch: 615141

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	3550C	
480-195030-2	TP-3 1-2'	Total/NA	Solid	3550C	
480-195030-3	TP-6 3-4'	Total/NA	Solid	3550C	
480-195030-4	TP-7 3-5'	Total/NA	Solid	3550C	
480-195030-5	TP-8 3-4'	Total/NA	Solid	3550C	
480-195030-6	TP-10 1-3'	Total/NA	Solid	3550C	
MB 480-615141/1-A	Method Blank	Total/NA	Solid	3550C	
LCS 480-615141/2-A	Lab Control Sample	Total/NA	Solid	3550C	
480-195030-3 MS	TP-6 3-4'	Total/NA	Solid	3550C	
480-195030-3 MSD	TP-6 3-4'	Total/NA	Solid	3550C	

Analysis Batch: 615423

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	8270D	615141
480-195030-2	TP-3 1-2'	Total/NA	Solid	8270D	615141
480-195030-3	TP-6 3-4'	Total/NA	Solid	8270D	615141
480-195030-4	TP-7 3-5'	Total/NA	Solid	8270D	615141
480-195030-5	TP-8 3-4'	Total/NA	Solid	8270D	615141
480-195030-6	TP-10 1-3'	Total/NA	Solid	8270D	615141
MB 480-615141/1-A	Method Blank	Total/NA	Solid	8270D	615141
LCS 480-615141/2-A	Lab Control Sample	Total/NA	Solid	8270D	615141
480-195030-3 MS	TP-6 3-4'	Total/NA	Solid	8270D	615141
480-195030-3 MSD	TP-6 3-4'	Total/NA	Solid	8270D	615141

Metals

Prep Batch: 615099

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	3050B	
480-195030-2	TP-3 1-2'	Total/NA	Solid	3050B	
480-195030-3	TP-6 3-4'	Total/NA	Solid	3050B	
480-195030-4	TP-7 3-5'	Total/NA	Solid	3050B	
480-195030-5	TP-8 3-4'	Total/NA	Solid	3050B	
480-195030-6	TP-10 1-3'	Total/NA	Solid	3050B	
MB 480-615099/1-A	Method Blank	Total/NA	Solid	3050B	
LCSSRM 480-615099/2-A	Lab Control Sample	Total/NA	Solid	3050B	
480-195030-1 MS	TP-1 3-4'	Total/NA	Solid	3050B	
480-195030-1 MSD	TP-1 3-4'	Total/NA	Solid	3050B	

Prep Batch: 615189

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	7471B	
480-195030-2	TP-3 1-2'	Total/NA	Solid	7471B	
480-195030-3	TP-6 3-4'	Total/NA	Solid	7471B	
480-195030-4	TP-7 3-5'	Total/NA	Solid	7471B	
480-195030-5	TP-8 3-4'	Total/NA	Solid	7471B	
480-195030-6	TP-10 1-3'	Total/NA	Solid	7471B	
MB 480-615189/1-A	Method Blank	Total/NA	Solid	7471B	
LCSSRM 480-615189/2-A ^10	Lab Control Sample	Total/NA	Solid	7471B	

Analysis Batch: 615267

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	7471B	615189
480-195030-2	TP-3 1-2'	Total/NA	Solid	7471B	615189
480-195030-3	TP-6 3-4'	Total/NA	Solid	7471B	615189
480-195030-4	TP-7 3-5'	Total/NA	Solid	7471B	615189
480-195030-5	TP-8 3-4'	Total/NA	Solid	7471B	615189
480-195030-6	TP-10 1-3'	Total/NA	Solid	7471B	615189
MB 480-615189/1-A	Method Blank	Total/NA	Solid	7471B	615189
LCSSRM 480-615189/2-A ^10	Lab Control Sample	Total/NA	Solid	7471B	615189

Analysis Batch: 615358

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	6010C	615099
480-195030-2	TP-3 1-2'	Total/NA	Solid	6010C	615099
480-195030-3	TP-6 3-4'	Total/NA	Solid	6010C	615099
480-195030-4	TP-7 3-5'	Total/NA	Solid	6010C	615099
480-195030-5	TP-8 3-4'	Total/NA	Solid	6010C	615099
480-195030-6	TP-10 1-3'	Total/NA	Solid	6010C	615099
MB 480-615099/1-A	Method Blank	Total/NA	Solid	6010C	615099
LCSSRM 480-615099/2-A	Lab Control Sample	Total/NA	Solid	6010C	615099
480-195030-1 MS	TP-1 3-4'	Total/NA	Solid	6010C	615099
480-195030-1 MSD	TP-1 3-4'	Total/NA	Solid	6010C	615099

General Chemistry

Analysis Batch: 615109

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-1	TP-1 3-4'	Total/NA	Solid	Moisture	

General Chemistry (Continued)

Analysis Batch: 615109 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-195030-2	TP-3 1-2'	Total/NA	Solid	Moisture	
480-195030-3	TP-6 3-4'	Total/NA	Solid	Moisture	
480-195030-4	TP-7 3-5'	Total/NA	Solid	Moisture	
480-195030-5	TP-8 3-4'	Total/NA	Solid	Moisture	
480-195030-6	TP-10 1-3'	Total/NA	Solid	Moisture	

Client Sample ID: TP-1 3-4' Lab Sample ID: 480-195030-1

Date Collected: 02/15/22 08:15 **Matrix: Solid**

Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Client Sample ID: TP-1 3-4' Lab Sample ID: 480-195030-1

Date Collected: 02/15/22 08:15 **Matrix: Solid**

Date Received: 02/15/22 17:05 **Percent Solids: 83.8**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		10	615137	02/17/22 13:18	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		1	615423	02/18/22 18:35	PJQ	TAL BUF
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:15	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:00	BMB	TAL BUF

Client Sample ID: TP-3 1-2' Lab Sample ID: 480-195030-2

Date Collected: 02/15/22 09:33 **Matrix: Solid**

Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Client Sample ID: TP-3 1-2' Lab Sample ID: 480-195030-2

Date Collected: 02/15/22 09:33 **Matrix: Solid**

Date Received: 02/15/22 17:05 **Percent Solids: 78.4**

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		20	615137	02/17/22 13:41	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		5	615423	02/18/22 18:59	PJQ	TAL BUF
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:33	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:01	BMB	TAL BUF

Client Sample ID: TP-6 3-4' Lab Sample ID: 480-195030-3

Date Collected: 02/15/22 11:17 **Matrix: Solid**

Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Lab Chronicle

Client Sample ID: TP-6 3-4'

Lab Sample ID: 480-195030-3
Date Collected: 02/15/22 11:17
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 72.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		10	615137	02/17/22 14:04	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		1	615423	02/18/22 18:12	PJQ	TAL BUF
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:37	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:02	BMB	TAL BUF

Client Sample ID: TP-7 3-5'

Lab Sample ID: 480-195030-4
Date Collected: 02/15/22 11:35
Matrix: Solid
Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Client Sample ID: TP-7 3-5'

Lab Sample ID: 480-195030-4
Date Collected: 02/15/22 11:35
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 75.9

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		20	615137	02/17/22 14:27	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		1	615423	02/18/22 19:23	PJQ	TAL BUF
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:52	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:03	BMB	TAL BUF

Client Sample ID: TP-8 3-4'

Lab Sample ID: 480-195030-5
Date Collected: 02/15/22 12:00
Matrix: Solid
Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Client Sample ID: TP-8 3-4'

Lab Sample ID: 480-195030-5
Date Collected: 02/15/22 12:00
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		20	615137	02/17/22 14:50	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		5	615423	02/18/22 19:47	PJQ	TAL BUF

Client Sample ID: TP-8 3-4'
Lab Sample ID: 480-195030-5

Date Collected: 02/15/22 12:00
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.6

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:55	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:05	BMB	TAL BUF

Client Sample ID: TP-10 1-3'
Lab Sample ID: 480-195030-6

Date Collected: 02/15/22 12:55
Matrix: Solid
Date Received: 02/15/22 17:05

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	615109	02/16/22 16:04	JMM	TAL BUF

Client Sample ID: TP-10 1-3'
Lab Sample ID: 480-195030-6

Date Collected: 02/15/22 12:55
Matrix: Solid
Date Received: 02/15/22 17:05
Percent Solids: 77.8

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			615092	02/16/22 17:28	LCH	TAL BUF
Total/NA	Analysis	8260C		4	615137	02/17/22 15:13	CRL	TAL BUF
Total/NA	Prep	3550C			615141	02/17/22 08:30	VXF	TAL BUF
Total/NA	Analysis	8270D		5	615423	02/18/22 20:11	PJQ	TAL BUF
Total/NA	Prep	3050B			615099	02/16/22 15:41	NBS	TAL BUF
Total/NA	Analysis	6010C		1	615358	02/17/22 17:59	AMH	TAL BUF
Total/NA	Prep	7471B			615189	02/17/22 11:06	NVK	TAL BUF
Total/NA	Analysis	7471B		1	615267	02/17/22 13:06	BMB	TAL BUF

Laboratory References:

TAL BUF = Eurofins Buffalo, 10 Hazelwood Drive, Amherst, NY 14228-2298, TEL (716)691-2600

Accreditation/Certification Summary

Laboratory: Eurofins Buffalo

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	**Program**	**Identification Number**	**Expiration Date**
New York	NELAP	10026	04-01-22

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
Moisture		Solid	Percent Moisture
Moisture		Solid	Percent Solids

Method Summary

Client: Benchmark Env. Eng. & Science, PLLC

Job ID: 480-195030-1

Project/Site: Benchmark - Howell Street

Method	Method Description	Protocol	Laboratory
8260C	Volatile Organic Compounds by GC/MS	SW846	TAL BUF
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL BUF
6010C	Metals (ICP)	SW846	TAL BUF
7471B	Mercury (CVAA)	SW846	TAL BUF
Moisture	Percent Moisture	EPA	TAL BUF
3050B	Preparation, Metals	SW846	TAL BUF
3550C	Ultrasonic Extraction	SW846	TAL BUF
5035A_H	Closed System Purge and Trap	SW846	TAL BUF
7471B	Preparation, Mercury	SW846	TAL BUF

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL BUF = Eurofins Buffalo, 10 Hazelwood Drive, Amherst, NY 14228-2298, TEL (716)691-2600

Sample Summary

Client: Benchmark Env. Eng. & Science, PLLC
Project/Site: Benchmark - Howell Street

Job ID: 480-195030-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
480-195030-1	TP-1 3-4'	Solid	02/15/22 08:15	02/15/22 17:05
480-195030-2	TP-3 1-2'	Solid	02/15/22 09:33	02/15/22 17:05
480-195030-3	TP-6 3-4'	Solid	02/15/22 11:17	02/15/22 17:05
480-195030-4	TP-7 3-5'	Solid	02/15/22 11:35	02/15/22 17:05
480-195030-5	TP-8 3-4'	Solid	02/15/22 12:00	02/15/22 17:05
480-195030-6	TP-10 1-3'	Solid	02/15/22 12:55	02/15/22 17:05

TestAmerica Buffalo
10 Hazelwood Drive

Amherst, NY 14228-2223
phone 716.691.2600 fax 716.691.7991

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	**Project Manager: Nate Munley**	**Site Contact: Ethan Smith**	**Date:** 2-15-22	COC No:
Benchmark-Turnkey Environmental Engineering and Science	**Tel/Fax:**	**Lab Contact: Brian Fischer**	**Carrier:**	1 of 1 COCs
2558 Hamburg Turnpike Suite 300	**Analysis Turnaround Time**			Sampler:
Lackawanna, NY 14218	☐ CALENDAR DAYS ☐ WORKING DAYS			**For Lab Use Only:**
(716) 856-0599 Phone	TAT if different from Below Standard			Walk-in Client:
(716) 856-0583 FAX	☐ 2 weeks			Lab Sampling:
Project Name: Howell Street Site	☐ 1 week			
Site: Buffalo, NY	☐ 2 days			Job / SDG No.:
P O # T0258-022-002	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	VOCs	PAHs	RCRA Metals	Sample Specific Notes:
TP-1 3-4'	2-15-22	0815	G	Soil	3			X	X	X	
TP-3 1-2'	2-15-22	0933	G	Soil	3			X	X	X	
TP-6 3-4'	2-15-22	1117	G	Soil	3			X	X	X	
TP-7 3-5'	2-15-22	1135	G	Soil	3			X	X	X	
TP-8 3-4'	2-15-22	1200	G	Soil	3			X	X	X	
TP-10 1-3'	2-15-22	1255	G	Soil	3			X	X	X	

480-195030 Chain of Custody

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☒ Disposal by Lab ☐ Archive for ________ Months

Special Instructions/QC Requirements & Comments:

#1 ICE

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temp. (°C): Obs'd: 5.2 Corr'd:		Therm ID No.:
Relinquished by:	Company: BMTK	Date/Time: 2-15-22 1705	Received by:	Company:	Date/Time: 2/15/22 1705
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.15, dated 9/27/2017

Login Sample Receipt Checklist

Client: Benchmark Env. Eng. & Science, PLLC

Job Number: 480-195030-1

Login Number: 195030

List Source: Eurofins Buffalo

List Number: 1

Creator: Sabuda, Brendan D

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	True	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	5.2 #1 ice
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	True	

APPENDIX C

PROJECT DOCUMENTATION FORMS

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.: P.M.:	IMPORTANT TELEPHONE CALLS:

PERSONNEL ON SITE:

SIGNATURE

DATE:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

DAILY LOG	DATE			
	REPORT NO.			
	PAGE	OF		

Date:

PROBLEM IDENTIFICATION REPORT

Project:

Job No:

Location:

CQA Monitor(s):

Client:

Contractor:

Contractor's Supervisor:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:

Ambient Air Temp. - P.M.:

Wind Direction:

Wind Speed:

Precipitation:

Problem Description:

Problem Location (reference test location, sketch on back of form as appropriate):

Problem Causes:

Suggested Corrective Measures or Variances:

Linked to Corrective Measures Report No. or Variance Log No.

Approvals (initial):

CQA Engineer:

Project Manager:

Signed:

CQA Representative

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DAILY LOG	DATE			
	REPORT NO.			
	PAGE	OF		

Date:

Project:

Job No:

Location:

CQA Monitor(s):

Client:

Contractor:

Contractor's Supervisor:

CORRECTIVE MEASURES REPORT

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:

Ambient Air Temp. - P.M.:

Wind Direction:

Wind Speed:

Precipitation:

Corrective Measures Undertaken (reference Problem Identification Report No.)

Retesing Location:

Suggested Method of Minimizing Re-Occurrence:

Approvals (initial):

CQA Engineer:

Project Manager:

Signed:

CQA Representative

APPENDIX D

FIELD OPERATING PROCEDURES

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FIELD OPERATING PROCEDURES

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FOP Number	Description
001.1	Abandonment of Borehole Procedures
002.0	Abandonment of Monitoring Wells Procedure
004.6	Soil Vapor Sample Collection Procedure
007.0	Calibration and Maintenance of Portable Dissolved Oxygen Meter
008.0	Calibration and Maintenance of Portable Field pH/Eh Meter
009.0	Calibration and Maintenance of Portable Field Turbidity Meter
011.1	Calibration and Maintenance of Portable Photoionization Detector
012.0	Calibration and Maintenance of Portable Specific Conductance Meter
013.0	Composite Sample Collection Procedure for Non-Volatile Organic Analysis
015.0	Documentation Requirements for Drilling and Well Installation
017.0	Drill Site Selection Procedure
018.0	Drilling and Excavation Equipment Decontamination Procedures
021.0	Establishing Horizontal and Vertical Control
022.0	Groundwater Level Measurement
023.1	Groundwater Purging Procedures Prior to Sample Collection
024.1	Groundwater Sample Collection Procedures
024.3	Groundwater Sample Collection Procedures for PFAS
025.0	Hand Augering Procedure
026.1	Hollow Stem Auger (HSA) Drilling Procedures
031.2	Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure
032.1	Management of Investigation-Derived Waste (IDW)
033.0	Monitoring Well Construction for Hollow Stem Auger Boreholes
036.0	Monitoring Well Development Procedures
039.1	NAPL Detection and Sample Collection Procedure
040.1	Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
041.0	Overburden Casing Installation Procedure
046.0	Sample Labeling, Storage and Shipment Procedures
047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities
048.0	Screening of Soil Samples for Organic Vapors During UST Removal Activities
054.2	Soil Description Procedures Using The Visual-Manual Method
057.0	Soil Sample Collection for VOC Analysis - EnCore Sampling
058.0	Split-Spoon Sampling Procedures
063.2	Surface and Subsurface Soil Sampling Procedures
065.1	Test Pit Excavation and Logging Procedures
070.0	Well/Piezometer Construction Materials and Design
073.2	Real-Time Air Monitoring During Intrusive Activities
074.0	Underground Storage Tank Excavation & Removal Procedures
076.0	"Before Going Into the Field" Procedure
078.0	Geoprobe Drilling Procedures
079.0	Stockpile Sampling Procedures for Chemical Analysis
080.0	Stockpile-Borrow Source Sampling Procedures for Physical Analysis
082.0	Waste Sampling Procedures
084.0	Calibration and Maintenance of Portable Particulate Meter
085.0	Field Quality Control Procedures
088.0	Underground Piping Decommissioning Procedures
090.0	Outdoor Ambient Air VOC Sample Collection Procedure

Notes:

1. FOPs are identified by the sequential FOP number and revision number. For example, FOP number 097.3 indicates FOP 97, revision 3.

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FIELD OPERATING PROCEDURES

Abandonment of Borehole Procedures

FOP 001.1

ABANDONMENT OF BOREHOLE PROCEDURE

PURPOSE

Soil borings that are not completed as monitoring wells will be plugged by filling the holes with a cement/bentonite grout. Field staff will calculate the borehole volume and compare it to the final installed volume of grout to evaluate whether bridging or loss to the formation has occurred. These calculations and the actual volume placed will be noted on the Boring Log.

PROCEDURE

1. Determine most suitable seal materials. Grout specifications generally have mixture ratios as follows:

   <u>Grout Slurry Composition (% Weight)</u>

1.5 to 3.0%	-	Bentonite (Quick Gel)
40 to 60 %	-	Cement (Portland Type I)
40 to 60 %	-	Potable Water

2. Calculate the volume of the borehole base on the bit or auger head diameter plus 10% and determine the volume of grout to be emplaced. Generally, the total mixed volume is the borehole volume plus 20%.

3. Identify the equipment to be used for the preparation and mixing of the grout. Ensure the volume of the tanks to be used for mixing has been measured adequately. Document these volumes on the Well Abandonment/Decommissioning Log (sample attached).

4. Identify the source of the water to be used for the grout and determine its suitability for use. In particular, water with high sulfate, or chloride levels or heated water should not be used. These types of waters can cause operational difficulties or modify the set-up for the grout.

5. Identify the equipment to be used for emplacing the grout. Ensure that the pump to be used has adequate pressure to enable complete return to surface.

6. Identify the volumes to be pumped at each stage or in total if only one stage is to be used.

7. Prepare the borehole abandonment plan and discuss the plan and activities with the drilling contractor prior to beginning any mixing activities.

8. Begin mixing the grout to be emplaced.

9. Record the type and amount of materials used during the mixing operation. Ensure the ratios are within specifications tolerance.

10. Begin pumping the grout through the return line bypass system to confirm all pump and surface fittings are secure.

11. Initiate downhole pumping from the bottom of the borehole. Record the times and volumes emplaced on the Well Abandonment/Decommissioning Log (sample attached).

12. Document the return circulation of grout. This may be facilitated by using a colored dye or other tagging method if a mudded borehole condition exists prior to grout injection.

13. Identify what procedures will be used for grouting in the upper 3 feet. When casing exists in the borehole, decisions are required as to the timing for removal and final disposition of the casing. Generally, it will not be removed prior to grouting because of the potential for difficult access and loss of circulation in the upper soil or rock layers. Accordingly, when cement return is achieved at surface, the casing is commonly removed and the borehole is topped off with grout or soils. If casing removal is not possible or not desired, the casing left in place should be cut off at a depth of 5 feet or greater below ground surface. If casing is not present during grouting, the grout level in the borehole is topped off after the rods or tremie pipe is removed.

14. Clear and clean the surface near the borehole.

15. The uppermost five feet of the borehole at the land surface should be filled with material physically similar to the natural soils. The surface of the borehole should be restored to the condition of the area surrounding the borehole. For example, concrete or asphalt will be patched with concrete or asphalt of the same type and thickness, grassed areas will be seeded, and topsoil will be used in other areas. All solid waste materials generated during the decommissioning process must be disposed of properly.

16. A follow-up check at each site should be made within one week to 10 days of completion. It should be noted that on occasion, the grout and/or surface material may settle over several days. If settling occurs, additional material physically similar to surrounding materials (i.e., asphalt, concrete, or soil) must be used to match the existing grade.

17. Document borehole and/or well/piezometer decommissioning activities on a Well Abandonment/Decommissioning Log (sample attached).

ATTACHMENTS

Well Abandonment/Decommissioning Log (sample)

REFERENCES

ASTM D 5299: *Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.*

NYSDEC, July 1988, *Drilling and Monitoring Well Installation Guidance Manual.*

NYSDEC, November 2009, *CP-43: Groundwater Monitoring Well Decommissioning Policy.*

Driscoll, F.G., 1987, *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota, 1089 p.

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WELL ABANDONMENT/ DECOMMISSIONING LOG

PROJECT INFORMATION	WELL INFORMATION
Project Name:	WELL I.D.:
Client:	Stick-up (fags):
Project Job Number:	Total Depth (fbgs):
Date:	Screen Interval (fbgs):
Weather:	Well Material:
	Diameter (inches):
BM/TK Personnel:	
Drilling Company:	Drilling Company Personnel:
Drill Rig Type:	

DECOMMISSIONING PROCEDURES

Time	Description of Field Activities

PREPARED BY: DATE:

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FIELD OPERATING PROCEDURES

Abandonment of Monitoring Wells Procedure

FOP 002.0

ABANDONMENT OF MONITORING WELLS PROCEDURE

PURPOSE

This guideline presents a method for the abandonment and decommissioning of wells that are no longer reliable as competent monitors of formation groundwater. Well abandonment and decommissioning is required in order to remove a potential pathway for the vertical migration of impacted groundwater and/or surface water.

PROCEDURE

1. Examine the existing well to be abandoned/decommissioned and review well construction detail information (if applicable) to determine well depth,, screened interval, diameter, material of composition and other construction details. Establish appropriate equipment requirements for removal of the well.

2. Determine the most suitable seal materials as discussed in the next section.

3. Attempt to remove the well using a drilling rig, by using the following procedures:
    - Attaching the winch line to the well to see if it can be removed by pulling;
    - Using the rig's hydraulics to advance casing incrementally;
    - If a cable tool rig is available, bump back the casing using the cathead and drive block.

3. Upon removal of the well, ream the borehole by advancing the augers approximately one foot beyond the total depth of the well. Rotate the augers at a speed sufficient to remove the construction materials (i.e., filter pack, bentonite seal, etc.) from the borehole annulus (if possible). Backfill the resulting borehole with cement/bentonite grout, by tremie method, to approximately one foot below ground surface. Fill the remaining borehole to match the existing grade elevation and material of construction (i.e., clean native soil, concrete or asphalt, as necessary). Go to Step 10.

4. If the well cannot be removed from the borehole over-drill the borehole and well to approximately two (2) feet below the well depth. Upon reaching the desired depth, remove the well from within the augers and go back to Step 3.

5. If the borehole cannot be reamed out using conventional drilling techniques (i.e., over-drilled), remove or puncture the base plate of the well screen using the drill rig and associated equipment by pounding with the drill rods. Upon filling the well with grout by tremie method, slowly pull the well from the ground surface to allow the grout to evacuate through the bottom of the well to fill the void space created by removal of the well casing. Continue adding grout mix to the well casing, as necessary, to fill the void space to approximately one foot below ground surface. Fill the remaining borehole to match the existing grade elevation and material of construction (i.e., clean native soil, concrete or asphalt, as necessary). Go to Step 10.

   If the driller is unsuccessful at removing or puncturing the base plate of the well due, in part, to well construction materials (i.e., stainless steel or black iron), go to Step 6.

6. Insert a tremie pipe down the well to the bottom and pump a cement/bentonite grout mixture to a depth one to two feet above the top of the screen.

7. Perform a hydraulic pressure test on the portion of the well casing above the grouted screen section. Allow the grout to set up for a period not less than 72 hours before pressure testing of the grouted interval. Place a pneumatic packer a maximum of 4.5 feet above the top of the slotted screen section of the well. The infiltration pressure applied to the packer shall not exceed the pressure rating of the well casing material. If the interval between the top of the grout and the bottom of the packer is not saturated, potable water will be used to fill the interval. A gauge pressure of 5 psig at the well head shall be applied to the interval for a period of 5 minutes to allow for temperature stabilization. After 5 minutes, the pressure will be maintained at 5 psig for 30 minutes. The grout seal shall be considered acceptable if the total loss of water to the seal does not exceed 0.5 gallons over a 30-minute period.

8. If the grout seal is determined to be unacceptable, tremie grout an additional 5 feet of well riser above the failing interval and retest as specified above (see Step 7).

9. If the grout seal is determined to be acceptable, tremie grout the remainder of the well until grout displaces all formation water and a grout return is visible in the well at the surface. Cut off well casing at a depth of five feet or greater below ground surface and backfill the remaining borehole to match the existing grade elevation and material of construction (i.e., clean native soil, concrete or asphalt, as necessary).

10. Record all well construction details and abandonment procedures on the **Well Abandonment/Decommissioning Log** (sample attached).

CEMENT/BENTONITE GROUT MIXTURE

The cement/bentonite grout mixture identified below is generally considered the most suitable seal material for monitoring well advancement and abandonment. Grout specifications generally have mixture ratios as follows:

Grout Slurry Composition (% Weight)

1.5 to 3.0% - Bentonite (Quick Gel)
40 to 60% - Cement (Portland Type I)
40 to 60% - Potable Water

MISCELLANEOUS

All removed well materials (PVC, stainless steel, steel pipe) should be decontaminated (if necessary) as per the project specific **Drilling and Excavation Equipment Decontamination FOP** and removed from the site. The project manager will determine the destination of final disposal for all well materials. All drill cuttings (depending on site protocol) should be placed in DOT-approved 55-gallon drums, labeled and sampled in accordance with Benchmark's field operating procedure **Management of Investigation-Derived Waste** in order to determine proper removal and disposal procedures. The drilling subcontractor will provide any potable water utilized during this field activity from a known and reliable source (see Notes section).

ATTACHMENTS

Well Abandonment/Decommissioning Log (sample)

REFERENCES

New York State Department of Environmental Conservation, July 1988, *Drilling and Monitoring Well Installation Guidance Manual.*

Driscoll, F.G., 1987, *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota, p. 1089.

Benchmark FOPs:
018 *Drilling/Excavation Equipment Decontamination Protocols*
032 *Management of Investigation-Derived Waste*

NOTES

Tap water may be used from any municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.

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WELL ABANDONMENT/ DECOMMISSIONING LOG

PROJECT INFORMATION	**WELL INFORMATION**
Project Name:	WELL I.D.:
Client:	Stick-up (fags):
Project Job Number:	Total Depth (fbgs):
Date:	Screen Interval (fbgs):
Weather:	Well Material:
	Diameter (inches):
BM/TK Personnel:	
Drilling Company:	Drilling Company Personnel:
Drill Rig Type:	

DECOMMISSIONING PROCEDURES

Time	Description of Field Activities

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FIELD OPERATING PROCEDURES

Soil Vapor Sample Collection Procedures

FOP 004.6

SOIL VAPOR SAMPLE
COLLECTION PROCEDURE

BACKGROUND

In October 2006, the New York State Department of Health (NYSDOH) finalized their vapor intrusion guidance document entitled "Guidance for Evaluating Soil Vapor Intrusion in the State of New York." (www.health.state.ny.us/nysdoh/gas/svi_guidance/), which has been guiding NYSDOH and New York State Department of Environmental Conservation (NYSDEC) decisions concerning the need for subslab vapor mitigation at sites undergoing investigation, cleanup and monitoring under formal NY Sate remedial programs (e.g., Brownfield Cleanup Program sites, Inactive Hazardous Waste Site Remediation Program sites, etc.). Per the most recent update, May 2017, guidance presents three (3) soil vapor/indoor air matrices to assist in interpreting the comparison of subslab and ambient air data. As of May 2017, eight compounds have been assigned to these three (3) current matrices (i.e., "Matrix A", "Matrix B", and "Matrix C") as follows:

Soil Vapor / Indoor Air Matrix	Volatile Chemical
Matrix A	Carbon tetrachloride
	1,1-Dichloroethene
	cis-1,2-Dichloroethene
	Trichloroethene
Matrix B	Methylene Chloride
	Tetrachlorethene
	1,1,1-Trichloroethane
Matrix C	Vinyl chloride

The matrices are attached as Figures 1, 2, and 3.

PURPOSE

The procedures presented herein delineate the scope of additional investigation at a building on the project site to determine if volatile organic compounds (VOCs) detected in groundwater and/or soil near the building are intruding into the building airspace or have the potential, in sufficient concentrations, to adversely impact indoor air quality. The soil vapor, subslab vapor, and ambient air monitoring procedures follow the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006) as well as USEPA Methods TO-14 and TO-15, for volatile organic compounds (VOCs) using Summa passive canisters.

SURVEYS AND PRE-SAMPLING BUILDING PREPARATION (IF REQUIRED)

If required, a pre-sampling inspection should be performed prior to each sampling event to identify and minimize conditions that may interfere with the proposed testing. The inspection should evaluate the type of structure, floor layout, airflows, and physical conditions of the building(s) being studied. This information, along with information on sources of potential indoor air contamination, should be identified on a building inventory form. An example of the building inventory form is attached. Items to be included in the building inventory include the following:

- Construction characteristics, including foundation cracks and utility penetrations or other openings that may serve as preferential pathways for vapor intrusion;
- Presence of an attached garage;
- Recent renovations or maintenance to the building (e.g., fresh paint, new carpet or furniture);
- Mechanical equipment that can affect pressure gradients (e.g., heating systems, clothes dryers or exhaust fans);

- Use or storage of petroleum products (e.g., fuel containers, gasoline operated equipment and unvented kerosene heaters); and
- Recent use of petroleum-based finishes or products containing volatile chemicals.

Each room on the floor of the building being tested and on lower floors, if possible, should be inspected. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building.

Potential interference from products or activities releasing volatile chemicals may need to be controlled. Removing the source from the indoor environment prior to testing is the most effective means of reducing interference. Ensuring that containers are tightly sealed may be acceptable. When testing for volatile organic compounds, containers should be tested with portable vapor monitoring equipment to determine whether compounds are leaking. The inability to eliminate potential interference may be justification for not testing, especially when testing for similar compounds at low levels. The investigator should consider the possibility that chemicals may adsorb onto porous materials and may take time to dissipate.

In some cases, the goal of the testing is to evaluate the impact from products used or stored in the building (e.g., pesticide misapplications, school renovation projects). If the goal of the testing is to determine whether products are an indoor volatile chemical contaminant source, the removing these sources does not apply.

Once interfering conditions are corrected (if applicable), ventilation may be needed prior to sampling to eliminate residual contamination in the indoor air. If ventilation is appropriate, it should be completed 24 hours or more prior to the scheduled sampling time. Where applicable, ventilation can be accomplished by operating the building's HVAC system to maximize outside air intake. Opening windows and doors, and operating exhaust fans may also help or may be needed if the building has no HVAC system.

Air samples are sometimes designed to represent typical exposure in a mechanically ventilated building and the operation of HVAC systems during sampling should be noted on the building inventory form (see attached sample). In general, the building's HVAC system should be operating under normal conditions. Unnecessary building ventilation should be avoided within 24 hours prior to and during sampling. During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time.

Depending upon the goal of the indoor air sampling, some situations may warrant deviation from the above protocol regarding building ventilation. In such cases, building conditions and sampling efforts should be understood and noted within the framework and scope of the investigation.

To avoid potential interferences and dilution effects, every effort should be made to avoid the following for 24 hours prior to sampling:

- Opening any windows, fireplace dampers, openings or vents;
- Operating ventilation fans unless special arrangements are made;
- Smoking in the building;
- Painting;
- Using a wood stove, fireplace or other auxiliary heating equipment (e.g., kerosene heater);
- Operating or storing automobile in an attached garage;

- Allowing containers of gasoline or oil to remain within the house or garage area, except for fuel oil tanks;
- Cleaning, waxing or polishing furniture, floors or other woodwork with petroleum- or oil-based products;
- Using air fresheners, scented candles or odor eliminators;
- Engaging in any hobbies that use materials containing volatile chemicals;
- Using cosmetics including hairspray, nail polish, nail polish removers, perfume/cologne, etc.;
- Lawn mowing, paving with asphalt, or snow blowing;
- Applying pesticides; and
- Using building repair or maintenance products, such as caulk or roofing tar.

PRODUCT INVENTORY (IF REQUIRED)

If required, the primary objective of the product inventory is to identify potential air sampling interference by characterizing the occurrence and use of chemicals and products throughout the building, keeping in mind the goal of the investigation and site-specific contaminants of concern. For example, it is not necessary to provide detailed information for each individual container of like items. However, it is necessary to indicate that "20 bottles of perfume" or "12 cans of latex paint" were present with containers in good condition. This information is used to help formulate an indoor environment profile.

An inventory should be provided for each room on the floor of the building being tested and on lower floors, if possible. This is important because even products stored in another area of a building can affect the air of the room being tested.

The presence and description of odors (e.g., solvent, moldy) and portable vapor monitoring equipment readings (e.g., PIDs, ppb RAE, Jerome Mercury Vapor Analyzer, etc.) should be noted and used to help evaluate potential sources. This includes taking readings near products stored or used in the building. Products in buildings should be inventoried every time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, Material Safety Data Sheets (MSDS) may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

SAMPLE LOCATIONS

The following are types of samples that are collected to investigate the soil vapor intrusion pathway:

- Subsurface vapor samples:
  - *Soil vapor* samples (i.e., soil vapor samples not beneath the foundation or slab of a building) and
  - *Sub-slab vapor* samples (i.e., soil vapor samples immediately beneath the foundation or slab of a building);
- Indoor air samples; and
- Outdoor air samples.

The types of samples that should be collected depend upon the specific objective(s) of the sampling, as described below.

- Soil vapor

  Soil vapor samples are collected to determine whether this environmental medium is contaminated, characterize the nature and extent of contamination, and identify possible sources of the contamination. Soil vapor sampling results are used when evaluating the following:
  - The potential for *current* human exposures;
  - The potential for *future* human exposures (e.g., should a building be constructed); and

  - The effectiveness of measures implemented to remediate contaminated subsurface vapors.

- Sub-slab vapor

  Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used when evaluating the following:
  - *Current* human exposures;
  - The potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
  - Site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

  Sub-slab vapor samples are collected after soil vapor characterization and/or other environmental sampling (e.g., soil and groundwater characterization) indicate a need. Subslab samples are typically collected concurrently with indoor and outdoor air samples. However, outside of the heating season, sub-slab vapor samples may be collected independently depending on the sampling objective (e.g., characterize the extent of subsurface vapor contamination outside of the heating season to develop a more comprehensive, focused investigation plan for the heating season).

- Indoor air

  Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors and crawlspaces. Indoor air sampling results are used when evaluating the following:
  - *Current* human exposures;
  - The potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
  - Site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

  Indoor air samples are collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate a need. When indoor air samples are collected, concurrent sub-slab vapor and outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system.

In addition, site-specific situations may warrant collecting indoor air samples prior to characterizing subsurface vapors and/or without concurrent sub-slab sampling due to a need to examine immediate inhalation hazards. Examples of such situations may include, but are not limited to, the following:

- In response to a spill event when there is a need to qualitatively and/or quantitatively characterize the contamination;
- If high readings are obtained in a building when screening with field equipment (e.g., a photoionization detector (PID), an organic vapor analyzer, or an explosimeter) and the source is unknown;
- If significant odors are present and the source needs to be characterized; or
- If groundwater beneath the building is contaminated, the building is prone to groundwater intrusion or flooding (e.g., sump pit overflows), and subsurface vapor sampling is not feasible.

- Outdoor air

  Outdoor air samples are collected to characterize site-specific background outdoor air conditions. These samples must be collected simultaneously with indoor air samples. They may also be collected concurrently with soil vapor samples. Outdoor air sampling results are primarily used when evaluating the extent to which outdoor sources may be influencing indoor air quality. They may also be used in the evaluation of soil vapor results (i.e., to identify potential outdoor air interferences associated with the infiltration of outdoor air into the sampling apparatus while the soil vapor sample was collected).

SOIL VAPOR SAMPLE COLLECTION PROCEDURES

Soil vapor probe installations (see Figure 4 attached) may be permanent, semi-permanent, or temporary. In general, permanent installations are preferred for data consistency reasons. Soil implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Soil vapor probes should be installed using direct push technology or, if necessary to attain the desired depth, using an auger;
- Porous backfill material (e.g., glass beads or coarse sand) should be used to create a sampling zone 1 to 2 feet in length;
- Soil vapor probes should be fitted with inert tubing (e.g., polyethylene, stainless steel, or Teflon®) of the appropriate size (typically 1/8 inch to 1/4 inch diameter) and of laboratory or food grade quality to the surface;
- Soil vapor probes should be sealed above the sampling zone with a bentonite slurry for a minimum distance of 3 feet to prevent outdoor air infiltration and the remainder of the borehole backfilled with clean material;
- For multiple probe depths, the borehole should be grouted with bentonite between probes to create discrete sampling zones; and
- For permanent installations, a protective casing should be set around the top of the probe tubing and grouted in place to the top of bentonite to minimize infiltration of water or outdoor air, as well as to prevent accidental damage.

Soil vapor samples should be collected in the same manner at all locations to minimize possible discrepancies. The following procedures should be included in any sampling protocol:

- At least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;

- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;

- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;

- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements; and

- A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) (discussed later in this procedure). Once verified, continued use of the tracer gas may be reconsidered.

When soil vapor samples are collected, the following actions should be taken to document local conditions during sampling that may influence interpretation of the results:

- If sampling near a commercial or industrial building, uses of volatile chemicals during normal operations of the facility should be identified;

- Outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north);

- Weather conditions (e.g., precipitation, outdoor temperature, barometric pressure, wind speed and direction) should be noted for the past 24 to 48 hours; and

- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

SUB-SLAB VAPOR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. Prior to installation of the sub-slab vapor probe, the building floor should be inspected and any penetrations (cracks, floor drains, utility perforations, sumps, etc.) should be noted and recorded. Probes should be installed at locations where the potential for ambient air infiltration via floor penetrations is minimal.

Sub-slab vapor probe installations (see Figure 5 attached) may be permanent, semi-permanent, or temporary. Sub-slab implants or probes should be constructed in the same manner at all sampling locations to minimize possible discrepancies. The following procedures should be included in any construction protocol:

- Permanent recessed probes must be constructed with brass or stainless steel tubing and fittings;
- Temporary probes must be constructed with polyethylene or Teflon® tubing of laboratory or food grade quality;
- Tubing should not extend further than 2 inches into the sub-slab material;
- Coarse sand or glass beads should be added to cover about 1 inch of the probe tip for permanent installations; and
- The soil vapor probe should be sealed to the surface with permagum grout, melted beeswax, putty or other non-VOC-containing and non-shrinking products for temporary installations or cement for permanent installations.

Sub-slab vapor samples should be collected in the following manner:

- After installation of the probes, one to three volumes (i.e., the volume of the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;
- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;

- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements [Section 2.9 of the Guidance], the flow rate, and the sampling duration; and
- Ideally, samples should be collected over the same period of time as concurrent indoor and outdoor air samples.

When sub-slab vapor samples are collected, the following actions should be taken to document conditions during sampling and ultimately to aid in the interpretation of the sampling results:

- If sampling within a commercial or industrial building, uses of volatile chemicals in commercial or industrial processes and/or during building maintenance, should be identified;
- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system air supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;
- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and
- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling depth,
- Identity of samplers,
- Sampling methods and devices,
- Soil vapor purge volumes,
- Volume of soil vapor extracted,
- If canisters used, the vacuum before and after samples collected,
- Apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the subslab air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.

4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample (discussed in the next section). Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations

preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure section in this procedure.

6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.

7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.

8. At each location, drill an approximately ¾-inch diameter hole through the concrete slab (typically 6-8 inches thick) using a hand-held hammer drill.

9. Measure and record the concrete thickness in the Project Field Book.

10. Insert polyethylene or Teflon® tubing of laboratory or food grade quality into the drilled hole and <u>no further than 2 inches</u> into the subslab material.

11. Seal the tubing with an appropriately sized volatile organic compound-free stopper (i.e., permagum grout, melted beeswax, putty, or other non-VOC-containing and non-shrinking product) into the concrete core hole and secure in-place making sure the fit is very snug. Supplement any visible gaps between the stopper and concrete slab with a VOC-free sealant, such as beeswax or bentonite slurry.

12. Run the tubing assembly through a shroud (plastic pail, cardboard box, or garbage bag) creating a tight seal with the surface making sure not to disturb the seal around the tubing penetration.

13. Enrich the atmosphere of the shroud with helium. Measure and record the helium concentration within the shroud.

14. Purge approximately 1 to 3 tubing volumes (i.e., the volume of the sample probe and tube) using a hand pump (or similar approved device) to ensure the collection of a representative sample.

15. Flow rates for both purging and sample collection must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling.

16. Use a portable monitoring device to analyze a sample of soil vapor for the tracer **prior to and after** sampling for the compounds of concern. Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.

17. If concentrations greater than 10% of tracer gas are observed either prior to and/or after sampling, the probe seal should be enhanced to reduce the infiltration of outdoor air. Following enhancement of the seal, repeat steps 14 through 17 above until purged concentrations are less than 10% of the tracer gas within the shroud.

18. Following tubing purge and adequate seal integrity testing via helium tracer gas, immediately attach a 6-liter Summa Canister fitted with a 24-hour regulator (or approved other duration) to the opposite end of the tubing. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.

19. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.

20. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

21. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

22. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

23. Repair all concrete openings with a cement patch.

24. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

INDOOR AIR SAMPLE COLLECTION PROCEDURES

During colder months, heating systems should be operating to maintain normal indoor air temperatures (i.e., 65 – 75 °F) for at least 24 hours prior to and during the scheduled sampling time. If possible, prior to collecting indoor samples, a pre-sampling inspection, discussed earlier in this procedure, should be performed to evaluate the physical layout and conditions of the building being investigated, to identify conditions that may affect or interfere with the proposed sampling, and to prepare the building for sampling.

In general, indoor air samples should be collected in the following manner:

- Sampling duration should reflect the exposure scenario being evaluated without compromising the detection limit or sample collection flow rate (e.g., an 8 hour sample from a workplace with a single shift versus a 24 hour sample from a workplace with multiple shifts). To ensure that air is representative of the locations sampled and to avoid undue influence from sampling personnel, samples should be collected for at least 1 hour. If the goal of the sampling is to represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;

- Personnel should avoid lingering in the immediate area of the sampling device while samples are being collected;
- Sample flow rates must conform to the specifications in the sample collection method and, if possible, should be consistent with the flow rates for concurrent outdoor air and sub-slab samples;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved); and
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory.

At sites with tetrachloroethene contamination, passive air monitors that are specifically analyzed for tetrachloroethene (i.e., "perc badges") are commonly used to collect indoor and outdoor air samples. If site characterization activities indicate that degradation products of tetrachloroethene also represent a vapor intrusion concern, perc badges may be used to indicate the likelihood of vapor intrusion (i.e., by using tetrachloroethene as a surrogate) followed, as needed, by more comprehensive sampling and laboratory analyses to quantify both tetrachloroethene and its degradation products. Perc badge samples ideally should be collected over a twenty-four hour period, but for no less than eight hours.

The following actions should be taken to document conditions during indoor air sampling and ultimately to aid in the interpretation of the sampling results:

- A product inventory survey must be completed (discussed earlier);
- The use of heating or air conditioning systems during sampling should be noted;
- Floor plan sketches should be drawn that include the floor layout with sample locations, chemical storage areas, garages, doorways, stairways, location of basement sumps or subsurface drains and utility perforations through building foundations, HVAC system supply and return registers, compass orientation (north), and any other pertinent information should be completed;
- If possible, photographs should accompany floor plan sketches;
- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported;
- Smoke tubes or other devices should be used to confirm pressure relationships and air flow patterns, especially between floor levels and between suspected contaminant sources and other areas; and
- Any pertinent observations, such as spills, floor stains, smoke tube results, odors and readings from field instrumentation (e.g., vapors via PID, ppb RAE, Jerome Mercury Vapor Analyzer, etc.), should be recorded.

The field sampling team must maintain a sample log sheet summarizing the following:

- Sample identification,
- Date and time of sample collection,
- Sampling height,

- Identity of samplers,
- Sampling methods and devices,
- Depending upon the method, volume of air sampled,
- If canisters used, the vacuum before and after samples collected,
- Chain of custody protocols and records used to track samples from sampling point to analysis.

The following describes the indoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan. Indoor air sampling typically requires the continuous collection of samples over a 24-hour period.

4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample. Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building

roof or site. See the Outdoor Ambient Air Sampling Procedure presented in this procedure.

6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.

7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.

8. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.

9. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.

10. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

11. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

12. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

13. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

OUTDOOR AIR SAMPLE COLLECTION PROCEDURES

Outdoor air samples must be collected simultaneously with indoor air samples and may be collected concurrently with subsurface vapor samples. Outdoor air samples must be collected in the same manner as indoor samples.

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the sampling results:

- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), footings that create separate foundation sections, and paved areas;

- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and

- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

The following describes the outdoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.

2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.

4. Sample locations typically are collected upwind of the facility.

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. Place canisters on the ground or step ladder, with a clear plastic sheet beneath to prevent contamination. Locate the sampling inlet approximately 18-inches above the ground surface.

6. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results.

7. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.

8. All Summa Canister valves should remain closed until all subslab borings are complete and all of the indoor and outdoor canisters in their respective positions.

9. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.

10. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.

11. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.

12. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-14 or TO-15.

13. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).

TRACER GAS

When collecting soil vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control device to verify the integrity of the soil vapor probe seal. Without the use of a tracer, there is no way to verify that a soil vapor sample has not been diluted by surface air.

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF6) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing.

There are two basic approaches to testing for the tracer gas:

- Include the tracer gas in the list of target analytes reported by the laboratory; or
- Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to and after sampling for the compounds of concern. (Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.)

The advantage of the second approach is that the real time tracer sampling results can be used to confirm the integrity of the probe seals prior to formal sample collection. Figure 6 (attached) depicts common methods for using tracer gas. In each of the examples, a, b and c, the tracer gas is released in the enclosure prior to initially purging the sample point. Care should be taken to avoid excessive purging prior to sample collection. Care should also be taken to prevent pressure build-up in the enclosure during introduction of the tracer gas. Inspection of the installed sample probe, specifically noting the integrity of the surface seal and the porosity of the soil in which the probe is installed, will help to determine the tracer gas setup. Figure 6(a) may be most effective at preventing tracer gas infiltration; however, it may not be required in some situations depending on site-specific conditions. Figures 6(b) and 6(c) may be sufficient for probes installed in tight soils with well-constructed surface seals. In all cases, the same tracer gas application should be used for all probes at any given site.

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the probe seal should be enhanced to reduce the infiltration of ambient air.

During the initial stages of a soil vapor sampling program, tracer gas samples should be collected at each of the sampling probes. If the results of the initial samples indicate that the probe seals are adequate, the project manager can consider reducing the number of locations at which tracer gas samples are employed. At a minimum, at least 10% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor probes as part of a long-term monitoring program, annual testing of the probe integrity is recommended.

QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Extreme care should be taken during all aspects of sample collection to ensure that sampling error is minimized and high quality data are obtained. The sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, and wearing freshly dry-cleaned clothing or personal fragrances), which can cause sample interference in the field. Appropriate QA/QC protocols must be followed for sample collection and laboratory analysis, such as use of certified clean sample devices, meeting sample holding times and temperatures, sample accession, chain of custody, etc. Samples should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures must be followed including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates, and laboratory duplicates, as appropriate.

Some methods require collecting samples in duplicate (e.g., indoor air sampling using passive sampling devices for tetrachloroethene) to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

For certain regulatory programs, a Data Usability Summary Report (DUSR) may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing a DUSR is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with detection limits similar to background (e.g., tetrachloroethene via EPA Method TO-15).

The work plan must state that all samples that will be used to make decisions on appropriate actions to address exposures and environmental contamination will be analyzed by an ELAP-certified laboratory. If known, the name of the laboratory should also be provided. Similarly, the name of the laboratory that was used must be included in the report of the sampling results. For samples collected and tested in the field for screening purposes by using field testing technology, the qualifications of the field technician must be documented in the work plan.

The target final field vacuum of any sample canister after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).

DECISION MATRICES (FIGURES 1, 2, AND 3)

The considerations in assigning a chemical to a matrix include the following:

- Human health risks, including such factors as a chemical's ability to cause cancer, reproductive, developmental, liver, kidney, nervous system, immune system or other effects, in animals and humans and the doses that may cause those effects;
- The data gaps in its toxicological database;
- Background concentrations of volatile chemicals in indoor air [Section 3.2.4]; and
- Analytical capabilities currently available.

To use the matrices accurately as a tool in the decision-making process, the following must be noted:

- The matrices are generic. As such, it may be necessary to modify recommended actions to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or site-specific conditions (e.g., proximity of building to identified subsurface contamination) for the protection of public health. Additionally, actions more conservative than those specified within the matrix may be implemented at any time. For example, the decision to implement more conservative actions may be based on a comparison of the costs associated with resampling or monitoring to the costs associated with installation and monitoring of a mitigation system.

- Indoor air concentrations detected in samples collected from the building's basement or, if the building has a slab-on-grade foundation, from the building's lowest occupied living space should be used.

- Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude the need to investigate possible sources of vapor contamination, nor does it preclude the need to remediate contaminated soil vapors or the source of soil vapor contamination.

- When current exposures are attributed to sources other than vapor intrusion, the agencies must be provided documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix and to support assessment and follow-up by the agencies.

RECOMMENDED ACTIONS

Actions recommended in the matrix are based on the relationship between sub-slab vapor concentrations and corresponding indoor air concentrations. They are intended to address both potential and current human exposures and include the following:

- *No further action*
  When the volatile chemical is not detected in the indoor air sample and the concentration detected in the corresponding sub-slab vapor sample is not expected to substantially affect indoor air quality.

- *Identify source(s) and resample or mitigate*
  Reasonable and practical actions are recommended to identify the source(s) affecting indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Resampling may be required in the event indoor and/or outdoor sources are not readily identified or confirmed to demonstrate SVI mitigation actions are not needed. Steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile chemical-containing products in places where people do not spend much time, such as a garage or shed). Mitigation may be required if soil vapor intrusion cannot be ruled out.

- *Monitor*
  Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure HVAC systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building specific basis, taking into account applicable environmental data and building operating conditions.

- *Mitigate*
  Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4 of the Guidance.

TIME OF YEAR

Sub-slab vapor samples and, unless there is an immediate need for sampling, indoor air samples are typically collected during the heating season because soil vapor intrusion is more likely to occur when a building's heating system is in operation and air is being drawn into the building. In general, heating systems are expected to be operating routinely from November 15th to March 31st throughout the state. However, this timeframe may vary depending on factors, such as the location of the site (e.g., upstate versus downstate) and the weather conditions for a particular year.

A vapor intrusion investigation may also be conducted outside of the heating season. However, the results may not be used to rule out exposures. For example, results indicating "no further action" or "monitoring required" must be verified during the heating season to ensure these actions are protective during the heating season as well.

SAMPLING ROUNDS

Investigating a soil vapor intrusion pathway usually requires more than one round of subsurface vapor, indoor air, and/or outdoor air sampling, for reasons such as the following:

- To characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;

- To evaluate fluctuations in concentrations due to
  - Different weather conditions (e.g., seasonal effects),
  - Changes in building conditions (e.g., various operating conditions of a building's HVAC system),
  - Changes in source strength, or
  - Vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or

- To confirm sampling results or the effectiveness of mitigation or remedial systems.

Overall, successive rounds of sampling are conducted until the following questions can be answered:

- Are subsurface vapors contaminated? If so, what are the nature and extent of contamination? What is/are the source(s) of the contamination?
- What are the current and potential exposures to contaminated subsurface vapors?
- What actions, if any, are needed to prevent or mitigate exposures and to remediate subsurface vapor contamination?

Toward this end, multiple rounds of sampling may be required to characterize the nature and extent of subsurface vapor contamination such that

- Both potential and current exposures are adequately addressed;
- Measures can be designed to remediate subsurface vapor contamination, either directly (e.g., SVE system) or indirectly (e.g., soil excavation or groundwater remediation), given that monitoring and mitigation are considered temporary measures implemented to address exposures related to vapor intrusion until contaminated environmental media are remediated; and
- The effectiveness of remedial measures can be monitored and confirmed (e.g., endpoint sampling).

ATTACHMENTS

Figure 1	*Soil Vapor/Indoor Air Matrix A*
Figure 2	*Soil Vapor/Indoor Air Matrix B*
Figure 3	*Soil Vapor/Indoor Air Matrix C*
Figure 4	*Schematics of a permanent soil vapor probe and permanent nested soil vapor probes*
Figure 5	*Schematic of a sub-slab vapor probe*
Figure 6	*Schematics of tracer gas applications*

Air Canister Field Record

Indoor Air Quality Questionnaire and Building Inventory

REFERENCES

New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, October 2006.

New York State Department of Health, *Indoor Air Sampling & Analysis Guidance.* (February 1, 2005).

Office of Solid Waste and Emergency Response (OSWER). *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* November 2002.

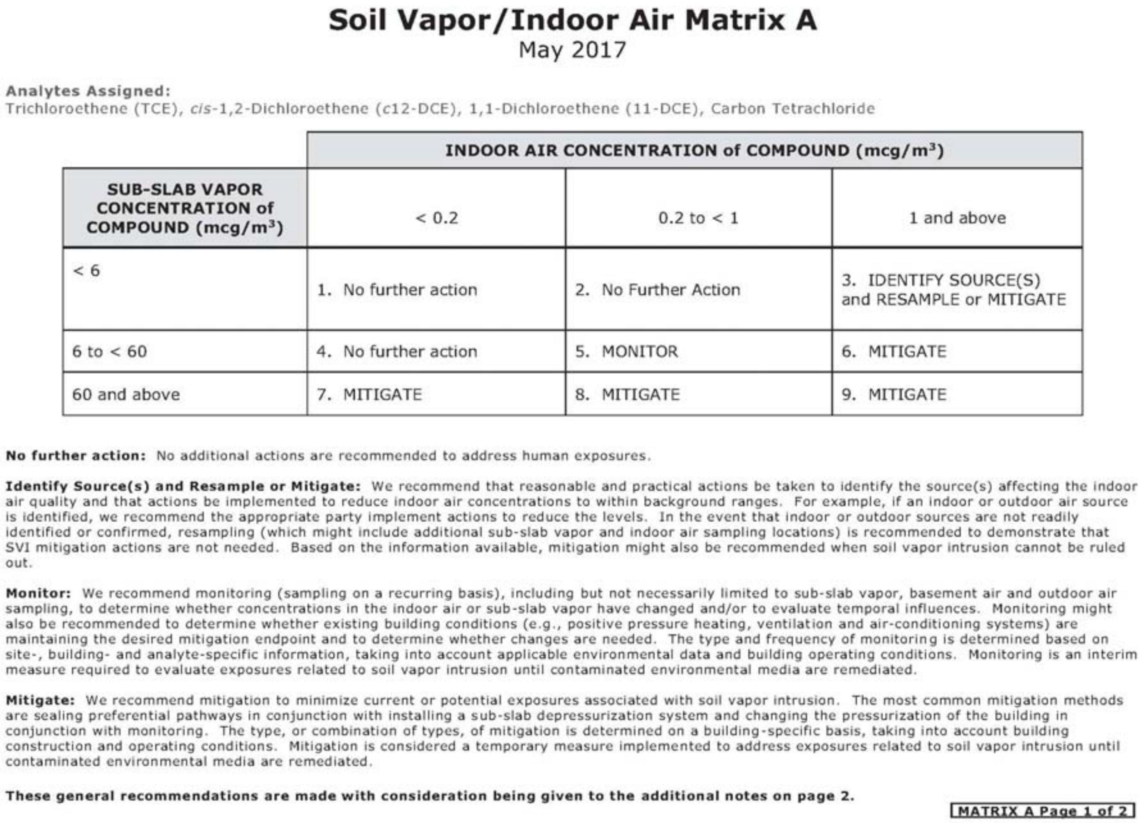
United States Environmental Protection Agency. *EPA Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.* 1988

- Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). Pp. 15-1 through 15-62.

- Method TO-17, Determination of Volatile Organic Compounds in Ambient Air using Active Sampling on Sorbent Tubes. Pp. 17-1 through 17-49.

- Compendium of Methods for the Determination of Air Pollutants in Indoor Air, EPA/600/4-90-010.

FIGURE 1



Soil Vapor/Indoor Air Matrix A

May 2017

Analytes Assigned:
Trichloroethene (TCE), *cis*-1,2-Dichloroethene (*c*12-DCE), 1,1-Dichloroethene (11-DCE), Carbon Tetrachloride

	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m^3)		
SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m^3)	< 0.2	0.2 to < 1	1 and above
< 6	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
6 to < 60	4. No further action	5. MONITOR	6. MITIGATE
60 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

No further action: No additional actions are recommended to address human exposures.

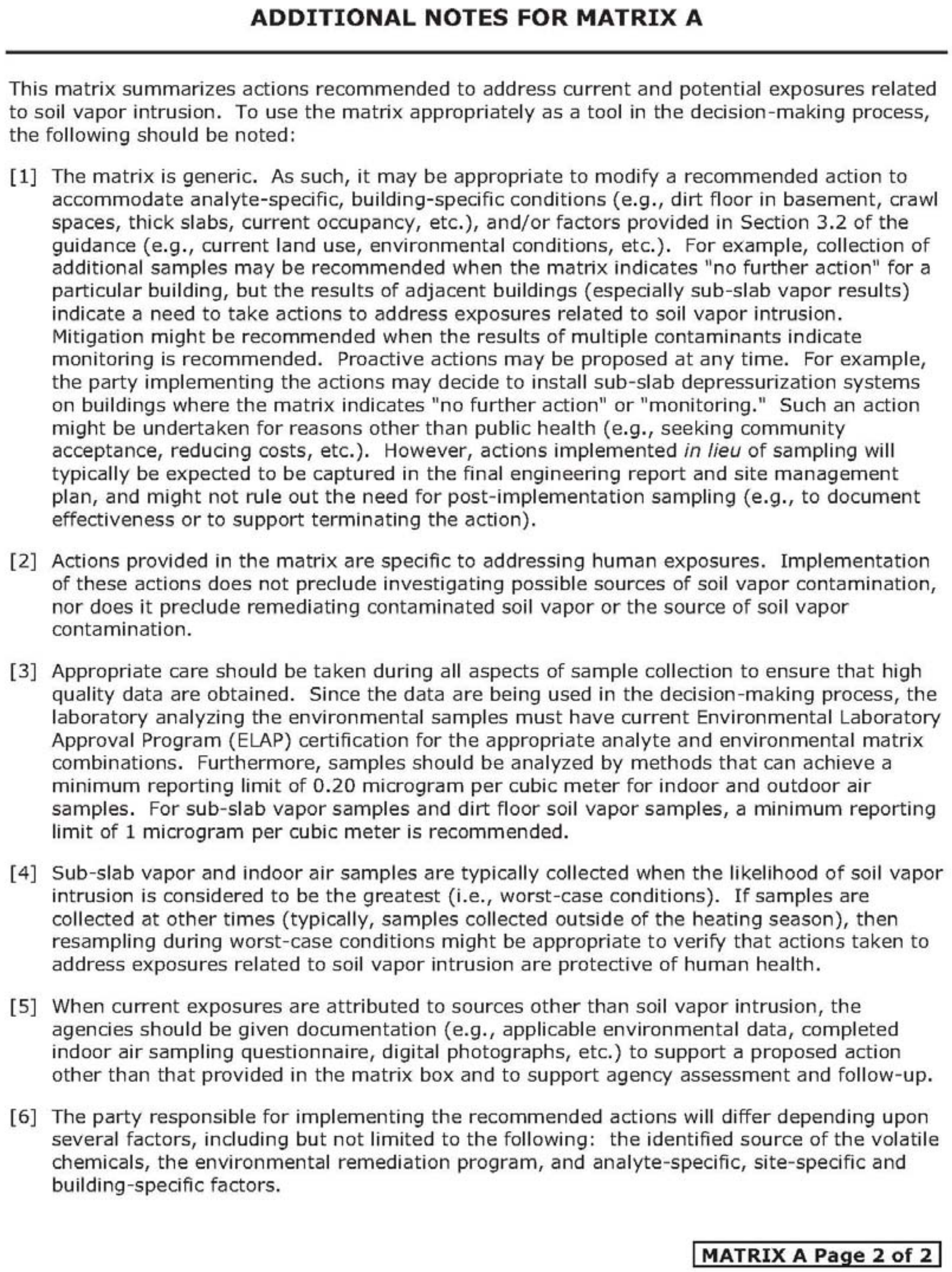
Identify Source(s) and Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX A Page 1 of 2



ADDITIONAL NOTES FOR MATRIX A

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.

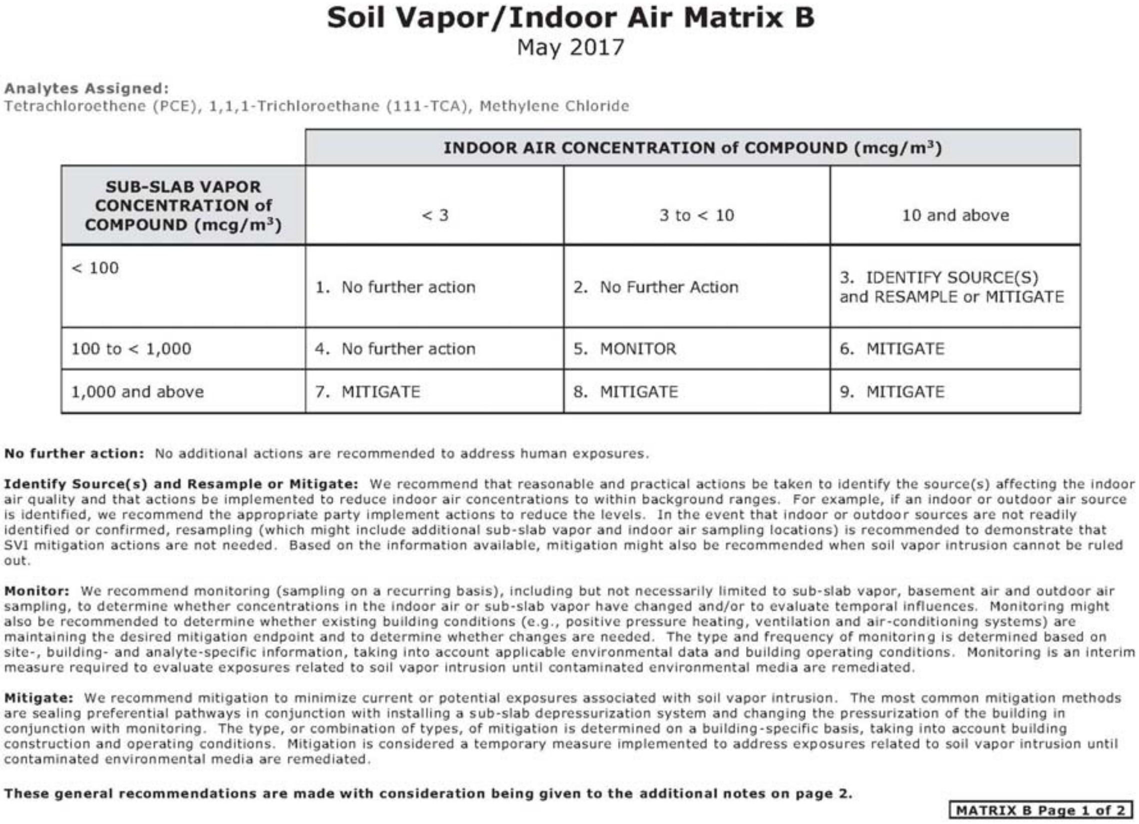
[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.20 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.

[4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.

[5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.

[6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

FIGURE 2



Soil Vapor/Indoor Air Matrix B

May 2017

Analytes Assigned:
Tetrachloroethene (PCE), 1,1,1-Trichloroethane (111-TCA), Methylene Chloride

	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m³)		
SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m³)	< 3	3 to < 10	10 and above
< 100	1. No further action	2. No Further Action	3. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
100 to < 1,000	4. No further action	5. MONITOR	6. MITIGATE
1,000 and above	7. MITIGATE	8. MITIGATE	9. MITIGATE

No further action: No additional actions are recommended to address human exposures.

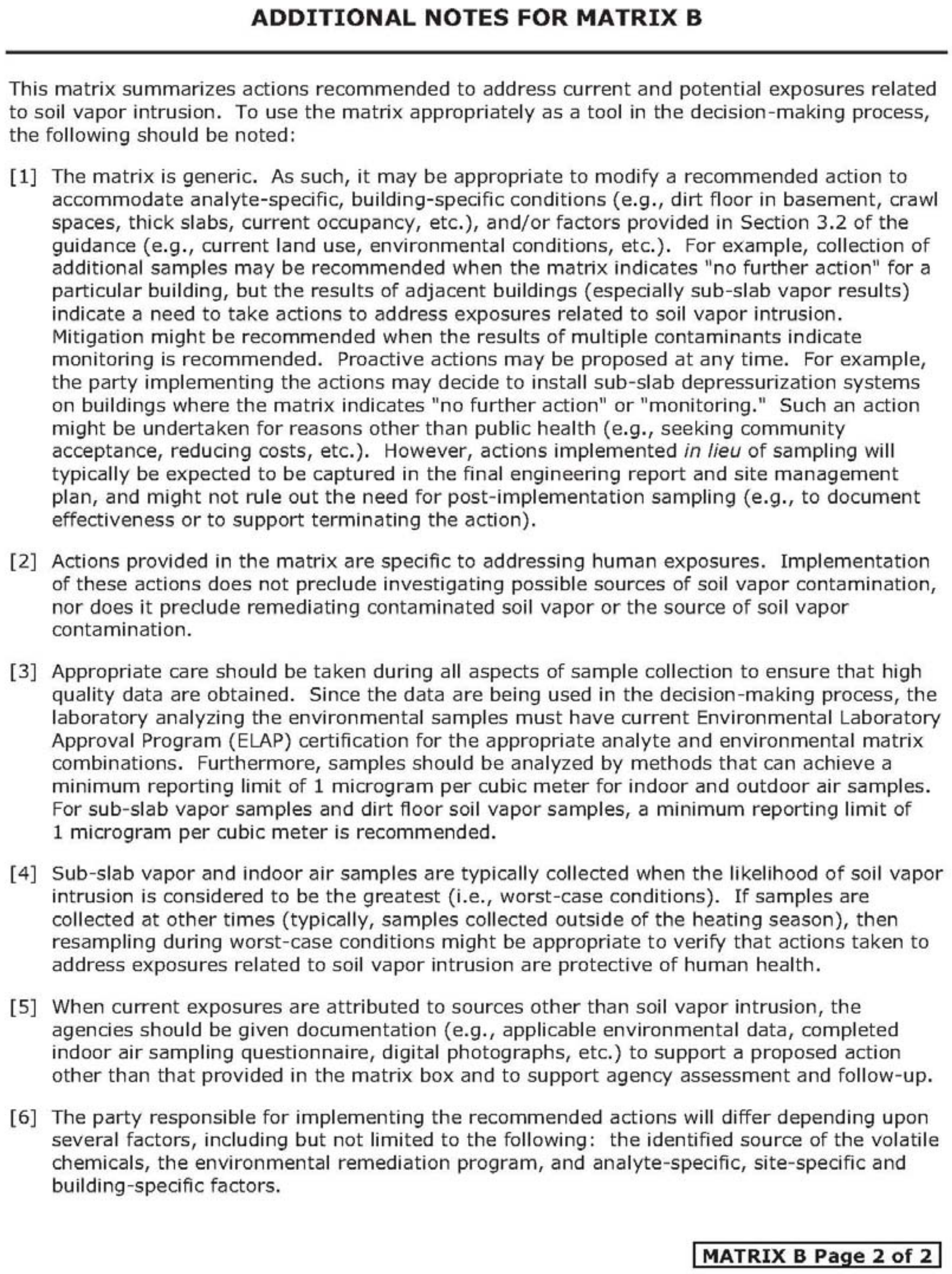
Identify Source(s) and Resample or Mitigate: We recommend that reasonable and practical actions be taken to identify the source(s) affecting the indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. For example, if an indoor or outdoor air source is identified, we recommend the appropriate party implement actions to reduce the levels. In the event that indoor or outdoor sources are not readily identified or confirmed, resampling (which might include additional sub-slab vapor and indoor air sampling locations) is recommended to demonstrate that SVI mitigation actions are not needed. Based on the information available, mitigation might also be recommended when soil vapor intrusion cannot be ruled out.

Monitor: We recommend monitoring (sampling on a recurring basis), including but not necessarily limited to sub-slab vapor, basement air and outdoor air sampling, to determine whether concentrations in the indoor air or sub-slab vapor have changed and/or to evaluate temporal influences. Monitoring might also be recommended to determine whether existing building conditions (e.g., positive pressure heating, ventilation and air-conditioning systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined based on site-, building- and analyte-specific information, taking into account applicable environmental data and building operating conditions. Monitoring is an interim measure required to evaluate exposures related to soil vapor intrusion until contaminated environmental media are remediated.

Mitigate: We recommend mitigation to minimize current or potential exposures associated with soil vapor intrusion. The most common mitigation methods are sealing preferential pathways in conjunction with installing a sub-slab depressurization system and changing the pressurization of the building in conjunction with monitoring. The type, or combination of types, of mitigation is determined on a building-specific basis, taking into account building construction and operating conditions. Mitigation is considered a temporary measure implemented to address exposures related to soil vapor intrusion until contaminated environmental media are remediated.

These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX B Page 1 of 2



ADDITIONAL NOTES FOR MATRIX B

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).

[2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.

[3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.

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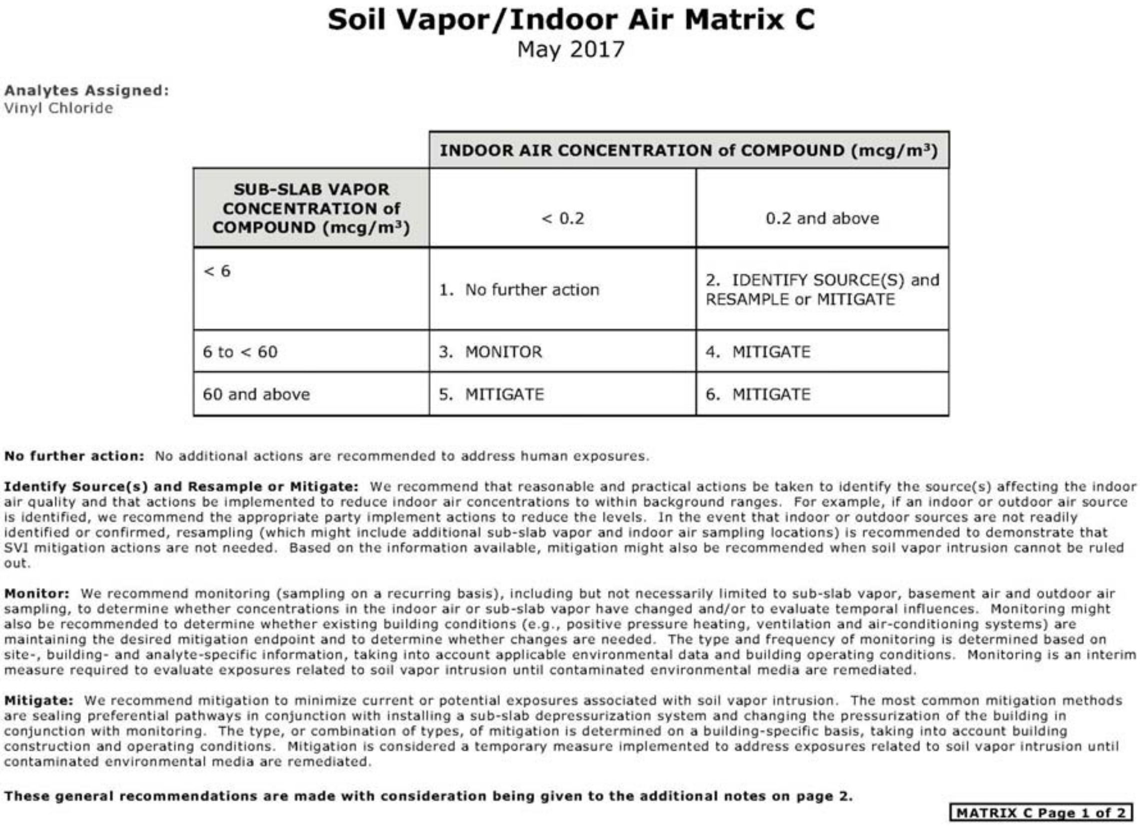
FIGURE 3



Soil Vapor/Indoor Air Matrix C

May 2017

Analytes Assigned:
Vinyl Chloride

	INDOOR AIR CONCENTRATION of COMPOUND (mcg/m³)	
SUB-SLAB VAPOR CONCENTRATION of COMPOUND (mcg/m³)	< 0.2	0.2 and above
< 6	1. No further action	2. IDENTIFY SOURCE(S) and RESAMPLE or MITIGATE
6 to < 60	3. MONITOR	4. MITIGATE
60 and above	5. MITIGATE	6. MITIGATE

No further action: No additional actions are recommended to address human exposures.

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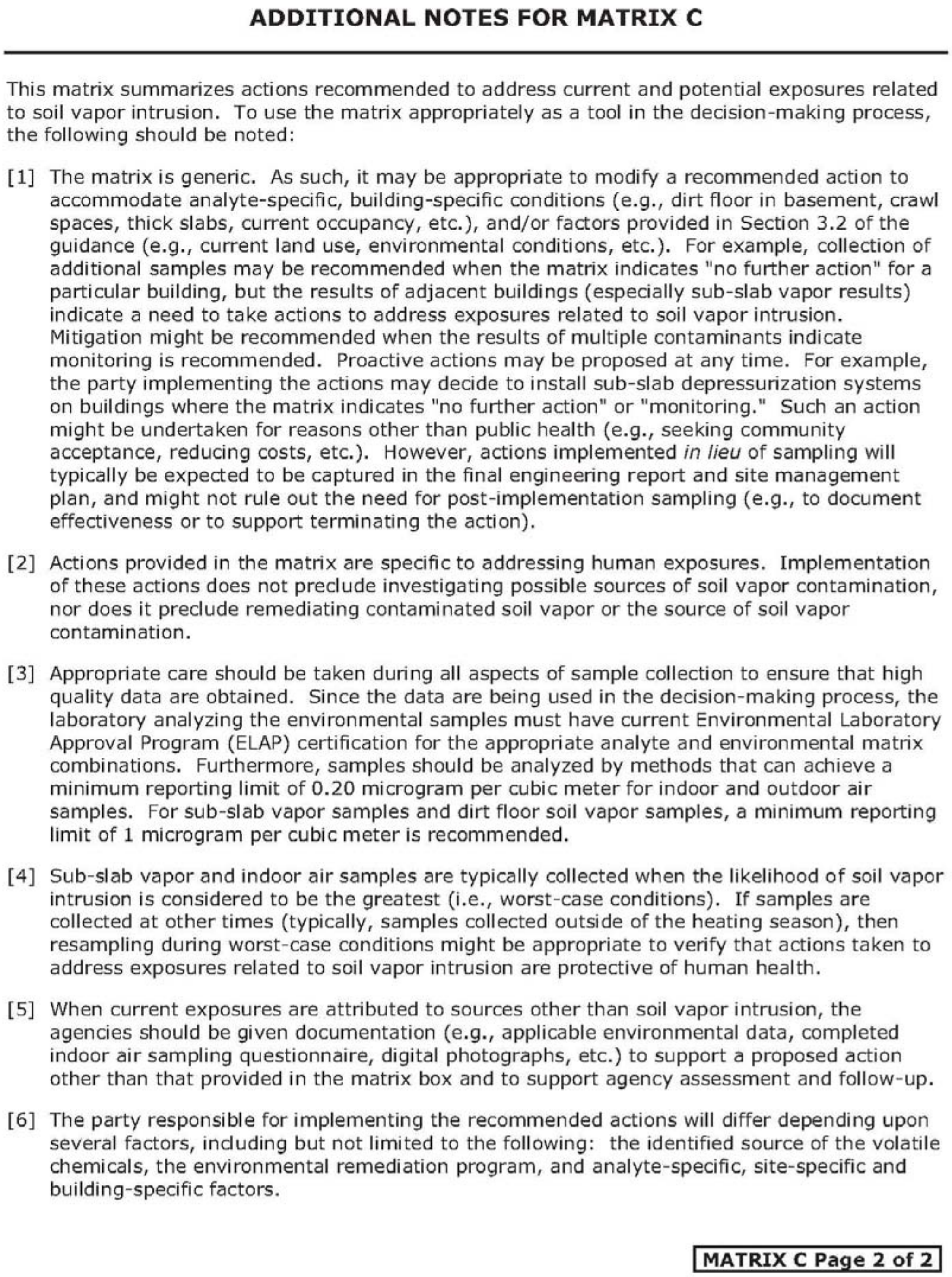
These general recommendations are made with consideration being given to the additional notes on page 2.

MATRIX C Page 1 of 2



ADDITIONAL NOTES FOR MATRIX C

This matrix summarizes actions recommended to address current and potential exposures related to soil vapor intrusion. To use the matrix appropriately as a tool in the decision-making process, the following should be noted:

[1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).

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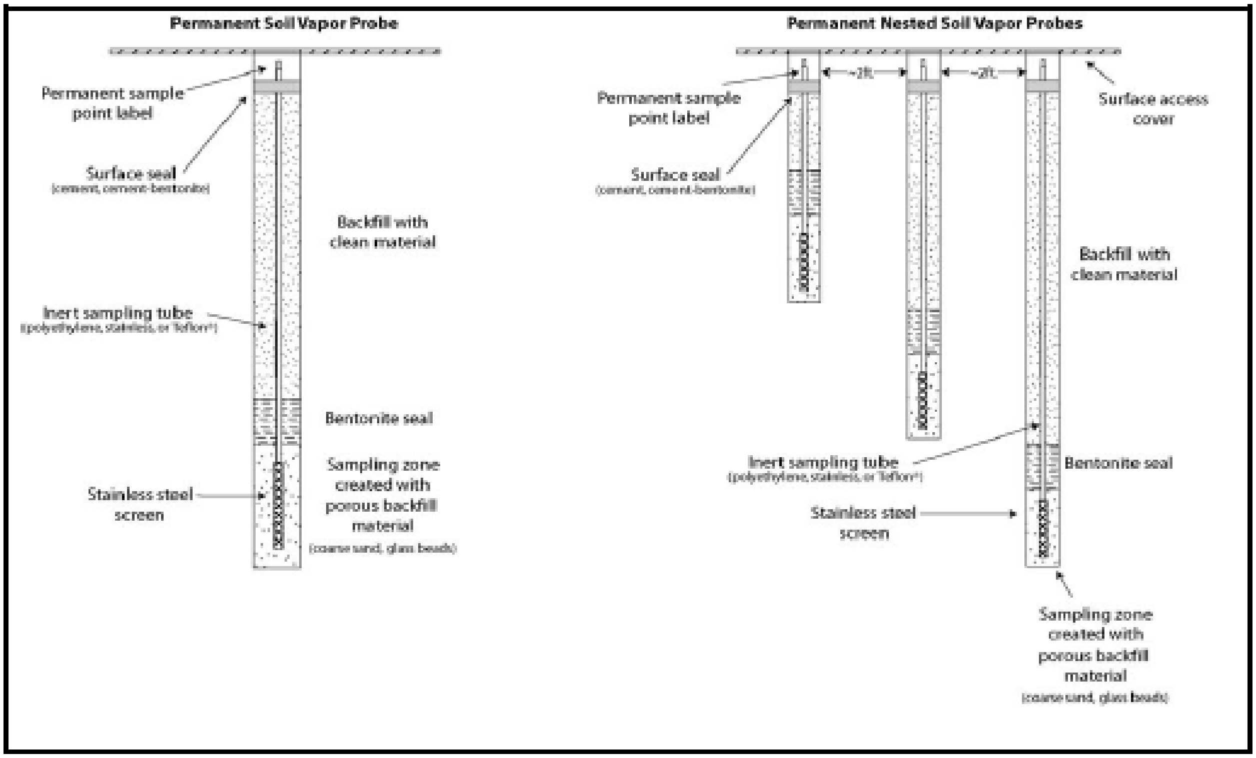
MATRIX C Page 2 of 2

FIGURE 4

Schematics of a permanent soil vapor probe and permanent nested soil vapor probes



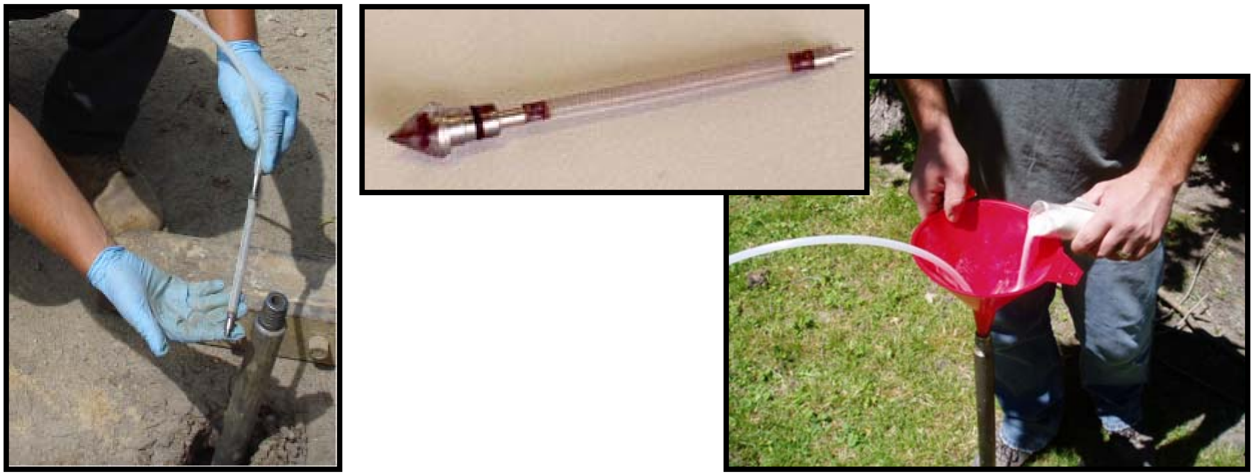
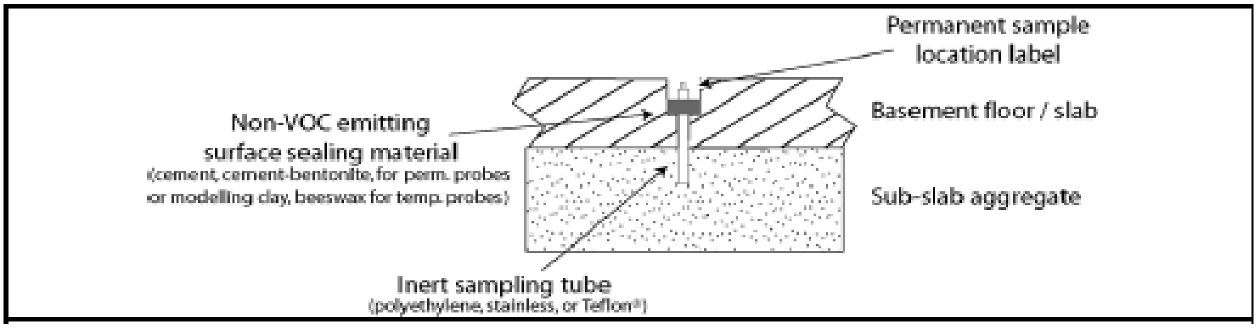


FIGURE 5

Schematic of a sub-slab vapor probe



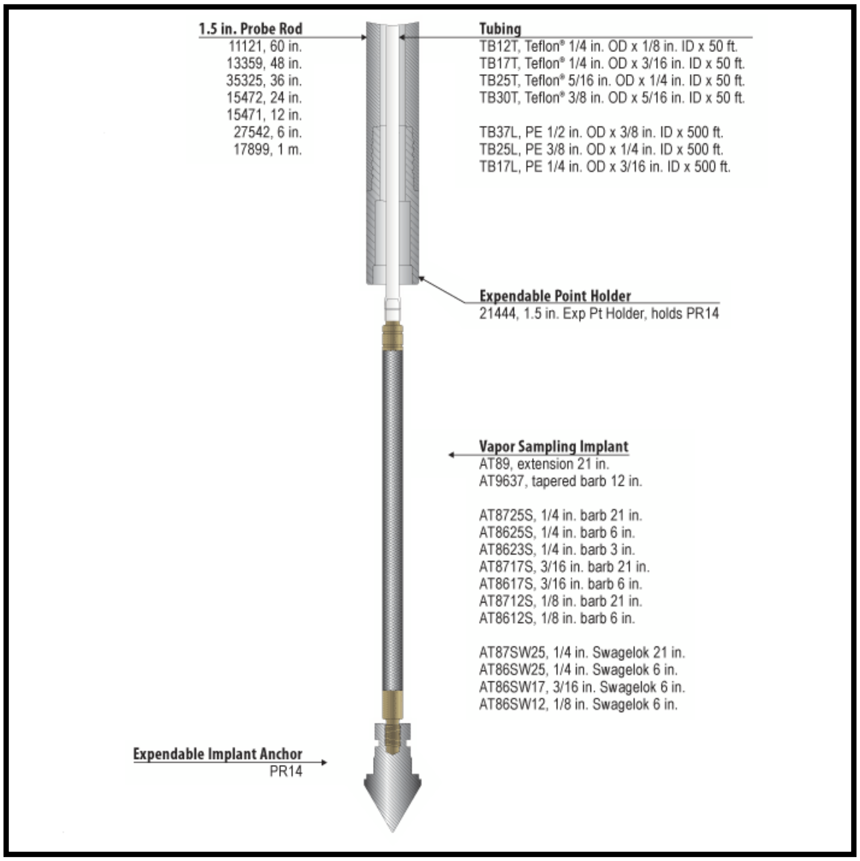
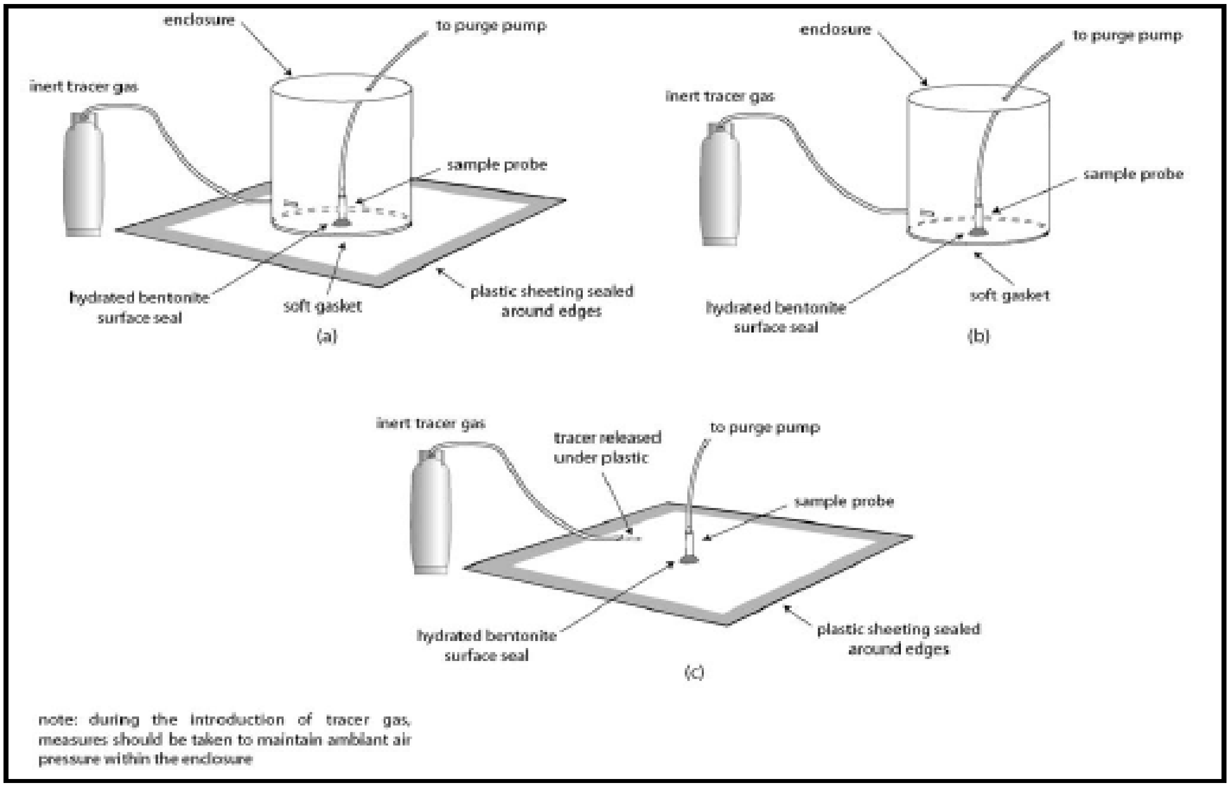
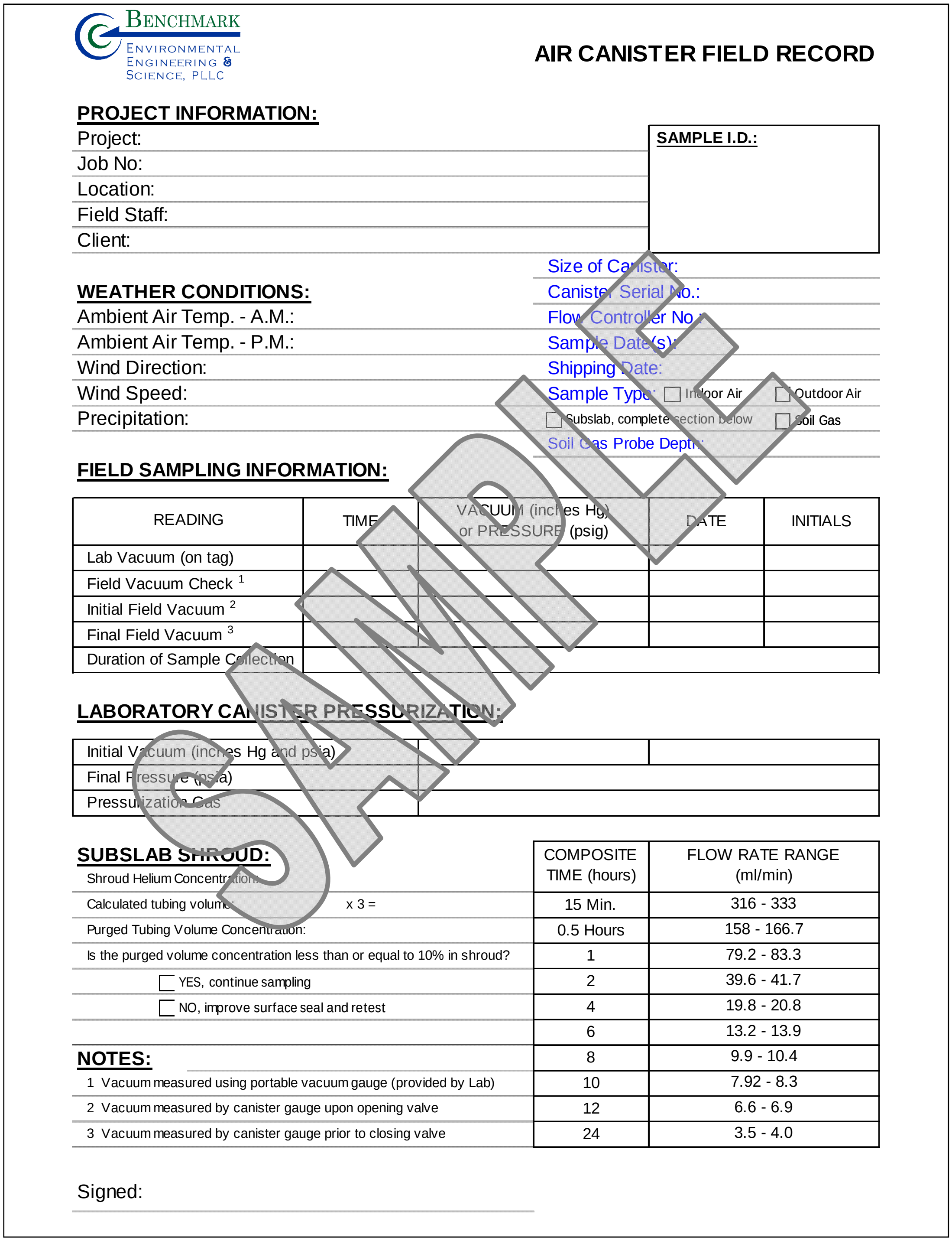


FIGURE 6

Schematics of tracer gas applications



note: during the introduction of tracer gas, measures should be taken to maintain ambiant air pressure within the enclosure



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project:
Job No:
Location:
Field Staff:
Client:

SAMPLE I.D.:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:
Ambient Air Temp. - P.M.:
Wind Direction:
Wind Speed:
Precipitation:

Size of Canister:
Canister Serial No.:
Flow Controller No.:
Sample Date(s):
Shipping Date:
Sample Type: ☐ Indoor Air ☐ Outdoor Air
☐ Subslab, complete section below ☐ Soil Gas
Soil Gas Probe Depth:

FIELD SAMPLING INFORMATION:

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check [1]				
Initial Field Vacuum [2]				
Final Field Vacuum [3]				
Duration of Sample Collection				

LABORATORY CANISTER PRESSURIZATION:

Initial Vacuum (inches Hg and psia)		
Final Pressure (psia)		
Pressurization Gas		

SUBSLAB SHROUD:

Shroud Helium Concentration:
Calculated tubing volume: x 3 =
Purged Tubing Volume Concentration:
Is the purged volume concentration less than or equal to 10% in shroud?
☐ YES, continue sampling
☐ NO, improve surface seal and retest

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

1 Vacuum measured using portable vacuum gauge (provided by Lab)
2 Vacuum measured by canister gauge upon opening valve
3 Vacuum measured by canister gauge prior to closing valve

Signed:

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY

Project Name: Project No.
Project Location: Client:
Preparer's Name: Date/Time:
Preparer's Affiliation: Phone No:
Purpose of Investigation:

1. OCCUPANT:
Interviewed: yes no
Last Name: First Name:
Address:
County:
Home Phone: Office Phone:
Number of Occupants/persons at this location: Age of Occupants:

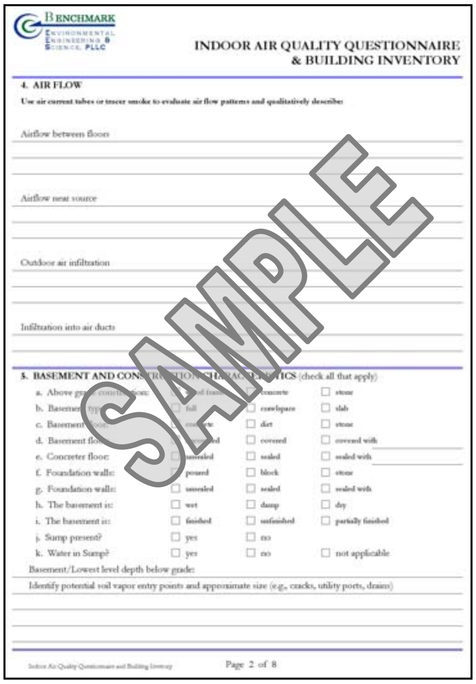
2. OWNER OR LANDLORD: (check if same as occupant ____)
Interviewed: yes no
Last Name: First Name:
Address:
County:
Home Phone: Office Phone:

3. BUILDING CHARACTERISTICS
Type of Building: (check appropriate response)
☐ Residential ☐ School ☐ Commercial/Multi-use
☐ Industrial ☐ Church ☐ Other:

If the property is residential, type? (check appropriate response)
☐ Ranch ☐ 2-Family ☐ 3-Family
☐ Raised Ranch ☐ Split Level ☐ Colonial
☐ Cape Cod ☐ Contemporary ☐ Mobile Home
☐ Duplex ☐ Apartment House ☐ Townhouse/Condo
☐ Modular ☐ Log Home ☐ Other:

If multiple units, how many?
If the property is commercial, type?
Business Type(s):
Does it include residences (i.e., multi-use)? yes no If yes, how many?
Other Characteristics:
Number of floors Building age
Is the building insulated? yes no How air tight? tight average not tight

Indoor Air Quality Questionnaire and Building Inventory Page 1 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY

4. AIR FLOW
Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:

Airflow between floors

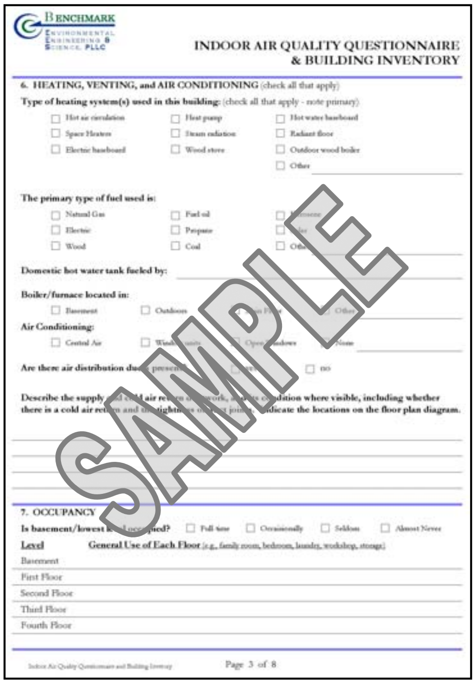
Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (check all that apply)
a. Above grade construction: ☐ wood frame ☐ concrete ☐ stone
b. Basement type: ☐ full ☐ crawlspace ☐ slab
c. Basement floor: ☐ concrete ☐ dirt ☐ stone
d. Basement floor: ☐ uncovered ☐ covered ☐ covered with
e. Concrete floor: ☐ unsealed ☐ sealed ☐ sealed with
f. Foundation walls: ☐ poured ☐ block ☐ stone
g. Foundation walls: ☐ unsealed ☐ sealed ☐ sealed with
h. The basement is: ☐ wet ☐ damp ☐ dry
i. The basement is: ☐ finished ☐ unfinished ☐ partially finished
j. Sump present? ☐ yes ☐ no
k. Water in Sump? ☐ yes ☐ no ☐ not applicable
Basement/Lowest level depth below grade:
Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Indoor Air Quality Questionnaire and Building Inventory Page 2 of 8



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY

6. HEATING, VENTING, and AIR CONDITIONING (check all that apply)
Type of heating system(s) used in this building: (check all that apply - note primary)
☐ Hot air circulation ☐ Heat pump ☐ Hot water baseboard
☐ Space Heaters ☐ Steam radiation ☐ Radiant floor
☐ Electric baseboard ☐ Wood stove ☐ Outdoor wood boiler
☐ Other

The primary type of fuel used is:
☐ Natural Gas ☐ Fuel oil ☐ Kerosene
☐ Electric ☐ Propane ☐ Solar
☐ Wood ☐ Coal ☐ Other

Domestic hot water tank fueled by:

Boiler/furnace located in:
☐ Basement ☐ Outdoors ☐ Main Floor ☐ Other

Air Conditioning:
☐ Central Air ☐ Window units ☐ Open Windows ☐ None

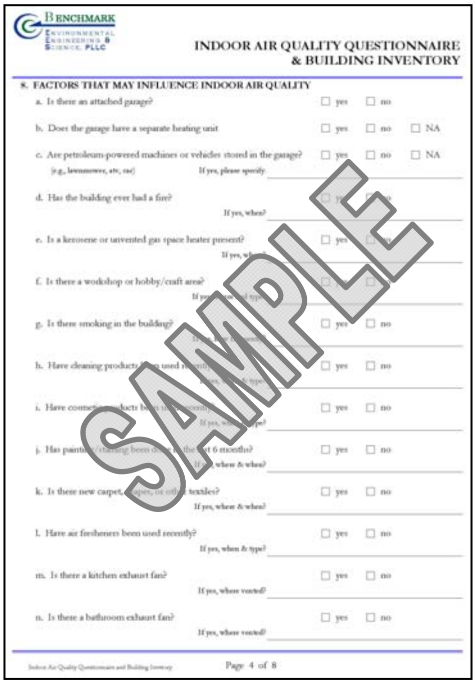
Are there air distribution ducts present? ☐ yes ☐ no

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY
Is basement/lowest level occupied? ☐ Full time ☐ Occasionally ☐ Seldom ☐ Almost Never

Level **General Use of Each Floor** (e.g., family room, bedroom, laundry, workshop, storage)
Basement
First Floor
Second Floor
Third Floor
Fourth Floor

Indoor Air Quality Questionnaire and Building Inventory Page 3 of 8

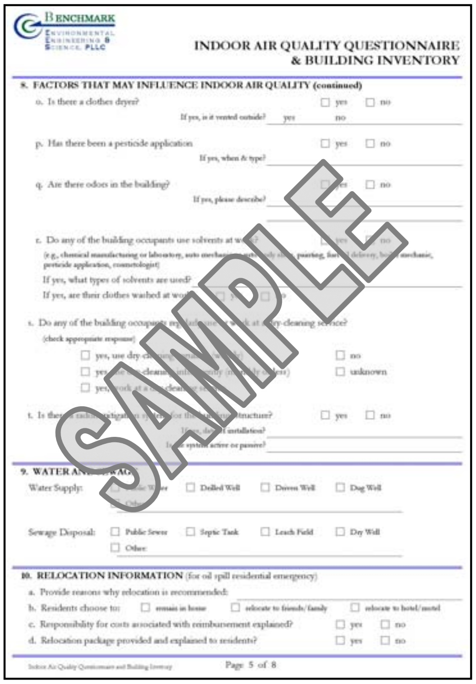


BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY
a. Is there an attached garage? ☐ yes ☐ no
b. Does the garage have a separate heating unit ☐ yes ☐ no ☐ NA
c. Are petroleum-powered machines or vehicles stored in the garage? ☐ yes ☐ no ☐ NA
(e.g., lawnmower, atv, car) If yes, please specify
d. Has the building ever had a fire? ☐ yes ☐ no
If yes, when?
e. Is a kerosene or unvented gas space heater present? ☐ yes ☐ no
If yes, where?
f. Is there a workshop or hobby/craft area? ☐ yes ☐ no
If yes, where and type?
g. Is there smoking in the building? ☐ yes ☐ no
If yes, how frequently?
h. Have cleaning products been used recently? ☐ yes ☐ no
If yes, when & type?
i. Have cosmetic products been used recently? ☐ yes ☐ no
If yes, when & type?
j. Has painting/staining been done in the last 6 months? ☐ yes ☐ no
If yes, where & when?
k. Is there new carpet, drapes, or other textiles? ☐ yes ☐ no
If yes, where & when?
l. Have air fresheners been used recently? ☐ yes ☐ no
If yes, when & type?
m. Is there a kitchen exhaust fan? ☐ yes ☐ no
If yes, where vented?
n. Is there a bathroom exhaust fan? ☐ yes ☐ no
If yes, where vented?

Indoor Air Quality Questionnaire and Building Inventory Page 4 of 8



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**INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY**

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY (continued)

o. Is there a clothes dryer? ☐ yes ☐ no
If yes, is it vented outside? yes no

p. Has there been a pesticide application ☐ yes ☐ no
If yes, when & type? ______

q. Are there odors in the building? ☐ yes ☐ no
If yes, please describe? ______

r. Do any of the building occupants use solvents at work? ☐ yes ☐ no
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)
If yes, what types of solvents are used? ______
If yes, are their clothes washed at work? ☐ yes ☐ no

s. Do any of the building occupants regularly use or work at a dry-cleaning service?
(check appropriate response)
☐ yes, use dry-cleaning regularly (weekly) ☐ no
☐ yes, use dry-cleaning infrequently (monthly or less) ☐ unknown
☐ yes, work at a dry-cleaning service

t. Is there a radon mitigation system for the building/structure? ☐ yes ☐ no
If yes, date of installation? ______
Is the system active or passive? ______

9. WATER AND SEWAGE

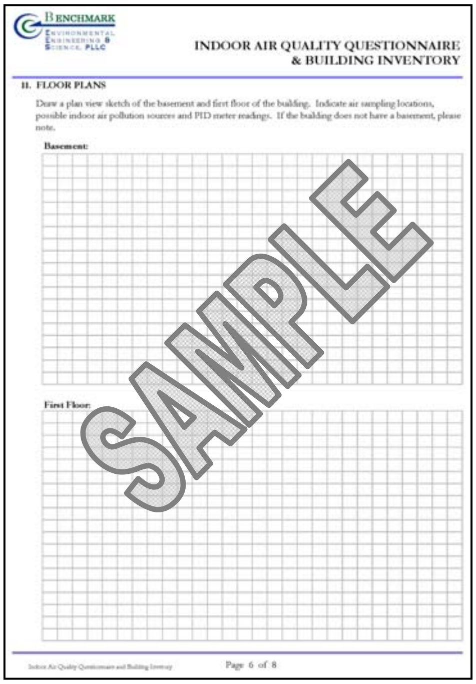
Water Supply: ☐ Public Water ☐ Drilled Well ☐ Driven Well ☐ Dug Well ☐ Other: ______

Sewage Disposal: ☐ Public Sewer ☐ Septic Tank ☐ Leach Field ☐ Dry Well ☐ Other: ______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: ______
b. Residents choose to: ☐ remain in home ☐ relocate to friends/family ☐ relocate to hotel/motel
c. Responsibility for costs associated with reimbursement explained? ☐ yes ☐ no
d. Relocation package provided and explained to residents? ☐ yes ☐ no

Indoor Air Quality Questionnaire and Building Inventory Page 5 of 8



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**INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY**

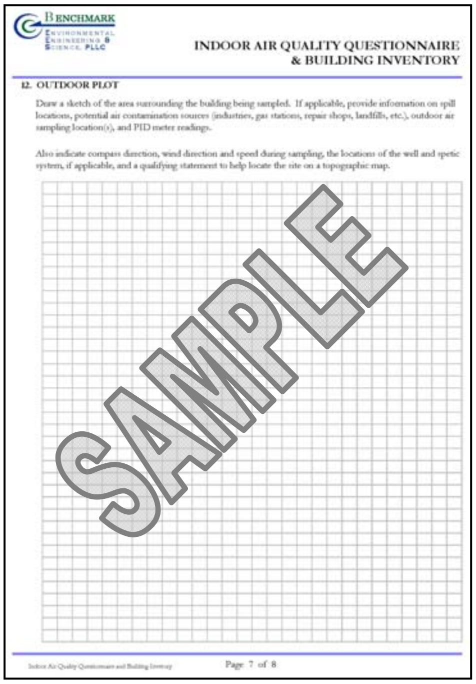
11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

Indoor Air Quality Questionnaire and Building Inventory Page 6 of 8



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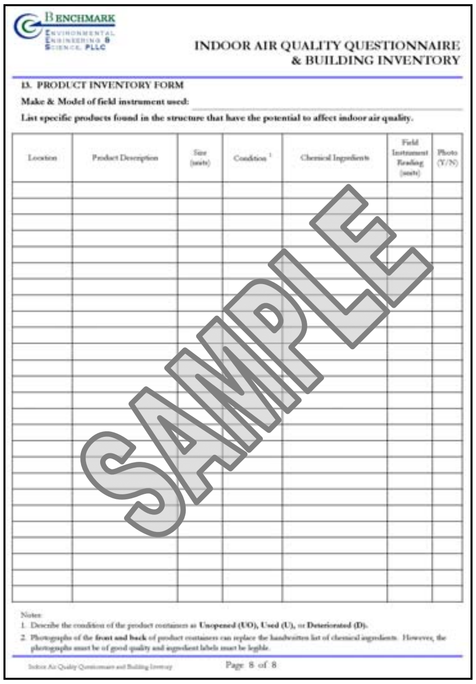
**INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY**

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

Indoor Air Quality Questionnaire and Building Inventory Page 7 of 8



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**INDOOR AIR QUALITY QUESTIONNAIRE
& BUILDING INVENTORY**

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ______

List specific products found in the structure that have the potential to affect indoor air quality.

Location	Product Description	Size (units)	Condition [1]	Chemical Ingredients	Field Instrument Reading (units)	Photo (Y/N)

Notes:
1. Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D).**
2. Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.

Indoor Air Quality Questionnaire and Building Inventory Page 8 of 8

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Dissolved Oxygen Meter

FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

PURPOSE

This guideline describes a method for calibration of a portable dissolved oxygen meter. This meter measures the concentration of dissolved oxygen within a water sample. This parameter is of interest both as a general indicator of water quality, and because of its pertinence to fate and transport of organics and inorganics. This guideline presents a method for calibration of this meter, which is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the dissolved oxygen meter will be within ± 1% of full-scale over the temperature range of 23° to 113° F (-5° to +45° C).

PROCEDURE

1. Calibrate the dissolved oxygen meter to ambient air based on probe temperature and true local atmospheric pressure conditions (or feet above sea level). Because procedures vary with different brands and models of meters, refer to the manufacturer's recommended calibration procedures.

2. In the event of a failure to adequately calibrate, follow the corrective action directed by the manufacturer.
3. If calibration cannot be achieved or maintained, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

4. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration dates of calibration solutions
    - The calibration readings
    - The instrument settings (if applicable)
    - The approximate response time
    - The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Step 5 above) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use or between measurements, the dissolved oxygen probe will be kept immersed in or moist with deionized water.

- The meter batteries will be checked prior to each meter's use and will be replaced when the meter cannot be redline adjusted.

- The meter response time and stability will be tracked to determine the need for instrument maintenance. When response time becomes greater than two minutes, probe service is indicated.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

	METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐	pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
							7.00		
							10.01		
☐	Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
							20		
							100		
							800		
☐	Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐	PID	ppm		Photovac 2020 PID	[illegible]		open air zero		MIBK re factor =
							_____ ppm Iso. Gas		
☐	Particulate meter	mg/m^3					zero air		
☐	Oxygen	%					open air		
☐	Hydrogen sulfide	ppm					open air		
☐	Carbon monoxide	ppm					open air		
☐	LEL	%					open air		
☐	Radiation Meter	uR/[illegible]					background area		
☐									

SAMPLE

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field pH/Eh Meter

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

PURPOSE

This guideline describes a method for calibration of a portable pH/Eh meter. The pH/Eh meter measures the hydrogen ion concentration or acidity of a water sample (pH function), and the oxidation/reduction potential of a water sample (Eh function). Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the pH/Eh meter will be:

pH	± 0.2 pH unit, over the temperature range of ± 0.2 C.
Eh	± 0.2 millivolts (mV) over the range of ± 399.9 mV, otherwise ± 2 mV.

PROCEDURE

Note: Meters produced by different manufacturers may have different calibration procedures. These instructions will take precedence over the procedure provided herein. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

1. Obtain and active the meter to be used. As stated above, initial calibrations will be performed at the beginning of each sampling day.

2. Immerse the sensing probe in a container of certified pH 7.0 buffer solution traceable to the National Bureau of Standards.

3. Measure the temperature of the buffer solution, and adjust the temperature setting accordingly.

4. Compare the meter reading to the known value of the buffer solution while stirring. If the reading obtained by the meter does not agree with the known value of the buffer solution, recalibrate the meter according to the manufacturer's instructions until the desired reading is obtained. This typically involves accessing and turning a dial or adjustment screw while measuring the pH of the buffer solution. The meter is adjusted until the output agrees with the known solution pH.

5. Repeat Steps 2 through 5 with a pH 4.0 and 10.0 buffer solution to provide a three-point calibration. Standards used to calibrate the pH meter will be of concentrations that bracket the expected values of the samples to be analyzed, especially for two-point calibrations (see note below).

Note: Some pH meters only allow two-point calibrations. Two-point calibrations should be within the suspected range of the groundwater to be analyzed. For example, if the groundwater pH is expected to be approximately 8, the two-point calibration should bracket that value. Buffer solutions of 7 and 10 should then be used for the two-point calibration.

6. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:

   - Time, date, and initials of the field team member performing the calibration
   - The unique identifier for the meter, including manufacturer, model, and serial number
   - The brand and expiration dates of buffer solutions
   - The instrument readings
   - The instrument settings (if applicable)

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use, or between measurements, keep the pH/Eh probe immersed in or moist with buffer solutions.

- Check the meter batteries at the end of each day and recharge or replace as needed.

- Replace the pH/Eh probe any time that the meter response time becomes greater than two minutes or the meeting system consistently fails to retain its calibrated accuracy for a minimum of ten sample measurements.

- If a replacement of the pH/Eh probe fails to resolve instrument response time and stability problems, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Date:

Project No.:

Client:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		[illegible] µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID	[illegible]		open air zero		MIBK re factor =
						_____ ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/[illegible]					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field Turbidity Meter

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

PURPOSE

This guideline describes the method for calibration of the HACH 2100P portable field turbidity meter. Turbidity is one water quality parameter measured during purging and development of wells. Turbidity is measured as a function of the samples ability to transmit light, expressed as Nephelometric Turbidity Units (NTUs). The turbidity meter is factory calibrated and must be checked daily prior to using the meter in the field. Calibration is performed to verify instrument accuracy and function. This procedure also documents critical maintenance activities for this meter.

ACCURACY

Accuracy shall be ± 2% of reading below 499 NTU or ± 3% of reading above 500 NTU with resolution to 0.01 NTU in the lowest range. The range key provides for automatic or manual range selection for ranges of 0.00 to 9.99, 0.0 to 99.9 and 0 to 1000 NTU. Another key provides for selecting automatic signal averaging. Pressing the key shall toggle signal averaging on or off.

PROCEDURE

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provides long-term stability and minimizes the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. During calibration, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Note: Meters produced by different manufacturers may have different calibration check procedures. These manufacturers' instructions will take precedence over the procedure provided here. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

Note: Because the turbidity meter measures light transmission, it is critical that the meter and standards be cared for as precision optical instruments. Scratches, dirt, dust, etc. can all temporarily or permanently affect the accuracy of meter readings.

Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3.*

Note: These instructions do not apply to < 0.1 NTU StablCal Standards; < 0.1 NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to re-suspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2 on page 11 of the manual*)

and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3 on page 12 of the manual*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.

Calibration Procedure

1. Turn the meter on.
2. Shake pre-mixed formazin primary standards in accordance with the above procedure.
3. Wipe the outside of the < 0.1 NTU standard and insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
4. Close the lid and press **I/O**.
5. Press the **CAL** button. The **CAL** and **S0** icons will be displayed and the 0 will flash. The four-digit display will show the value of the **S0** standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the right arrow key (→) to get a numerical display.
6. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (*see Section 3.6.2.3 on page 31 of the manual*). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment

Note: The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show "S0 NTU" and the ↑ key must be pressed to continue with the next standard.

7. Repeat steps 1 through 7 for the 20, 100 and 800 standards.

8. Following the 800 NTU standard calibration, the display will increment back to the **S0** display. Remove the sample cell from the cell compartment.

9. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

10. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand of calibration standards
    - The instrument readings
    - The instrument settings (if applicable)
    - Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

Note: Pressing CAL completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after CAL is pressed. If E 1 or E 2 appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If "CAL?" appears, an error may have

occurred during calibration. If "CAL?" is flashing, the instrument is using the default calibration.

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑ , and →keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2)**. To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If "**CAL?"** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

MAINTENANCE

- **Cleaning**: Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1 on page 11of the manual* for more information about sample cell care.

- **Battery Replacement**: AA alkaline cells typically last for about 300 tests with the signal-averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2 on page 5 of the manual* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

- **Lamp Replacement**: The procedure in *Section 4.0 on page 49 of the manual* explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Date:

Project No.:

Client:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		μS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID	[illegible]		open air zero		MIBK re factor =
						_____ ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Photoionization Detector (PID)

FOP 011.1

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

PURPOSE

This procedure describes a general method for the calibration and maintenance of a portable photoionization detector (PID). The PID detects and initially quantifies a reading of the volatile organic compound (VOC) concentration in air. The PID is used as a field-screening tool for initial evaluation of soil samples and for ambient air monitoring of compounds with ionization potentials (IP) less than the PID lamp electron voltage (eV) rating. The IP is the amount of energy required to move an electron to an infinite distance from the nucleus thus creating a positive ion plus an electron. It should be noted that all of the major components of air (i.e., carbon dioxide, methane, nitrogen, oxygen etc.) have IP's above 12 eV. As a result, they will not be ionized by the 9.8, 10.6, or 11.7 eV lamps typically utilized in field PIDs. The response of the PID will then be the sum of the organic and inorganic compounds in air that are ionized by the appropriate lamp (i.e., 9.8, 10.6 or 11.7 eV). Attached to this FOP is a table summarizing common organic compounds and their respective IPs.

Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Compound-specific calibration methods should be selected on a project-by-project basis to increase the accuracy of the instrument. The best way to calibrate a PID to different compounds is to use a standard of the gas of interest. However, correction factors have been determined that enable the user to quantify a large number of chemicals using only a single calibration gas, typically isobutylene. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the MiniRAE 2000 Portable VOC Monitor equipped with a 10.6 eV lamp. The actual equipment to be used in the field will be equivalent or similar. The following information is provided for general reference; the equipment-specific manufacturer's manual should be followed with precedence over this FOP.

Note: The PID indicates <u>total</u> VOC concentration readings that are normalized to a calibration standard, so actual quantification of individual compounds is not provided. In addition, the PID response to compounds is highly variable, dependent on ionization potential of the compound, and the presence or absence of other compounds.

ACCURACY

The MiniRAE 2000 is accurate to ± 2 ppm or 10% of the reading for concentrations ranging from 0-2,000 ppm and ± 20% of the reading at concentrations greater than 2,000 ppm. Response time is less than two seconds to 90 percent of full-scale. The operating temperature range is 0 to 45° C and the operating humidity range is 0 to 95 % relative humidity (non-condensing).

CALIBRATION PROCEDURE

The calibration method and correction factor, if applicable, will be selected on a project-by-project basis and confirmed with the Project Manager prior to the start of field work.

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the PID according to the manufacture's specifications.

2. Calibrate the PID using a compressed gas cylinder or equivalent containing the calibration standard, a flow regulator, and a tubing assembly. In addition, a compressed gas cylinder containing zero air ("clean" air) may be required if ambient air conditions do not permit calibration to "clean air".

3. Fill two Tedlar® bags equipped with a one-way valve with zero-air (if applicable) and the calibration standard gas.

4. Assemble the calibration equipment and actuate the PID in its calibration mode.

5. Select the appropriate calibration method. Calibration may be completed with two methods: 1) where the calibration standard gas is the same as the measurement gas (no correction factor is applied) or 2) where the calibration standard gas is not the same as the measurement gas and a correction factor will be applied. An isobutylene standard gas must be used as the calibration standard gas for the use of correction factors with the MiniRAE 2000. See below for additional instructions for calibration specific to use with or without correction factors.

Calibrating Without a Correction Factor

Navigate within the menu to select the "cal memory" for the specific calibration standard gas prior to calibration. The default gas selections for the MiniRAE 2000 are as follows:

Cal Memory #0	Isobutylene
Cal Memory #1	Hexane
Cal Memory #2	Xylene
Cal Memory #3	Benzene
Cal Memory #4	Styrene
Cal Memory #5	Toluene
Cal Memory #6	Vinyl Chloride
Cal Memory #7	Custom

The calibration standard gas for Cal Memory #1-7 may be toggled for selection of any of the approximately 100 preprogrammed calibration standard gases for use without an applied correction factor (i.e., the calibration gas must be the same as the measurement gas).

Calibrating With a Correction Factor

Navigate within the menu to select the "Cal Memory".

Select "Cal Memory #0" and toggle for selection of any of the approximately 100 preprogrammed chemicals. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected chemical and applies the correction factor.

If the pre-programmed list does not include the desired chemical or a user-defined measurement gas and correction factor is desired, toggle Cal Memory #0 to "user defined custom gas". A list of approximately 300 correction factors is attached in Technical Note 106 generated by MiniRAE.

6. Once the PID settings have been verified, connect the PID probe to the zero air calibration bag (or calibrate to ambient air if conditions permit) and wait for a stable indication.

7. Connect the PID probe to the calibration standard bag. Measure an initial reading of the standard and wait for a stable indication.

8. Keep the PID probe connected to the calibration standard bag, calibrate to applicable concentration (typically 100 ppm with isobutylene) with the standard and wait for a stable indication.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish

maintenance schedules and component replacement. Information will include, at a minimum:

- Time, date and initials of the field team member performing the calibration
- The unique identifier for the meter, including manufacturer, model, and serial number
- The calibration standard and concentration
- Correction factors used, if any
- The brand and expiration date of the calibration standard gas
- The instrument readings: before and after calibration
- The instrument settings (if applicable)
- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

- The probe and dust filter of the PID should be checked before and after every use for cleanliness. Should instrument response become unstable, recalibration should be performed. If this does not resolve the problem, access the photoionization bulb and clean with the manufacturer-supplied abrasive compound, then recalibrate.

- The PID battery must be recharged after each use. Store the PID in its carrying case when not in use. Additional maintenance details related to individual components of the PID are provided in the equipment manufacturer's instruction manual. If calibration or instrument performance is not in accordance with specifications, send the instrument to the equipment manufacturer for repair.

- Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Table 1; Summary of Ionization Potentials
Equipment Calibration Log (sample)
Technical Note TN-106

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
A		
2-Amino pyridine	8	
Acetaldehyde	10.21	
Acetamide	9.77	
Acetic acid	10.69	X
Acetic anhydride	10	
Acetone	9.69	
Acetonitrile	12.2	X
Acetophenone	9.27	
Acetyl bromide	10.55	
Acetyl chloride	11.02	X
Acetylene	11.41	X
Acrolein	10.1	
Acrylamide	9.5	
Acrylonitrile	10.91	X
Allyl alcohol	9.67	
Allyl chloride	9.9	
Ammonia	10.2	
Aniline	7.7	
Anisidine	7.44	
Anisole	8.22	
Arsine	9.89	
B		
1,3-Butadiene (butadiene)	9.07	
1-Bromo-2-chloroethane	10.63	X
1-Bromo-2-methylpropane	10.09	
1-Bromo-4-fluorobenzene	8.99	
1-Bromobutane	10.13	
1-Bromopentane	10.1	
1-Bromopropane	10.18	
1-Bromopropene	9.3	
1-Butanethiol	9.14	
1-Butene	9.58	
1-Butyne	10.18	
2,3-Butadione	9.23	
2-Bromo-2-methylpropane	9.89	
2-Bromobutane	9.98	
2-Bromopropane	10.08	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Bromothiophene	8.63	
2-Butanone (MEK)	9.54	
3-Bromopropene	9.7	
3-Butene nitrile	10.39	
Benzaldehyde	9.53	
Benzene	9.25	
Benzenethiol	8.33	
Benzonitrile	9.71	
Benzotrifluoride	9.68	
Biphenyl	8.27	
Boron oxide	13.5	X
Boron trifluoride	15.56	X
Bromine	10.54	
Bromobenzene	8.98	
Bromochloromethane	10.77	X
Bromoform	10.48	
Butane	10.63	X
Butyl mercaptan	9.15	
cis-2-Butene	9.13	
m-Bromotoluene	8.81	
n-Butyl acetate	10.01	
n-Butyl alcohol	10.04	
n-Butyl amine	8.71	
n-Butyl benzene	8.69	
n-Butyl formate	10.5	
n-Butyraldehyde	9.86	
n-Butyric acid	10.16	
n-Butyronitrile	11.67	X
o-Bromotoluene	8.79	
p-Bromotoluene	8.67	
p-tert-Butyltoluene	8.28	
s-Butyl amine	8.7	
s-Butyl benzene	8.68	
sec-Butyl acetate	9.91	
t-Butyl amine	8.64	
t-Butyl benzene	8.68	
trans-2-Butene	9.13	
C		

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
1-Chloro-2-methylpropane	10.66	X
1-Chloro-3-fluorobenzene	9.21	
1-Chlorobutane	10.67	X
1-Chloropropane	10.82	X
2-Chloro-2-methylpropane	10.61	X
2-Chlorobutane	10.65	X
2-Chloropropane	10.78	X
2-Chlorothiophene	8.68	
3-Chloropropene	10.04	
Camphor	8.76	
Carbon dioxide	13.79	X
Carbon disulfide	10.07	
Carbon monoxide	14.01	X
Carbon tetrachloride	11.47	X
Chlorine	11.48	X
Chlorine dioxide	10.36	
Chlorine trifluoride	12.65	X
Chloroacetaldehyde	10.61	X
α -Chloroacetophenone	9.44	
Chlorobenzene	9.07	
Chlorobromomethane	10.77	X
Chlorofluoromethane (Freon 22)	12.45	X
Chloroform	11.37	X
Chlorotrifluoromethane (Freon 13)	12.91	X
Chrysene	7.59	
Cresol	8.14	
Crotonaldehyde	9.73	
Cumene (isopropyl benzene)	8.75	
Cyanogen	13.8	X
Cyclohexane	9.8	
Cyclohexanol	9.75	
Cyclohexanone	9.14	
Cyclohexene	8.95	
Cyclo-octatetraene	7.99	
Cyclopentadiene	8.56	
Cyclopentane	10.53	
Cyclopentanone	9.26	
Cyclopentene	9.01	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Cyclopropane	10.06	
m-Chlorotoluene	8.83	
o-Chlorotoluene	8.83	
p-Chlorotoluene	8.7	
D		
1,1-Dibromoethane	10.19	
1,1-Dichloroethane	11.12	X
1,1-Dimethoxyethane	9.65	
1,1-Dimethylhydrazine	7.28	
1,2-Dibromoethene	9.45	
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	12.2	X
1,2-Dichloroethane	11.12	X
1,2-Dichloropropane	10.87	X
1,3-Dibromopropane	10.07	
1,3-Dichloropropane	10.85	X
2,2-Dimethyl butane	10.06	
2,2-Dimethyl propane	10.35	
2,3-Dichloropropene	9.82	
2,3-Dimethyl butane	10.02	
3,3-Dimethyl butanone	9.17	
cis-Dichloroethene	9.65	
Decaborane	9.88	
Diazomethane	9	
Diborane	12	X
Dibromochloromethane	10.59	
Dibromodifluoromethane	11.07	X
Dibromomethane	10.49	
Dibutylamine	7.69	
Dichlorodifluoromethane (Freon 12)	12.31	X
Dichlorofluoromethane	12.39	X
Dichloromethane	11.35	X
Diethoxymethane	9.7	
Diethyl amine	8.01	
Diethyl ether	9.53	
Diethyl ketone	9.32	
Diethyl sulfide	8.43	
Diethyl sulfite	9.68	
Difluorodibromomethane	11.07	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Dihydropyran	8.34	
Diiodomethane	9.34	
Diisopropylamine	7.73	
Dimethoxymethane (methylal)	10	
Dimethyl amine	8.24	
Dimethyl ether	10	
Dimethyl sulfide	8.69	
Dimethylaniline	7.13	
Dimethylformamide	9.18	
Dimethylphthalate	9.64	
Dinitrobenzene	10.71	X
Dioxane	9.19	
Diphenyl	7.95	
Dipropyl amine	7.84	
Dipropyl sulfide	8.3	
Durene	8.03	
m-Dichlorobenzene	9.12	
N,N-Diethyl acetamide	8.6	
N,N-Diethyl formamide	8.89	
N,N-Dimethyl acetamide	8.81	
N,N-Dimethyl formamide	9.12	
o-Dichlorobenzene	9.06	
p-Dichlorobenzene	8.95	
p-Dioxane	9.13	
trans-Dichloroethene	9.66	
E		
Epichlorohydrin	10.2	
Ethane	11.65	X
Ethanethiol (ethyl mercaptan)	9.29	
Ethanolamine	8.96	
Ethene	10.52	
Ethyl acetate	10.11	
Ethyl alcohol	10.48	
Ethyl amine	8.86	
Ethyl benzene	8.76	
Ethyl bromide	10.29	
Ethyl chloride (chloroethane)	10.98	X
Ethyl disulfide	8.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Ethyl ether	9.51	
Ethyl formate	10.61	X
Ethyl iodide	9.33	
Ethyl isothiocyanate	9.14	
Ethyl mercaptan	9.29	
Ethyl methyl sulfide	8.55	
Ethyl nitrate	11.22	X
Ethyl propionate	10	
Ethyl thiocyanate	9.89	
Ethylene chlorohydrin	10.52	
Ethylene diamine	8.6	
Ethylene dibromide	10.37	
Ethylene dichloride	11.05	X
Ethylene oxide	10.57	
Ethylenelmine	9.2	
Ethynylbenzene	8.82	
F		
2-Furaldehyde	9.21	
Fluorine	15.7	X
Fluorobenzene	9.2	
Formaldehyde	10.87	X
Formamide	10.25	
Formic acid	11.05	X
Freon 11 (trichlorofluoromethane)	11.77	X
Freon 112 (1,1,2,2-tetrachloro-1,2-difluoroethane)	11.3	X
Freon 113 (1,1,2-trichloro-1,2,2-trifluororethane)	11.78	X
Freon 114 (1,2-dichloro-1,1,2,2-tetrafluoroethane)	12.2	X
Freon 12 (dichlorodifluoromethane)	12.31	X
Freon 13 (chlorotrifluoromethane)	12.91	X
Freon 22 (chlorofluoromethane)	12.45	X
Furan	8.89	
Furfural	9.21	
m-Fluorotoluene	8.92	
o-Fluorophenol	8.66	
o-Fluorotoluene	8.92	
p-Fluorotoluene	8.79	
H		
1-Hexene	9.46	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Heptanone	9.33	
2-Hexanone	9.35	
Heptane	10.08	
Hexachloroethane	11.1	X
Hexane	10.18	
Hydrazine	8.1	
Hydrogen	15.43	X
Hydrogen bromide	11.62	X
Hydrogen chloride	12.74	X
Hydrogen cyanide	13.91	X
Hydrogen fluoride	15.77	X
Hydrogen iodide	10.38	
Hydrogen selenide	9.88	
Hydrogen sulfide	10.46	
Hydrogen telluride	9.14	
Hydroquinone	7.95	
I		
1-Iodo-2-methylpropane	9.18	
1-Iodobutane	9.21	
1-Iodopentane	9.19	
1-Iodopropane	9.26	
2-Iodobutane	9.09	
2-Iodopropane	9.17	
Iodine	9.28	
Iodobenzene	8.73	
Isobutane	10.57	
Isobutyl acetate	9.97	
Isobutyl alcohol	10.12	
Isobutyl amine	8.7	
Isobutyl formate	10.46	
Isobutyraldehyde	9.74	
Isobutyric acid	10.02	
Isopentane	10.32	
Isophorone	9.07	
Isoprene	8.85	
Isopropyl acetate	9.99	
Isopropyl alcohol	10.16	
Isopropyl amine	8.72	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Isopropyl benzene	8.69	
Isopropyl ether	9.2	
Isovaleraldehyde	9.71	
m-Iodotoluene	8.61	
o-Iodotoluene	8.62	
p-Iodotoluene	8.5	
K		
Ketene	9.61	
L		
2,3-Lutidine	8.85	
2,4-Lutidine	8.85	
2,6-Lutidine	8.85	
M		
2-Methyl furan	8.39	
2-Methyl napthalene	7.96	
1-Methyl napthalene	7.96	
2-Methyl propene	9.23	
2-Methyl-1-butene	9.12	
2-Methylpentane	10.12	
3-Methyl-1-butene	9.51	
3-Methyl-2-butene	8.67	
3-Methylpentane	10.08	
4-Methylcyclohexene	8.91	
Maleic anhydride	10.8	X
Mesityl oxide	9.08	
Mesitylene	8.4	
Methane	12.98	X
Methanethiol (methyl mercaptan)	9.44	
Methyl acetate	10.27	
Methyl acetylene	10.37	
Methyl acrylate	9.9	
Methyl alcohol	10.85	X
Methyl amine	8.97	
Methyl bromide	10.54	
Methyl butyl ketone	9.34	
Methyl butyrate	10.07	
Methyl cellosolve	9.6	
Methyl chloride	11.28	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Methyl chloroform (1,1,1-trichloroethane)	11	X
Methyl disulfide	8.46	
Methyl ethyl ketone	9.53	
Methyl formate	10.82	X
Methyl iodide	9.54	
Methyl isobutyl ketone	9.3	
Methyl isobutyrate	9.98	
Methyl isocyanate	10.67	X
Methyl isopropyl ketone	9.32	
Methyl isothiocyanate	9.25	
Methyl mercaptan	9.44	
Methyl methacrylate	9.7	
Methyl propionate	10.15	
Methyl propyl ketone	9.39	
α -Methyl styrene	8.35	
Methyl thiocyanate	10.07	
Methylal (dimethoxymethane)	10	
Methylcyclohexane	9.85	
Methylene chloride	11.32	X
Methyl-n-amyl ketone	9.3	
Monomethyl aniline	7.32	
Monomethyl hydrazine	7.67	
Morpholine	8.2	
n-Methyl acetamide	8.9	
N		
1-Nitropropane	10.88	X
2-Nitropropane	10.71	X
Naphthalene	8.12	
Nickel carbonyl	8.27	
Nitric oxide, (NO)	9.25	
Nitrobenzene	9.92	
Nitroethane	10.88	X
Nitrogen	15.58	X
Nitrogen dioxide	9.78	
Nitrogen trifluoride	12.97	X
Nitromethane	11.08	X
Nitrotoluene	9.45	
p-Nitrochloro benzene	9.96	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
O		
Octane	9.82	
Oxygen	12.08	X
Ozone	12.08	X
P		
1-Pentene	9.5	
1-Propanethiol	9.2	
2,4-Pentanedione	8.87	
2-Pentanone	9.38	
2-Picoline	9.02	
3-Picoline	9.02	
4-Picoline	9.04	
n-Propyl nitrate	11.07	X
Pentaborane	10.4	
Pentane	10.35	
Perchloroethylene	9.32	
Pheneloic	8.18	
Phenol	8.5	
Phenyl ether (diphenyl oxide)	8.82	
Phenyl hydrazine	7.64	
Phenyl isocyanate	8.77	
Phenyl isothiocyanate	8.52	
Phenylene diamine	6.89	
Phosgene	11.77	X
Phosphine	9.87	
Phosphorus trichloride	9.91	
Phthalic anhydride	10	
Propane	11.07	X
Propargyl alcohol	10.51	
Propiolactone	9.7	
Propionaldehyde	9.98	
Propionic acid	10.24	
Propionitrile	11.84	X
Propyl acetate	10.04	
Propyl alcohol	10.2	
Propyl amine	8.78	
Propyl benzene	8.72	
Propyl ether	9.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Propyl formate	10.54	
Propylene	9.73	
Propylene dichloride	10.87	X
Propylene imine	9	
Propylene oxide	10.22	
Propyne	10.36	
Pyridine	9.32	
Pyrrole	8.2	
Q		
Quinone	10.04	
S		
Stibine	9.51	
Styrene	8.47	
Sulfur dioxide	12.3	X
Sulfur hexafluoride	15.33	X
Sulfur monochloride	9.66	
Sulfuryl fluoride	13	X
T		
o-Terphenyls	7.78	
1,1,2,2-Tetrachloro-1,2-difluoroethane (Freon 112)	11.3	X
1,1,1-Trichloroethane	11	X
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	11.78	X
2,2,4-Trimethyl pentane	9.86	
o-Toluidine	7.44	
Tetrachloroethane	11.62	X
Tetrachloroethene	9.32	
Tetrachloromethane	11.47	X
Tetrahydrofuran	9.54	
Tetrahydropyran	9.25	
Thiolacetic acid	10	
Thiophene	8.86	
Toluene	8.82	
Tribromoethene	9.27	
Tribromofluoromethane	10.67	X
Tribromomethane	10.51	
Trichloroethene	9.45	
Trichloroethylene	9.47	
Trichlorofluoromethane (Freon 11)	11.77	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Trichloromethane	11.42	X
Triethylamine	7.5	
Trifluoromonobromo-methane	11.4	X
Trimethyl amine	7.82	
Tripropyl amine	7.23	
V		
o-Vinyl toluene	8.2	
Valeraldehyde	9.82	
Valeric acid	10.12	
Vinyl acetate	9.19	
Vinyl bromide	9.8	
Vinyl chloride	10	
Vinyl methyl ether	8.93	
W		
Water	12.59	X
X		
2,4-Xylidine	7.65	
m-Xylene	8.56	
o-Xylene	8.56	
p-Xylene	8.45	

EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name: ______________________ Date: ______________________

Project No.: ______________________

Client: ______________________ Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	POST CAL. READING	SETTINGS
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	9706000145		< 0.4		
						[illegible]		
						[illegible]		
						800		
☐ Sp. Cond. meter	uS mS		Myron L Company Ultra Meter 6P	[illegible]		_______ mS @ 25 ^{o}C		
☐ PID	ppm		MinRAE 20			open air zero		MIBK response factor = 1.0
						_____ ppm Iso. Gas		
☐ Dissolved Oxygen	ppm		YSI Model 5	[illegible]				
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								

ADDITIONAL REMARKS: ______________________

____

PREPARED BY: ______________________ **DATE:** ______________________

Technical Note TN-106

Revised 08/2010

Correction Factors, Ionization Energies*, And Calibration Characteristics

Correction Factors and Ionization Energies

RAE Systems PIDs can be used for the detection of a wide variety of gases that exhibit different responses. In general, any compound with ionization energy (IE) lower than that of the lamp photons can be measured.* The best way to calibrate a PID to different compounds is to use a standard of the gas of interest. However, correction factors have been determined that enable the user to quantify a large number of chemicals using only a single calibration gas, typically isobutylene. In our PIDs, correction factors can be used in one of three ways:

1) Calibrate the monitor with isobutylene in the usual fashion to read in isobutylene equivalents. Manually multiply the reading by the correction factor (CF) to obtain the concentration of the gas being measured.

2) Calibrate the unit with isobutylene in the usual fashion to read in isobutylene equivalents. Call up the correction factor from the instrument memory or download it from a personal computer and then call it up. The monitor will then read directly in units of the gas of interest.

3) Calibrate the unit with isobutylene, but input an equivalent, "corrected" span gas concentration when prompted for this value. The unit will then read directly in units of the gas of interest.

* *The term “ionization energy” is more scientifically correct and replaces the old term “ionization potential.” High-boiling (“heavy”) compounds may not vaporize enough to give a response even when their ionization energies are below the lamp photon energy. Some inorganic compounds like* H_2O_2 *and* NO_2 *give weak response even when their ionization energies are well below the lamp photon energy.*

Example 1:

With the unit calibrated to read isobutylene equivalents, the reading is 10 ppm with a 10.6 eV lamp. The gas being measured is butyl acetate, which has a correction factor of 2.6. Multiplying 10 by 2.6 gives an adjusted butyl acetate value of 26 ppm. Similarly, if the gas being measured were trichloroethylene (CF = 0.54), the adjusted value with a 10 ppm reading would be 5.4 ppm.

Example 2:

With the unit calibrated to read isobutylene equivalents, the reading is 100 ppm with a 10.6 eV lamp. The gas measured is m-xylene (CF = 0.43). After downloading this factor, the unit should read about 43 ppm when exposed to the same gas, and thus read directly in m-xylene values.

Example 3:

The desired gas to measure is ethylene dichloride (EDC). The CF is 0.6 with an 11.7 eV lamp. During calibration with 100 ppm isobutylene, insert 0.6 times 100, or 60 at the prompt for the calibration gas concentration. The unit then reads directly in EDC values.

Conversion to mg/m^3

To convert from ppm to mg/m^3, use the following formula:

$$\text{Conc. (mg/m}^3\text{)} = \frac{\text{[Conc.(ppmv) x mol. wt. (g/mole)]}}{\text{molar gas volume (L)}}$$

For air at 25 °C (77 °F), the molar gas volume is 24.4 L/mole and the formula reduces to:

$$\text{Conc.(mg/m}^3\text{)} = \text{Conc.(ppmv) x mol. wt. (g/mole) x } 0.041$$

For example, if the instrument is calibrated with a gas standard in ppmv, such as 100 ppm isobutylene, and the user wants the display to read in mg/m^3 of hexane, whose m.w. is 86 and CF is 4.3, the overall correction factor would be 4.3 x 86 x 0.041 equals 15.2.

Correction Factors for Mixtures

The correction factor for a mixture is calculated from the sum of the mole fractions Xi of each component divided by their respective correction factors CFi:

$$\text{CFmix} = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + \ldots Xi/CFi)$$

Thus, for example, a vapor phase mixture of 5% benzene and 95% n-hexane would have a CFmix of CFmix = 1 / (0.05/0.53 + 0.95/4.3) = 3.2. A reading of 100 would then correspond to 320 ppm of the total mixture, comprised of 16 ppm benzene and 304 ppm hexane.

For a spreadsheet to compute the correction factor and TLV of a mixture see the appendix at the end of the CF table.

TLVs and Alarm Limits for Mixtures

The correction factor for mixtures can be used to set alarm limits for mixtures. To do this one first needs to calculate the exposure limit for the mixture. The Threshold Limit Value (TLV) often defines exposure limits. The TLV for the mixture is calculated in a manner similar to the CF calculation:

$$\text{TLV mix} = 1 / (X_1/\text{TLV}_1 + X_2/\text{TLV}_2 + X_3/\text{TLV}_3 + \ldots X_i/\text{TLV}_i)$$

In the above example, the 8-h TLV for benzene is 0.5 ppm and for n-hexane 50 ppm. Therefore the TLV of the mixture is TLVmix = 1 / (0.05/0.5 + 0.95/50) = 8.4 ppm, corresponding to 8.0 ppm hexane and 0.4 ppm benzene. For an instrument calibrated on isobutylene, the reading corrsponding to the TLV is:

$$\text{Alarm Reading} = \text{TLVmix} / \text{CFmix} = 8.4 / 3.2 = 2.6 \text{ ppm}$$

A common practice is to set the lower alarm limit to half the TLV, and the higher limit to the TLV. Thus, one would set the alarms to 1.3 and 2.6 ppm, respectively.

Calibration Characteristics

a) Flow Configuration. PID response is essentially independent of gas flow rate as long as it is sufficient to satisfy the pump demand. Four main flow configurations are used for calibrating a PID:

1) **Pressurized gas cylinder (Fixed-flow regulator):** The flow rate of the regulator should match the flow demand of the instrument pump or be slightly higher.
2) **Pressurized gas cylinder (Demand-flow regulator):** A demand-flow regulator better matches pump speed differences, but results in a slight vacuum during calibration and thus slightly high readings.
3) **Collapsible gas bag:** The instrument will draw the calibration gas from the bag at its normal flow rate, as long as the bag valve is large enough. The bag should be filled with enough gas to allow at least one minute of flow (~ 0.6 L for a MiniRAE, ~0.3 L for MultiRAE).
4) **T (or open tube) method:** The T method uses a T-junction with gas flow higher than the pump draw. The gas supply is connected to one end of the T, the instrument inlet is connected to a second end of the T, and excess gas flow escapes through the third, open end of the T. To prevent ambient air mixing, a long tube should be connected to the open end, or a high excess rate should be used. Alternatively, the instrument probe can be inserted into an open tube slightly wider than the probe. Excess gas flows out around the probe.

The first two cylinder methods are the most efficient in terms of gas usage, while the bag and T methods give slightly more accurate results because they match the pump flow better.

b) Pressure. Pressures deviating from atmospheric pressure affect the readings by altering gas concentration and pump characteristics. It is best to calibrate with the instrument and calibration gas at the same pressure as each other and the sample gas. (Note that the cylinder pressure is not relevant because the regulator reduces the pressure to ambient.) If the instrument is calibrated at atmospheric pressure in one of the flow configurations described above, then 1) pressures slightly above ambient are acceptable but high pressures can damage the pump and 2) samples under vacuum may give low readings if air leaks into the sample train.

c) Temperature. Because temperature effects gas density and concentration, the temperature of the calibration gas and instrument should be as close as possible to the ambient temperature where the unit will be used. We recommend that the temperature of the calibration gas be within the instrument's temperature specification (typically 14° to 113° F or -10° to 45° C). Also, during actual measurements, the instrument should be kept at the same or higher temperature than the sample temperature to avoid condensation in the unit.

d) Matrix. The matrix gas of the calibration compound and VOC sample is significant. Some common matrix components, such as methane and water vapor can affect the VOC signal. PIDs are most commonly used for monitoring VOCs in air, in which case the preferred calibration gas matrix is air. For a MiniRAE, methane, methanol, and water vapor reduce the response by about 20% when their concentration is 15,000 ppm and by about 40% at 30,000 ppm. Despite earlier reports of oxygen effects, RAE PID responses with 10.6 eV lamps are independent of oxygen concentration, and calibration gases in a pure nitrogen matrix can be used. H_2 and CO_2 up to 5 volume % also have no effect.

e) Concentration. Although RAE Systems PIDs have electronically linearized output, it is best to calibrate in a concentration range close to the actual measurement range. For example, 100 ppm standard gas for anticipated vapors of 0 to 250 ppm, and 500 ppm standard for expected concentrations of 250 to 1000 ppm. The correction factors in this table were typically measured at 50 to 100 ppm and apply from the ppb range up to about 1000 ppm. Above 1000 ppm the CF may vary and it is best to calibrate with the gas of interest near the concentration of interest.

f) Filters. Filters affect flow and pressure conditions and therefore all filters to be used during sampling should also be in place during calibration. Using a water trap (hydrophobic filter) greatly reduces the chances of drawing water aerosols or dirt particles into the instrument. Regular filter replacements are recommended because dirty filters can adsorb VOCs and cause slower response time and shifts in calibration.

g) Instrument Design. High-boiling (“heavy”) or very reactive compounds can be lost by reaction or adsorption onto materials in the gas sample train, such as filters, pumps and other sensors. Multi-gas meters, including EntryRAE, MultiRAE and AreaRAE have the pump and other sensors upstream of the PID and are prone to these losses. Compounds possibly affected by such losses are shown in green in the table, and may give slow response, or in extreme cases, no response at all. In many cases the multi-gas meters can still give a rough indication of the relative concentration, without giving an accurate, quantitative reading. The ppbRAE and MiniRAE series instruments have inert sample trains and therefore do not exhibit significant loss; nevertheless, response may be slow for the very heavy compounds and additional sampling time up to a minute or more should be allowed to get a stable reading.

Table Abbreviations:

CF = Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutylene)
NR= No Response
IE = Ionization Energy (values in parentheses are not well established)
C = Confirmed Value indicated by “+” in this column; all others are preliminary or estimated values and are subject to change
ne = Not Established ACGIH 8-hr. TWA
C## = Ceiling value, given where 8-hr.TWA is not available

Disclaimer:

Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors. For accurate work, the instrument should be calibrated regularly under the operating conditions used. The factors in this table were measured in dry air at room temperature, typically at 50-100 ppm. CF values may vary above about 1000 ppm.

Updates:

The values in this table are subject to change as more or better data become available. Watch for updates of this table on the Internet at **http://www.raesystems.com**

IE data are taken from the CRC Handbook of Chemistry and Physics, 73rd Edition, D.R. Lide (Ed.), CRC Press (1993) and NIST Standard Ref. Database 19A, NIST Positive Ion Energetics, Vers. 2.0, Lias, et.al., U.S. Dept. Commerce (1993). Exposure limits (8-h TWA and Ceiling Values) are from the 2005 ACGIH Guide to Occupational Exposure Values, ACGIH, Cincinnati, OH 2005. Equations for exposure limits for mixtures of chemicals were taken from the 1997 TLVs and BEIs handbook published by the ACGIH (1997).

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Acetaldehyde		75-07-0	C_2H_4O	NR	+	6	+	3.3	+	10.23	C25
Acetic acid	Ethanoic Acid	64-19-7	$C_2H_4O_2$	NR	+	22	+	2.6	+	10.66	10
Acetic anhydride	Ethanoic Acid Anhydride	108-24-7	$C_4H_6O_3$	NR	+	6.1	+	2.0	+	10.14	5
Acetone	2-Propanone	67-64-1	C_3H_6O	1.2	+	1.1	+	1.4	+	9.71	500
Acetone cyanohydrin	2-Hydroxyisobutyronitrile	75-86-5	C_4H_7NO					4	+	11.1	C5
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C_2H_3N					100		12.19	40
Acetylene	Ethyne	74-86-2	C_2H_2					2.1	+	11.40	ne
Acrolein	Propenal	107-02-8	C_3H_4O	42	+	3.9	+	1.4	+	10.10	0.1
Acrylic acid	Propenoic Acid	79-10-7	$C_3H_4O_2$			12	+	2.0	+	10.60	2
Acrylonitrile	Propenenitrile	107-13-1	C_3H_3N			NR	+	1.2	+	10.91	2
Allyl alcohol		107-18-6	C_3H_6O	4.5	+	2.4	+	1.6	+	9.67	2
Allyl chloride	3-Chloropropene	107-05-1	C_3H_5Cl			4.3		0.7		9.9	1
Ammonia		7664-41-7	H_3N	NR	+	9.7	+	5.7	+	10.16	25
Amyl acetate	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	$C_7H_{14}O_2$	11	+	2.3	+	0.95	+	<9.9	100
Amyl alcohol	1-Pentanol	75-85-4	$C_5H_{12}O$			5		1.6		10.00	ne
Aniline	Aminobenzene	62-53-3	C_7H_7N	0.50	+	0.48	+	0.47	+	7.72	2
Anisole	Methoxybenzene	100-66-3	C_7H_8O	0.89	+	0.58	+	0.56	+	8.21	ne
Arsine	Arsenic trihydride	7784-42-1	AsH_3			1.9	+			9.89	0.05
Benzaldehyde		100-52-7	C_7H_6O					1		9.49	ne
Benzenamine, N-methyl-	N-Methylphenylamine	100-61-8	C_7H_9N			0.7				7.53	
Benzene		71-43-2	C_6H_6	0.55	+	0.53	+	0.6	+	9.25	0.5
Benzonitrile	Cyanobenzene	100-47-0	C_7H_5N			1.6				9.62	ne
Benzyl alcohol	α-Hydroxytoluene, Hydroxymethylbenzene, Benzenemethanol	100-51-6	C_7H_8O	1.4	+	1.1	+	0.9	+	8.26	ne
Benzyl chloride	α-Chlorotoluene, Chloromethylbenzene	100-44-7	C_7H_7Cl	0.7	+	0.6	+	0.5	+	9.14	1
Benzyl formate	Formic acid benzyl ester	104-57-4	$C_8H_8O_2$	0.9	+	0.73	+	0.66	+		ne
Boron trifluoride		7637-07-2	BF_3	NR		NR		NR		15.5	C1
Bromine		7726-95-6	Br_2	NR	+	1.30	+	0.74	+	10.51	0.1
Bromobenzene		108-86-1	C_6H_5Br			0.6		0.5		8.98	ne
2-Bromoethyl methyl ether		6482-24-2	C_3H_7OBr			0.84	+			~10	ne
Bromoform	Tribromomethane	75-25-2	$CHBr_3$	NR	+	2.5	+	0.5	+	10.48	0.5
Bromopropane,1-	n-Propyl bromide	106-94-5	C_3H_7Br	150	+	1.5	+	0.6	+	10.18	ne
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C_4H_6	0.8		0.85	+	1.1		9.07	2
Butadiene diepoxide, 1,3-	1,2,3,4-Diepoxybutane	298-18-0	$C_4H_6O_2$	25	+	3.5	+	1.2		~10	ne
Butanal	1-Butanal	123-72-8	C_4H_8O			1.8				9.84	
Butane		106-97-8	C_4H_{10}			67	+	1.2		10.53	800
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	$C_4H_{10}O$	70	+	4.7	+	1.4	+	9.99	20
Butanol, t-	tert-Butanol, t-Butyl alcohol	75-65-0	$C_4H_{10}O$	6.9	+	2.9	+			9.90	100
Butene, 1-	1-Butylene	106-98-9	C_4H_8			0.9				9.58	ne
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	$C_6H_{14}O_2$	1.8	+	1.2	+	0.6	+	<10	25
Butoxyethanol acetate	Ethanol, 2-(2-butoxyethoxy)-, acetate	124-17-4	$C_{10}H_{20}O_4$			5.6				≤10.6	
Butoxyethoxyethanol	2-(2-Butoxyethoxy)ethanol	112-34-5	$C_8H_{18}O_3$			4.6				≤10.6	
Butyl acetate, n-		123-86-4	$C_6H_{12}O_2$			2.6	+			10	150
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	$C_7H_{12}O_2$			1.6	+	0.6	+		10
Butylamine, n-		109-73-9	$C_4H_{11}N$	1.1	+	1.1	+	0.7	+	8.71	C5
Butyl cellosolve	see 2-Butoxyethanol	111-76-2									
Butyl hydroperoxide, t-		75-91-2	$C_4H_{10}O_2$	2.0	+	1.6	+			<10	1
Butyl mercaptan	1-Butanethiol	109-79-5	$C_4H_{10}S$	0.55	+	0.52	+			9.14	0.5
Carbon disulfide		75-15-0	CS_2	4	+	1.2	+	0.44		10.07	10
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl_4	NR	+	NR	+	1.7	+	11.47	5
Carbonyl sulfide	Carbon oxysulfide	463-58-1	COS							11.18	
Cellosolve see 2-Ethoxyethanol											
CFC-14 see Tetrafluoromethane											
CFC-113 see 1,1,2-Trichloro-1,2,2-trifluoroethane											

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Chlorine		7782-50-5	Cl_2					1.0	+	11.48	0.5
Chlorine dioxide		10049-04-4	ClO_2	NR	+	NR	+	NR	+	10.57	0.1
Chlorobenzene	Monochlorobenzene	108-90-7	C_6H_5Cl	0.44	+	0.40	+	0.39	+	9.06	10
Chlorobenzotrifluoride, 4-	PCBTF, OXSOL 100 p-Chlorobenzotrifluoride	98-56-6	$C_7H_4ClF_3$	0.74	+	0.63	+	0.55	+	<9.6	25
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C_4H_5Cl			3					10
Chloro-1,1-difluoroethane, 1-	HCFC-142B, R-142B	75-68-3	$C_2H_3ClF_2$	NR		NR		NR		12.0	ne
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	$CHClF_2$	NR		NR		NR		12.2	1000
Chloroethane	Ethyl chloride	75-00-3	C_2H_5Cl	NR	+	NR	+	1.1	+	10.97	100
Chloroethanol	Ethylene chlrohydrin	107-07-3	C_2H_5ClO					2.9		10.52	C1
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	$C_4H_8Cl_2O$	8.6	+	3.0	+				5
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C_3H_7ClO			3					ne
Chloroform	Trichloromethane	67-66-3	$CHCl_3$	NR	+	NR	+	3.5	+	11.37	10
Chloro-2-methylpropene, 3-	Methallyl chloride, Isobutenyl chloride	563-47-3	C_4H_7Cl	1.4	+	1.2	+	0.63	+	9.76	ne
Chloropicrin		76-06-2	CCl_3NO_2	NR	+	~400	+	7	+	?	0.1
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C_7H_7Cl			0.5		0.6		8.83	50
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C_7H_7Cl					0.6		8.69	ne
Chlorotrifluoroethene	CTFE, Chlorotrifluoroethylene Genetron 1113	79-38-9	C_2ClF_3	6.7	+	3.9	+	1.2	+	9.76	5
Chlorotrimethylsilane		75-77-4	C_3H_9ClSi	NR		NR		0.82	+	10.83	ne
Cresol, m-	m-Hydroxytoluene	108-39-4	C_7H_8O	0.57	+	0.50	+	0.57	+	8.29	5
Cresol, o-	o-Hydroxytoluene	95-48-7	C_7H_8O			1.0				8.50	
Cresol, p-	p-Hydroxytoluene	106-44-5	C_7H_8O			1.4				8.35	
Crotonaldehyde	*trans*-2-Butenal	123-73-9 4170-30-3	C_4H_6O	1.5	+	1.1	+	1.0	+	9.73	2
Cumene	Isopropylbenzene	98-82-8	C_9H_{12}	0.58	+	0.54	+	0.4	+	8.73	50
Cyanogen bromide		506-68-3	$CNBr$	NR		NR		NR		11.84	ne
Cyanogen chloride		506-77-4	$CNCl$	NR		NR		NR		12.34	C0.3
Cyclohexane		110-82-7	C_6H_{12}	3.3	+	1.4	+	0.64	+	9.86	300
Cyclohexanol	Cyclohexyl alcohol	108-93-0	$C_6H_{12}O$	1.5	+	0.9	+	1.1	+	9.75	50
Cyclohexanone		108-94-1	$C_6H_{10}O$	1.0	+	0.9	+	0.7	+	9.14	25
Cyclohexene		110-83-8	C_6H_{10}			0.8	+			8.95	300
Cyclohexylamine		108-91-8	$C_6H_{13}N$			1.2				8.62	10
Cyclopentane 85% 2,2-dimethylbutane 15%		287-92-3	C_5H_{10}	NR	+	15	+	1.1		10.33	600
Cyclopropylamine	Aminocyclpropane	765-30-0	C_3H_7N	1.1	+	0.9	+	0.9	+		ne
Decamethylcyclopentasiloxane		541-02-6	$C_{10}H_{30}O_5Si_5$	0.16	+	0.13	+	0.12	+		ne
Decamethyltetrasiloxane		141-62-8	$C_{10}H_{30}O_3Si_4$	0.17	+	0.13	+	0.12	+	<10.2	ne
Decane		124-18-5	$C_{10}H_{22}$	4.0	+	1.4	+	0.35	+	9.65	ne
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	$C_6H_{12}O_2$			0.7					50
Dibromochloromethane	Chlorodibromomethane	124-48-1	$CHBr_2Cl$	NR	+	5.3	+	0.7	+	10.59	ne
Dibromo-3-chloropropane, 1,2-	DBCP	96-12-8	$C_3H_5Br_2Cl$	NR	+	1.7	+	0.43	+		0.001
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	$C_2H_4Br_2$	NR	+	1.7	+	0.6	+	10.37	ne
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	$C_6H_4Cl_2$	0.54	+	0.47	+	0.38	+	9.08	25
Dichlorodifluoromethane	CFC-12	75-71-8	CCl_2F_2			NR	+	NR	+	11.75	1000
Dichlorodimethylsilane		75-78-5	$C_2H_6Cl_2Si$	NR		NR		1.1	+	>10.7	ne
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	$C_2H_4Cl_2$			NR	+	0.6	+	11.04	10
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	$C_2H_2Cl_2$			0.82	+	0.8	+	9.79	5
Dichloroethene, c-1,2-	*c*-1,2-DCE, *cis*-Dichloroethylene	156-59-2	$C_2H_2Cl_2$			0.8				9.66	200
Dichloroethene, t-1,2-	*t*-1,2-DCE, *trans*-Dichloroethylene	156-60-5	$C_2H_2Cl_2$			0.45	+	0.34	+	9.65	200
Dichloro-1-fluoroethane, 1,1-	R-141B	1717-00-6	$C_2H_3Cl_2F$	NR	+	NR	+	2.0	+		ne
Dichloromethane	see Methylene chloride										

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Dichloropentafluoropropane	AK-225, mix of ~45% 3,3-dichloro-1,1,1,2,2-pentafluoro-propane (HCFC-225ca) & ~55% 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	442-56-0 507-55-1	$C_3HCl_2F_5$	NR	+	NR	+	25	+		ne
Dichloropropane, 1,2-		78-87-5	$C_3H_6Cl_2$					0.7		10.87	75
Dichloro-1-propene, 1,3-		542-75-6	$C_3H_4C_{12}$	1.3	+	0.96	+			<10	1
Dichloro-1-propene, 2,3-		78-88-6	$C_3H_4Cl_2$	1.9	+	1.3	+	0.7	+	<10	ne
Dichloro-1,1,1-trifluoroethane, 2,2-	R-123	306-83-2	$C_2HCl_2F_3$	NR	+	NR	+	10.1	+	11.5	ne
Dichloro-2,4,6-trifluoropyridine, 3,5-	DCTFP	1737-93-5	$C_5Cl_2F_3N$	1.1	+	0.9	+	0.8	+		ne
Dichlorvos *	Vapona; O,O-dimethyl O-dichlorovinyl phosphate	62-73-7	$C_4H_7Cl_2O_4P$			0.9	+			<9.4	0.1
Dicyclopentadiene	DCPD, Cyclopentadiene dimer	77-73-6	$C_{10}H_{12}$	0.57	+	0.48	+	0.43	+	8.8	5
Diesel Fuel		68334-30-5	m.w. 226			0.9	+				11
Diesel Fuel #2 (Automotive)		68334-30-5	m.w. 216	1.3		0.7	+	0.4	+		11
Diethylamine		109-89-7	$C_4H_{11}N$			1	+			8.01	5
Diethylaminopropylamine, 3-		104-78-9	$C_7H_{18}N_2$			1.3					ne
Diethylbenzene	See Dowtherm J										
Diethylmaleate		141-05-9	$C_8H_{12}O_4$			4					ne
Diethyl sulfide	see Ethyl sulfide										
Diglyme	See Methoxyethyl ether	111-96-6	$C_6H_{14}O_3$								
Diisobutyl ketone	DIBK, 2,2-dimethyl-4-heptanone	108-83-8	$C_9H_{18}O$	0.71	+	0.61	+	0.35	+	9.04	25
Diisopropylamine		108-18-9	$C_6H_{15}N$	0.84	+	0.74	+	0.5	+	7.73	5
Diketene	Ketene dimer	674-82-8	$C_4H_4O_2$	2.6	+	2.0	+	1.4	+	9.6	0.5
Dimethylacetamide, N,N-	DMA	127-19-5	C_4H_9NO	0.87	+	0.8	+	0.8	+	8.81	10
Dimethylamine		124-40-3	C_2H_7N			1.5				8.23	5
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	$C_3H_6O_3$	NR	+	~70	+	1.7	+	~10.5	ne
Dimethyl disulfide	DMDS	624-92-0	$C_2H_6S_2$	0.2	+	0.20	+	0.21	+	7.4	ne
Dimethyl ether	see Methyl ether										
Dimethylethylamine	DMEA	598-56-1	$C_4H_{11}N$	1.1	+	1.0	+	0.9	+	7.74	~3
Dimethylformamide, N,N-	DMF	68-12-2	C_3H_7NO	0.7	+	0.7	+	0.8	+	9.13	10
Dimethylhydrazine, 1,1-	UDMH	57-14-7	$C_2H_8N_2$			0.8	+	0.8	+	7.28	0.01
Dimethyl methylphosphonate	DMMP, methyl phosphonic acid dimethyl ester	756-79-6	$C_3H_9O_3P$	NR	+	4.3	+	0.74	+	10.0	ne
Dimethyl sulfate		77-78-1	$C_2H_6O_4S$	~23		~20	+	2.3	+		0.1
Dimethyl sulfide	see Methyl sulfide										
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C_2H_6OS			1.4	+			9.10	ne
Dioxane, 1,4-		123-91-1	$C_4H_8O_2$			1.3				9.19	25
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	$C_3H_6O_2$	4.0	+	2.3	+	1.6	+	9.9	20
Dowtherm A see Therminol® *											
Dowtherm J (97% Diethylbenzene) *		25340-17-4	$C_{10}H_{14}$			0.5					
DS-108F Wipe Solvent	Ethyl lactate/Isopar H/ Propoxypropanol ~7:2:1	97-64-3 64742-48-9 1569-01-3	m.w. 118	3.3	+	1.6	+	0.7	+		ne
Epichlorohydrin	ECH Chloromethyloxirane, 1-chloro2,3-epoxypropane	106-89-8	C_2H_5ClO	~200	+	8.5	+	1.4	+	10.2	0.5
Ethane		74-84-0	C_2H_6			NR	+	15	+	11.52	ne
Ethanol	Ethyl alcohol	64-17-5	C_2H_6O			10	+	3.1	+	10.47	1000
Ethanolamine *	MEA, Monoethanolamine	141-43-5	C_2H_7NO	5.6	+	1.6	+			8.96	3
Ethene	Ethylene	74-85-1	C_2H_4			9	+	4.5	+	10.51	ne
Ethoxyethanol, 2-	Ethyl cellosolve	110-80-5	$C_4H_{10}O_2$			1.3				9.6	5
Ethyl acetate		141-78-6	$C_4H_8O_2$			4.6	+	3.5		10.01	400
Ethyl acetoacetate		141-97-9	$C_6H_{10}O_3$	1.4	+	1.2	+	1.0	+	<10	ne
Ethyl acrylate		140-88-5	$C_5H_8O_2$			2.4	+	1.0	+	<10.3	5
Ethylamine		75-04-7	C_2H_7N			0.8				8.86	5

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (Ev)	TWA
Ethylbenzene		100-41-4	C_8H_{10}	0.52	+	0.52	+	0.51	+	8.77	100
Ethyl caprylate	Ethyl octanoate	106-32-1	$C_{10}H_{20}O_2$		+	0.52	+	0.51	+		
Ethylenediamine	1,2-Ethanediamine; 1,2-Diaminoethane	107-15-3	$C_2H_8N_2$	0.9	+	0.8	+	1.0	+	8.6	10
Ethylene glycol *	1,2-Ethanediol	107-21-1	$C_2H_6O_2$			16	+	6	+	10.16	C100
Ethylene glycol, Acrylate	2-hydroxyethyl Acrylate	818-61-1	$C_5H_8O_3$			8.2				≤10.6	
Ethylene glycol dimethyl ether	1,2-Dimethoxyethane, Monoglyme	110-71-4	$C_4H_{10}O_2$	1.1		0.86		0.7		9.2	ne
Ethylene glycol monobutyl ether acetate	2-Butoxyethyl acetate	112-07-2	$C_8H_{16}O_3$			1.3				≤10.6	
Ethylene glycol, monothio	mercapto-2-ethanol	60-24-2	C_2H_6OS			1.5				9.65	
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C_2H_4O			13	+	3.5	+	10.57	1
Ethyl ether	Diethyl ether	60-29-7	$C_4H_{10}O$			1.1	+	1.7		9.51	400
Ethyl 3-ethoxypropionate	EEP	763-69-9	$C_7H_{14}O_3$	1.2	+	0.75	+				ne
Ethyl formate		109-94-4	$C_3H_6O_2$					1.9		10.61	100
Ethylhexyl acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	$C_{11}H_{20}O_2$			1.1	+	0.5	+		ne
Ethylhexanol	2-Ethyl-1-hexanol	104-76-7	$C_8H_{18}O$			1.9				≤10.6	
Ethylidenenorbornene	5-Ethylidene bicyclo(2,2,1)hept-2-ene	16219-75-3	C_9H_{12}	0.4	+	0.39	+	0.34	+	≤8.8	ne
Ethyl (S)-(-)-lactate see also DS-108F	Ethyl lactate, Ethyl (S)-(-)-hydroxypropionate	687-47-8 97-64-3	$C_5H_{10}O_3$	13	+	3.2	+	1.6	+	~10	ne
Ethyl mercaptan	Ethanethiol	75-08-1	C_2H_6S	0.60	+	0.56	+			9.29	0.5
Ethyl sulfide	Diethyl sulfide	352-93-2	$C_4H_{10}S$			0.5	+			8.43	ne
Formaldehyde	Formalin	50-00-0	CH_2O	NR	+	NR	+	1.6	+	10.87	C0.3
Formamide		75-12-7	CH_3NO			6.9	+	4		10.16	10
Formic acid		64-18-6	CH_2O_2	NR	+	NR	+	9	+	11.33	5
Furfural	2-Furaldehyde	98-01-1	$C_5H_4O_2$			0.92	+	0.8	+	9.21	2
Furfuryl alcohol		98-00-0	$C_5H_6O_2$			0.80	+			<9.5	10
Gasoline #1		8006-61-9	m.w. 72			0.9	+				300
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	+	1.0	+	0.5	+		300
Glutaraldehyde	1,5-Pentanedial, Glutaric dialdehyde	111-30-8	$C_5H_8O_2$	1.1	+	0.8	+	0.6	+		C0.05
Glycidyl methacrylate	2,3-Epoxypropyl methacrylate	106-91-2	$C_7H_{10}O_3$	2.6	+	1.2	+	0.9	+		0.5
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	$C_2HBrClF_3$					0.6		11.0	50
HCFC-22 see Chlorodifluoromethane											
HCFC-123 see 2,2-Dichloro-1,1,1-trifluoroethane											
HCFC-141B see 1,1-Dichloro-1-fluoroethane											
HCFC-142B see 1-Chloro-1,1-difluoroethane											
HCFC-134A see 1,1,1,2-Tetrafluoroethane											
HCFC-225 see Dichloropentafluoropropane											
Heptane, n-		142-82-5	C_7H_{16}	45	+	2.8	+	0.60	+	9.92	400
Heptanol, 4-	Dipropylcarbinol	589-55-9	$C_7H_{16}O$	1.8	+	1.3	+	0.5	+	9.61	ne
Hexamethyldisilazane, 1,1,1,3,3,3- *	HMDS	999-97-3	$C_6H_{19}NSi_2$			0.2	+	0.2	+	~8.6	ne
Hexamethyldisiloxane	HMDSx	107-46-0	$C_6H_{18}OSi_2$	0.33	+	0.27	+	0.25	+	9.64	ne
Hexane, n-		110-54-3	C_6H_{14}	350	+	4.3	+	0.54	+	10.13	50
Hexanol, 1-	Hexyl alcohol	111-27-3	$C_6H_{14}O$	9	+	2.5	+	0.55	+	9.89	ne
Hexene, 1-		592-41-6	C_6H_{12}			0.8				9.44	30
HFE-7100 see Methyl nonafluorobutyl ether											
Histoclear (Histo-Clear)	Limonene/corn oil reagent		m.w. ~136	0.5	+	0.4	+	0.3	+		ne
Hydrazine *		302-01-2	H_4N_2	>8	+	2.6	+	2.1	+	8.1	0.01
Hydrazoic acid	Hydrogen azide		HN_3							10.7	
Hydrogen	Synthesis gas	1333-74-0	H_2	NR	+	NR	+	NR	+	15.43	ne
Hydrogen cyanide	Hydrocyanic acid	74-90-8	HCN	NR	+	NR	+	NR	+	13.6	C4.7
Hydrogen iodide *	Hydriodic acid	10034-85-2	HI			~0.6*				10.39	
Hydrogen peroxide		7722-84-1	H_2O_2	NR	+	NR	+	NR	+	10.54	1
Hydrogen sulfide		7783-06-4	H_2S	NR	+	3.3	+	1.5	+	10.45	10
Hydroxypropyl methacrylate		27813-02-1 923-26-2	$C_7H_{12}O_3$	9.9	+	2.3	+	1.1	+		ne
Iodine *		7553-56-2	I_2	0.1	+	0.1	+	0.1	+	9.40	C0.1

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Iodomethane	Methyl iodide	74-88-4	CH_3I	0.21	+	0.22	+	0.26	+	9.54	2
Isoamyl acetate	Isopentyl acetate	123-92-2	$C_7H_{14}O_2$	10.1		2.1		1.0		<10	100
Isobutane	2-Methylpropane	75-28-5	C_4H_{10}			100	+	1.2	+	10.57	ne
Isobutanol	2-Methyl-1-propanol	78-83-1	$C_4H_{10}O$	19	+	3.8	+	1.5		10.02	50
Isobutene	Isobutylene, Methyl butene	115-11-7	C_4H_8	1.00	+	1.00	+	1.00	+	9.24	Ne
Isobutyl acrylate	Isobutyl 2-propenoate	106-63-8	$C_7H_{12}O_2$			1.5	+	0.60	+		Ne
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether, forane	26675-46-7	$C_3H_2ClF_5O$	NR	+	NR	+	48	+	~11.7	Ne
Isooctane	2,2,4-Trimethylpentane	540-84-1	C8H18			1.2				9.86	ne
Isopar E Solvent	Isoparaffinic hydrocarbons	64741-66-8	m.w. 121	1.7	+	0.8	+				Ne
Isopar G Solvent	Photocopier diluent	64742-48-9	m.w. 148			0.8	+				Ne
Isopar K Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 156	0.9	+	0.5	+	0.27	+		Ne
Isopar L Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 163	0.9	+	0.5	+	0.28	+		Ne
Isopar M Solvent	Isoparaffinic hydrocarbons	64742-47-8	m.w. 191			0.7	+	0.4	+		Ne
Isopentane	2-Methylbutane	78-78-4	C_5H_{12}			8.2					Ne
Isophorone		78-59-1	$C_9H_{14}O$					3		9.07	C5
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C_5H_8	0.69	+	0.63	+	0.60	+	8.85	Ne
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C_3H_8O	500	+	6.0	+	2.7		10.12	200
Isopropyl acetate		108-21-4	$C_5H_{10}O_2$			2.6				9.99	100
Isopropyl ether	Diisopropyl ether	108-20-3	$C_6H_{14}O$			0.8				9.20	250
Jet fuel JP-4	Jet B, Turbo B, F-40 Wide cut type aviation fuel	8008-20-6 + 64741-42-0	m.w. 115			1.0	+	0.4	+		Ne
Jet fuel JP-5	Jet 5, F-44, Kerosene type aviation fuel	8008-20-6 + 64747-77-1	m.w. 167			0.6	+	0.5	+		29
Jet fuel JP-8	Jet A-1, F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 165			0.6	+	0.3	+		30
Jet fuel A-1 (JP-8)	F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 145			0.67					34
Jet Fuel TS	Thermally Stable Jet Fuel, Hydrotreated kerosene fuel	8008-20-6 + 64742-47-8	m.w. 165	0.9	+	0.6	+	0.3	+		30
Limonene, D-	(R)-(+)-Limonene	5989-27-5	$C_{10}H_{16}$			0.33	+			~8.2	Ne
Kerosene C10-C16 petro.distillate – see Jet Fuels		8008-20-6									
MDI – see 4,4'-Methylenebis(phenylisocyanate)											
Maleic anhydride	2,5-Furandione	108-31-6	$C_4H_2O_3$							~10.8	0.1
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C_9H_{12}	0.36	+	0.35	+	0.3	+	8.41	25
Methallyl chloride – see 3-Chloro-2-methylpropene											
Methane	Natural gas	74-82-8	CH_4	NR	+	NR	+	NR	+	12.61	Ne
Methanol	Methyl alcohol, carbinol	67-56-1	CH_4O	NR	+	NR	+	2.5	+	10.85	200
Methoxyethanol, 2-	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	$C_3H_8O_2$	4.8	+	2.4	+	1.4	+	10.1	5
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy)ethanol Diethylene glycol monomethyl ether	111-77-3	$C_7H_{16}O$	2.3	+	1.2	+	0.9	+	<10	Ne
Methoxyethyl ether, 2-	bis(2-Methoxyethyl) ether, Diethylene glycol dimethyl ether, Diglyme	111-96-6	$C_6H_{14}O_3$	0.64	+	0.54	+	0.44	+	<9.8	Ne
Methyl acetate		79-20-9	$C_3H_6O_2$	NR	+	6.6	+	1.4	+	10.27	200
Methyl acrylate	Methyl 2-propenoate, Acrylic acid methyl ester	96-33-3	$C_4H_6O_2$			3.7	+	1.2	+	(9.9)	2
Methylamine	Aminomethane	74-89-5	CH_5N			1.2				8.97	5
Methyl amyl ketone	MAK, 2-Heptanone, Methyl pentyl ketone	110-43-0	$C_7H_{14}O$	0.9	+	0.85	+	0.5	+	9.30	50
Methyl bromide	Bromomethane	74-83-9	CH_3Br	110	+	1.7	+	1.3	+	10.54	1
Methyl t-butyl ether	MTBE, *tert*-Butyl methyl ether	1634-04-4	$C_5H_{12}O$			0.9	+			9.24	40
Methyl cellosolve	see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH_3Cl	NR	+	NR	+	0.74	+	11.22	50
Methylcyclohexane		107-87-2	C_7H_{14}	1.6	+	0.97	+	0.53	+	9.64	400
Methylene bis(phenyl-isocyanate), 4,4'- *	MDI, Mondur M		$C_{15}H_{10}N_2O_2$	Very slow ppb level response							0.005

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Methylene chloride	Dichloromethane	75-09-2	CH_2Cl_2	NR	+	NR	+	0.89	+	11.32	25
Methyl ether	Dimethyl ether	115-10-6	C_2H_6O	4.8	+	3.1	+	2.5	+	10.03	Ne
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3	C_4H_8O	0.86	+	0.9	+	1.1	+	9.51	200
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	$C_2H_6N_2$	1.4	+	1.2	+	1.3	+	7.7	0.01
Methyl isoamyl ketone	MIAK, 5-Methyl-2-hexanone	110-12-3	$C_7H_{14}O$	0.8	+	0.76	+	0.5	+	9.28	50
Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	$C_6H_{12}O$	0.9	+	0.8	+	0.6	+	9.30	50
Methyl isocyanate	CH3NCO	624-83-9	C_2H_3NO	NR	+	4.6	+	1.5		10.67	0.02
Methyl isothiocyanate	CH3NCS	551-61-6	C_2H_3NS	0.5	+	0.45	+	0.4	+	9.25	ne
Methyl mercaptan	Methanethiol	74-93-1	CH_4S	0.65		0.54		0.66		9.44	0.5
Methyl methacrylate		80-62-6	$C_5H_8O_2$	2.7	+	1.5	+	1.2	+	9.7	100
Methyl nonafluorobutyl ether	HFE-7100DL	163702-08-7, 163702-07-6	$C_5H_3F_9O$			NR	+	~35	+		ne
Methyl-1,5-pentanediamine, 2- (coats lamp) *	Dytek-A amine, 2-Methyl pentamethylenediamine	15520-10-2	C6H16N2			~0.6	+			<9.0	ne
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	$C_5H_{12}O$			0.93	+	0.79	+	9.38	200
Methyl-2-pyrrolidinone, N-	NMP, N-Methylpyrrolidone, 1-Methyl-2-pyrrolidinone, 1-Methyl-2-pyrrolidone	872-50-4	C_5H_9NO	1.0	+	0.8	+	0.9	+	*9.17*	ne
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C_8H_8O3	1.3	+	0.9	+	0.9	+	~9	ne
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C_9H_{10}			0.5				8.18	50
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C_2H_6S	0.49	+	0.44	+	0.46	+	8.69	ne
Mineral spirits	Stoddard Solvent, Varsol 1, White Spirits	8020-83-5 8052-41-3 68551-17-7	m.w. 144	1.0		0.69	+	0.38	+		100
Mineral Spirits - Viscor 120B Calibration Fluid, b.p. 156-207°C		8052-41-3	m.w. 142	1.0	+	0.7	+	0.3	+		100
Monoethanolamine - see Ethanolamine											
Mustard *	HD, Bis(2-chloroethyl) sulfide	505-60-2 39472-40-7 68157-62-0	$C_4H_8Cl_2S$			0.6					0.0005
Naphtha - see VM & P Naptha											
Naphthalene	Mothballs	91-20-3	$C_{10}H_8$	0.45	+	0.42	+	0.40	+	8.13	10
Nickel carbonyl (in CO)	Nickel tetracarbonyl	13463-39-3	C_4NiO_4			0.18				<8.8	0.001
Nicotine		54-11-5	$C_{10}H_{14}N_2$			2.0				≤10.6	
Nitric oxide		10102-43-9	NO	~6		5.2	+	2.8	+	9.26	25
Nitrobenzene		98-95-3	$C_6H_5NO_2$	2.6	+	1.9	+	1.6	+	9.81	1
Nitroethane		79-24-3	$C_2H_5NO_2$					3		10.88	100
Nitrogen dioxide		10102-44-0	NO_2	23	+	16	+	6	+	9.75	3
Nitrogen trifluoride		7783-54-2	NF_3	NR		NR		NR		13.0	10
Nitromethane		75-52-5	CH_3NO_2					4		11.02	20
Nitropropane, 2-		79-46-9	$C_3H_7NO_2$					2.6		10.71	10
Nonane		111-84-2	C_9H_{20}			1.4				9.72	200
Norpar 12	n-Paraffins, mostly C_{10}-C_{13}	64771-72-8	m.w. 161	3.2	+	1.1	+	0.28	+		ne
Norpar 13	n-Paraffins, mostly C_{13}-C_{14}	64771-72-8	m.w. 189	2.7	+	1.0	+	0.3	+		ne
Octamethylcyclotetrasiloxane		556-67-2	$C_8H_{24}O_4Si_4$	0.21	+	0.17	+	0.14	+		ne
Octamethyltrisiloxane		107-51-7	$C_8H_{24}O_2Si_3$	0.23	+	0.18	+	0.17	+	<10.0	ne
Octane, n-		111-65-9	C_8H_{18}	13	+	1.8	+			9.82	300
Octene, 1-		111-66-0	C_8H_{16}	0.9	+	0.75	+	0.4	+	9.43	75
Pentane		109-66-0	C_5H_{12}	80	+	8.4	+	0.7	+	10.35	600
Peracetic acid *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$	NR	+	NR	+	2.3	+		ne
Peracetic/Acetic acid mix *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$			50	+	2.5	+		ne
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C_2Cl_4	0.69	+	0.57	+	0.31	+	9.32	25
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	$C_6H_{12}O_3$	2.4	+	1.5	+	1.1	+		100

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
PGMEA	Propylene glycol methyl ether acetate, 1-Methoxy-2-acetoxypropane, 1-Methoxy-2-propanol acetate	108-65-6	$C_6H_{12}O_3$	1.65	+	1.0	+	0.8	+		ne
Phenol	Hydroxybenzene	108-95-2	C_6H_6O	1.0	+	1.0	+	0.9	+	8.51	5
Phosgene	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	8.5	+	11.2	0.1
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	6.8	+	11.2	0.1
Phosphine (coats lamp)		7803-51-2	PH_3	28		3.9	+	1.1	+	9.87	0.3
Photocopier Toner	Isoparaffin mix					0.5	+	0.3	+		ne
Picoline, 3-	3-Methylpyridine	108-99-6	C_6H_7N			0.9				9.04	ne
Pinene, α-		2437-95-8	$C_{10}H_{16}$			0.31	+	0.47		8.07	ne
Pinene, β-		18172-67-3	$C_{10}H_{16}$	0.38	+	0.37	+	0.37	+	~8	100
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C_5H_8	0.76	+	0.69	+	0.64	+	8.6	100
Propane		74-98-6	C_3H_8			NR	+	1.8	+	10.95	2500
Propanol, n-	Propyl alcohol	71-23-8	C_3H_8O			5		1.7		10.22	200
Propene	Propylene	115-07-1	C_3H_6	1.5	+	1.4	+	1.6	+	9.73	ne
Propionaldehyde	Propanal	123-38-6	C_3H_6O			1.9				9.95	ne
Propyl acetate, n-		109-60-4	$C_5H_{10}O_2$			3.5		2.3		10.04	200
Propylamine, n-	1-Propylamine, 1-Aminopropane	107-10-8	C_3H_9N	1.1	+	1.1	+	0.9	+	8.78	ne
Propylene carbonate *		108-32-7	$C_4H_6O_3$			62	+	1	+	10.5	ne
Propylene glycol	1,2-Propanediol	57-55-6	$C_3H_8O_2$	18		5.5	+	1.6	+	<10.2	ne
Propylene glycol propyl ether	1-Propoxy-2-propanol	1569-01-3	$C_6H_{14}O_2$	1.3	+	1.0	+	1.6	+		ne
Propylene oxide	Methyloxirane	75-56-9 16088-62-3 15448-47-2	C_3H_6O	~240		6.6	+	2.9	+	10.22	20
Propyleneimine	2-Methylaziridine	75-55-8	C_3H_7N	1.5	+	1.3	+	1.0	+	9.0	2
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl mercaptan	75-33-2	C_3H_8S	0.64	+	0.66	+			9.15	ne
Pyridine		110-86-1	C_5H_5N	0.78	+	0.7	+	0.7	+	9.25	5
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C_4H_9N	2.1	+	1.3	+	1.6	+	~8.0	ne
RR7300 (PGME/PGMEA)	70:30 PGME:PGMEA (1-Methoxy-2-propanol:1-Methoxy-2-acetoxypropane)	107-98-2	$C_4H_{10}O_2$ / $C_6H_{12}O_3$			1.4	+	1.0	+		ne
Sarin	GB, Isopropyl methylphosphonofluoridate	107-44-8 50642-23-4	$C_4H_{10}FO_2P$			~3					
Stoddard Solvent - see Mineral Spirits		8020-83-5									
Styrene		100-42-5	C_8H_8	0.45	+	0.40	+	0.4	+	8.43	20
Sulfur dioxide		7446-09-5	SO_2	NR		NR	+	NR	+	12.32	2
Sulfur hexafluoride		2551-62-4	SF_6	NR		NR		NR		15.3	1000
Sulfuryl fluoride	Vikane	2699-79-8	SO_2F_2	NR		NR		NR		13.0	5
Tabun *	Ethyl N, N-dimethylphosphoramidocyanidate	77-81-6	$C_5H_{11}N_2O_2P$			0.8					15ppt
Tetrachloroethane, 1,1,1,2-		630-20-6	$C_2H_2Cl_4$					1.3		~11.1	ne
Tetrachloroethane, 1,1,2,2-		79-34-5	$C_2H_2Cl_4$	NR	+	NR	+	0.60	+	~11.1	1
Tetrachlorosilane		10023-04-7	$SiCl_4$	NR		NR		15	+	11.79	ne
Tetraethyl lead	TEL	78-00-2	$C_8H_{20}Pb$	0.4		0.3		0.2		~11.1	0.008
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	$C_8H_{20}O_4Si$			0.7	+	0.2	+	~9.8	10
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	$C_2H_2F_4$			NR		NR			ne
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C_2F_4			~15				10.12	ne
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF_4			NR	+	NR	+	>15.3	ne
Tetrahydrofuran	THF	109-99-9	C_4H_8O	1.9	+	1.7	+	1.0	+	9.41	200
Tetramethyl orthosilicate	Methyl silicate, TMOS	681-84-5	$C_4H_{12}O_4Si$	10	+	1.9	+			~10	1
Therminol® D-12 *	Hydrotreated heavy naphtha	64742-48-9	m.w. 160	0.8	+	0.51	+	0.33	+		ne
Therminol® VP-1 *	Dowtherm A, 3:1 Diphenyl oxide: Biphenyl	101-84-8 92-52-4	$C_{12}H_{10}O$ $C_{12}H_{10}$			0.4	+				1
Toluene	Methylbenzene	108-88-3	C_7H_8	0.54	+	0.50	+	0.51	+	8.82	50

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Tolylene-2,4-diisocyanate	TDI, 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	$C_9H_6N_2O_2$	1.4	+	1.4	+	2.0	+		0.002
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	$C_6H_3Cl_3$	0.7	+	0.46	+			9.04	C5
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	$C_2H_3Cl_3$			NR	+	1	+	11	350
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	$C_2H_3Cl_3$	NR	+	NR	+	0.9	+	11.0	10
Trichloroethene	TCE, Trichoroethylene	79-01-6	C_2HCl_3	0.62	+	0.54	+	0.43	+	9.47	50
Trichloromethylsilane	Methyltrichlorosilane	75-79-6	CH_3Cl_3Si	NR		NR		1.8	+	11.36	ne
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	$C_2Cl_3F_3$			NR		NR		11.99	1000
Triethylamine	TEA	121-44-8	$C_6H_{15}N$	0.95	+	0.9	+	0.65	+	7.3	1
Triethyl borate	TEB; Boric acid triethyl ester	150-46-9	$C_6H_{15}O_3B$			2.2	+	1.1	+	~10	ne
Triethyl phosphate	Ethyl phosphate	78-40-0	$C_6H_{15}O_4P$	~50	+	3.1	+	0.60	+	9.79	ne
Trifluoroethane, 1,1,2-		430-66-0	$C_2H_3F_3$					34		*12.9*	ne
Trimethylamine		75-50-3	C_3H_9N			0.9				7.82	5
Trimethylbenzene, 1,3,5- - see Mesitylene		108-67-8									25
Trimethyl borate	TMB; Boric acid trimethyl ester, Boron methoxide	121-43-7	$C_3H_9O_3B$			5.1	+	1.2	+	10.1	ne
Trimethyl phosphate	Methyl phosphate	512-56-1	$C_3H_9O_4P$			8.0	+	1.3	+	9.99	ne
Trimethyl phosphite	Methyl phosphite	121-45-9	$C_3H_9O_3P$			1.1	+		+	*8.5*	2
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	$C_{10}H_{16}$	0.37	+	0.30	+	0.29	+	~8	20
Undecane		1120-21-4	$C_{11}H_{24}$			2				9.56	ne
Varsol – see Mineral Spirits											
Vinyl actetate		108-05-4	$C_4H_6O_2$	1.5	+	1.2	+	1.0	+	9.19	10
Vinyl bromide	Bromoethylene	593-60-2	C_2H_3Br			0.4				9.80	5
Vinyl chloride	Chloroethylene, VCM	75-01-4	C_2H_3Cl			2.0	+	0.6	+	9.99	5
Vinyl-1-cyclohexene, 4-	Butadiene dimer, 4-Ethenylcyclohexene	100-40-3	C_8H_{12}	0.6	+	0.56	+			9.83	0.1
Vinylidene chloride - see 1,1-Dichloroethene											
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, 1-ethenyl-2-pyrrolidinone	88-12-0	C_6H_9NO	1.0	+	0.8	+	0.9	+		ne
Viscor 120B - see Mineral Spirits - Viscor 120B Calibration Fluid											
V. M. & P. Naphtha	Ligroin; Solvent naphtha; Varnish maker's & painter's naptha	64742-89-8	m.w. 111 (C_8-C_9)	1.7	+	0.97	+				300
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C_8H_{10}	0.50	+	0.44	+	0.40	+	8.56	100
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C_8H_{10}	0.56	+	0.46	+	0.43		8.56	100
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C_8H_{10}	0.48	+	0.39	+	0.38	+	8.44	100
None				1		1		1			
Undetectable				1E+6		1E+6		1E+6			

* Compounds indicated in green can be detected using a MiniRAE 2000 or ppbRAE/+ with slow response, but may be lost by adsorption on a MultiRAE or EntryRAE. Response on multi-gas meters can give an indication of relative concentrations, but may not be quantitative and for some chemicals no response is observed.

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Appendix I:
Example of Automatic Calculation of Correction Factors, TLVs and Alarm Limits for Mixtures
(Calculations performed using Excel version of this database, available on request)

Compound	CF 9.8 eV	CF 10.6 eV	CF 11.7eV	Mol. Frac	Conc ppm	TLV ppm	STEL Ppm
Benzene	0.55	0.53	0.6	0.01	1	0.5	2.5
Toluene	0.54	0.5	0.51	0.06	10	50	150
Hexane, n-	300	4.3	0.54	0.06	10	50	150
Heptane, n-	45	2.8	0.6	0.28	50	400	500
Styrene	0.45	0.4	0.42	0.06	10	20	40
Acetone	1.2	1.1	1.4	0.28	50	750	1000
Isopropanol	500	6	2.7	0.28	50	400	500
None	1	1	1	0.00	0	1	
Mixture Value:	2.1	1.5	0.89	1.00	181 ppm	56 ppm	172 ppm
TLV Alarm Setpoint when Calibrated to Isobutylene:	26 ppm	37 ppm	62 ppm				
STEL Alarm Setpoint, same Calibration	86 ppm	115 ppm	193 ppm				

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FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Specific Conductance Meter

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

PURPOSE

This guideline describes a method for calibration of a portable specific conductance meter. This meter measures the ability of a water sample to conduct electricity, which is largely a function of the dissolved solids within the water. The instrument has been calibrated by the manufacturer according to factory specifications. This guideline presents a method for checking the factory calibration of a portable specific conductance meter. A calibration check is performed to verify instrument accuracy and function. All field test equipment will be checked at the beginning of each sampling day. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the specific conductance meter will be within ± 1 percent of full-scale, with repeatability of ± 1 percent. The built-in cell will be automatically temperature compensated from at least 32° to 160° F (0° to 71°C).

PROCEDURE

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Myron L Company Ultrameter Model 6P. The actual equipment to be used in the field will be equivalent or similar.

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the specific conductance meter according to the manufacture's specifications.

2. Use a calibration solution of known specific conductivity and salinity. For maximum accuracy, use a Standard Solution Value closest to the samples to be tested.

3. Rinse conductivity cell three times with proper standard.

4. Re-fill conductivity cell with same standard.

5. Press **COND** or **TDS**, then press **CAL/MCLR**. The "CAL" icon will appear on the display.

6. Press the **↑/MS** or **MR/↓** key to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.

7. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type.

8. Repeat steps 1 through 7 with additional new solutions, as necessary.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
    - Time, date and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration date of the calibration standards
    - The instrument readings: before and after calibration

- The instrument settings (if applicable)
- The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above.
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

NOTE: Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F voiding the warranty.

Battery Replacement

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. Carefully detach battery from circuit board. Replace with 9-volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement.

Cleaning Sensors

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

NOTE: Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Date:

Project No.:

Client:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		< 0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		µS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re factor =
						_____ ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

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FIELD OPERATING PROCEDURES

Composite Sample Collection Procedure for Non-VOC Analysis

FOP 013.0

COMPOSITE SAMPLE COLLECTION PROCEDURE FOR NON-VOLATILE ORGANIC ANALYSIS

PURPOSE

This guideline addresses the procedure to be used when soil samples are to be composited in the field.

PROCEDURE

1. Transfer equal weighted aliquots of soil from individual split-spoon samples, excavator bucket, hand auger or surface soil sample location to a large precleaned stainless steel (or Pyrex glass) mixing bowl.

2. Thoroughly mix (homogenize) and break up the soil using a stainless steel scoop or trowel.

3. Spread the composite sample evenly on a stainless steel tray and quarter the sample.

4. Discard alternate (i.e., diagonal) quarters and, using a small stainless steel scoop or spatula, collect equal portions of subsample from the remaining two quarters until the amount required for the composite sample is acquired. Transfer these subsamples to a precleaned stainless steel (or Pyrex glass) mixing bowl and re-mix.

5. Transfer the composite sample to the laboratory provided, precleaned sample jars. Store any excess sample from the stainless steel tray in a separate, precleaned, wide-mouth sample jar and refrigerate for future use, if applicable.

6. Decontaminate all stainless steel (or Pyrex glass) equipment in accordance with Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures.

7. Prepare samples in accordance with Benchmark's Sample Labeling, Storage and Shipment FOP.

8. Record all sampling details in the Project Field Book and on the Soil/Sediment Sample Collection Summary Log (sample attached).

ATTACHMENTS

Soil/Sediment Sample Collection Summary Log (sample)

REFERENCES

<u>Benchmark FOPs:</u>

040	*Non-disposable and Non-dedicated Sampling Equipment Decontamination*
046	*Sample Labeling, Storage and Shipment*

SOIL/SEDIME
SAMPLE COLLECTION SUMMARY L

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to varian location changes, depth changes, import matrix observations or description, grav thickness, etc.)
			from	to						

Equipment Rinsate Blanks *- Pour clean deionized water [illegible] d sa[illegible]uipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples coll the same day. HSL Metals can be substituted by only the Metals an[illegible] [illegible]exa[illegible] [illegible]romium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionzied water lot # or distilay. manufacturers info & date.*

MS/MSD/MSB *- Collect at a frequency of 1 per 20 samples of each matri[illegible] [illegible]or all those parameters analyzed for 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' sectio*

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. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
5. BD - Blind Duplicate - indicate location of duplicate.

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FIELD OPERATING PROCEDURES

Documentation Requirements for Drilling and Well Installation

FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

PURPOSE

The purpose of these documentation requirements is to document the procedures used for drilling and installing wells in order to ensure the quality of the data obtained from these operations. Benchmark field technical personnel will be responsible for developing and maintaining documentation for quality control of field operations. At least one field professional will monitor each major operation (e.g. one person per drilling rig) to document and record field procedures for quality control. These procedures provide a description of the format and information for this documentation.

PROCEDURE

Project Field Book

Personnel assigned by the Benchmark Field Team Leader or Project Manager will maintain a Project Field Book for all site activities. These Field Books will be started upon initiation of any site activities to document the field investigation process. The Field Books will meet the following criteria:

- Permanently bound, with nominal 8.5-inch by 11-inch gridded pages.
- Water resistant paper.
- Pages must be pre-numbered or numbered in the field, front and back.

Notations in the field book will be in black or blue ink that will not smudge when wet. Information that may be recorded in the Field Book includes:

- Time and date of all entries.

- Name and location of project site and project job number.
- Listing of key project, client and agency personnel and telephone numbers.
- Date and time of daily arrivals and departures, name of person keeping the log, names and affiliation of persons on site, purpose of visit (if applicable), weather conditions, outline of project activities to be completed.
- Details of any variations to the procedures/protocols (i.e., as presented in the Work Plan or Field Operating Procedures) and the basis for the change.
- Field-generated data relating to implementation of the field program, including sample locations, sample descriptions, field measurements, instrument calibration, etc.
- Record of all photographs taken in the field, including date, time, photographer, site location and orientation, sequential number of photograph, and roll number.

Upon completion of the site activities, all Field Books will be photocopied and both the original and photocopied versions placed in the project files. In addition, all field notes except those presented on specific field forms will be neatly transcribed into Field Activity Daily Log (FADL) forms (sample attached).

Field Borehole/Monitoring Well Installation Log Form

Examples of the Field Borehole Log and Field Borehole/Monitoring Well Installation Log forms are attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the drilling. At a minimum, these forms will include:

- Project name, location, and number.
- Boring number.

- Rig type and drilling method.
- Drilling dates.
- Sampling method.
- Sample descriptions, to meet the requirements of the Unified Soil Classification System (USCS) for soils and the Unified Rock Classification System (URCS) for rock.
- Results of photoionization evaluations (scan and/or headspace determinations).
- Blow counts for sampler penetration (Standard Penetration Test, N-Value).
- Drilling rate, rig chatter, and other drilling-related information, as necessary.

All depths recorded on Boring/Monitoring Well Installation Log forms will be expressed in increments tenths of feet, and not in inches.

Well Completion Detail Form

An example of this form is attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the well installation. At a minimum, these forms will include:

- Project name, location, and number.
- Well number.
- Installation dates.
- Dimensions and depths of the various well components illustrated in the Well Completion Detail (attached). These include the screened interval, bottom caps or plugs, centralizers, and the tops and bottoms of the various annular materials.

- Drilling rate, rig chatter, and other drilling related information.

All depths recorded on Field Borehole/Monitoring Well Installation Logs will be expressed in tenths of feet, and not in inches.

Daily Drilling Report Form

An example of this form is attached to this Field Operating Procedure. This form should be used to summarize all drilling activities. One form should be completed for each rig for each day. These forms will include summaries of:

- Footage drilled, broken down by diameter (e.g. 200 feet of 6-inch diameter hole, 50 feet of 10-inch diameter hole).
- Footage of well and screen installed, broken down by diameter.
- Quantities of materials used, including sand, cement, bentonite, centralizers, protective casings, traffic covers, etc. recorded by well or boring location.
- Active time (hours), and activity (drilling, decontamination, development, well installation, surface completions, etc.)
- Down-time (hours) and reason.
- Mobilizations and other events.
- Other quantities that will be the basis for drilling invoices.

The form should be signed daily by both the Benchmark field supervisor and the driller's representative, and provided to the Benchmark Field Team Leader.

<u>Other Project Field Forms</u>

Well purging/well development forms, test pit logs, environmental sampling field data sheets, water level monitoring forms, and well testing (slug test or pumping test) forms. Refer to specific guidelines for form descriptions.

ATTACHMENTS

Field Activity Daily Log (FADL) (sample)
Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)
Stick-up Well/Piezometer Completion Detail (sample)
Flush-mount Well/Piezometer Completion Detail (sample)
Daily Drilling Report (sample)

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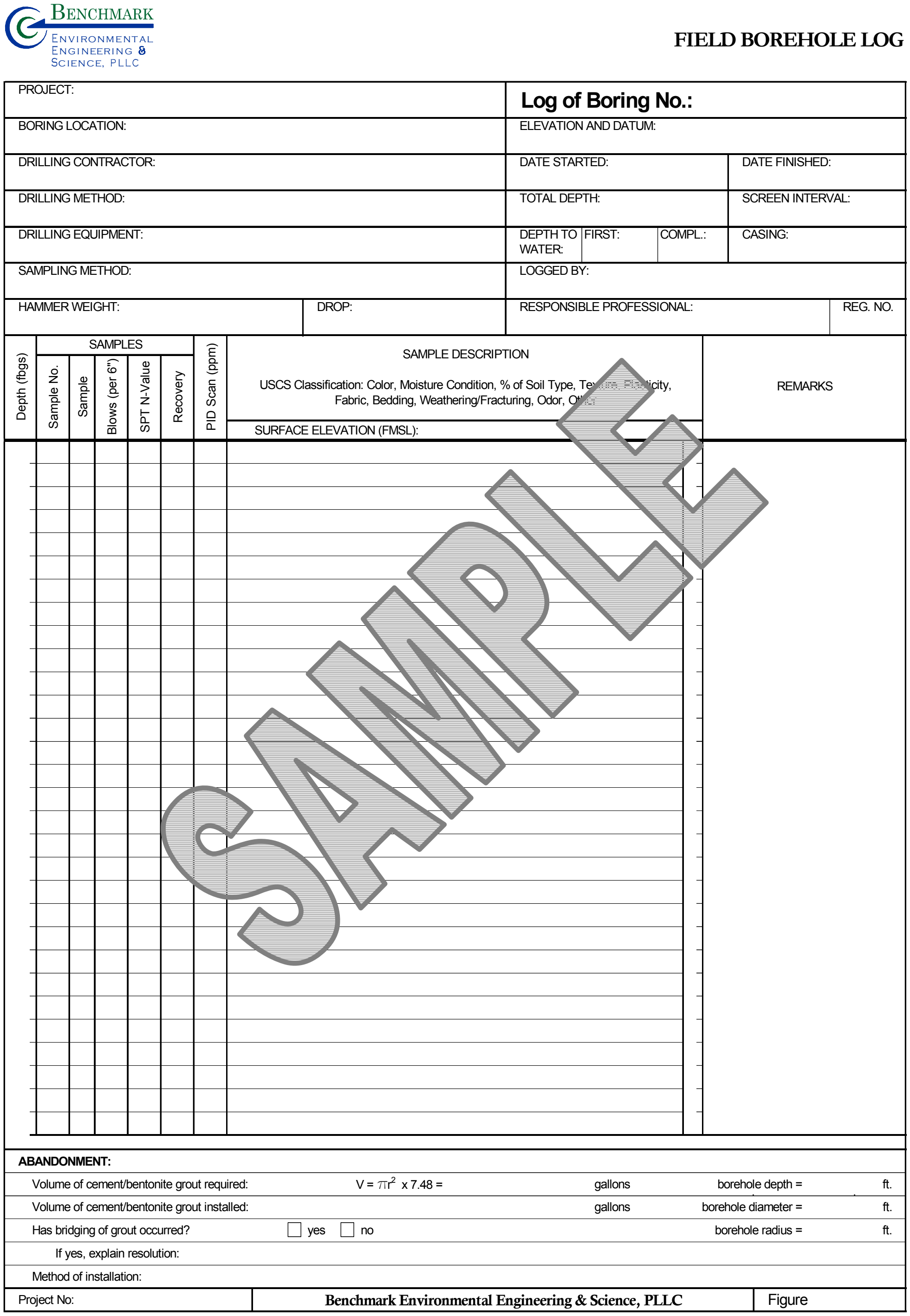
DAILY LOG	DATE			
	NO.			
	SHEET	OF		

FIELD ACTIVITY DAILY LOG

PROJECT NAME:	PROJECT NO.
PROJECT LOCATION:	CLIENT:
FIELD ACTIVITY SUBJECT:	
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.: P.M.:	IMPORTANT TELEPHONE CALLS:
BM/TK PERSONNEL ON SITE:	
SIGNATURE	DATE:

(CONTINUED)



FIELD BOREHOLE LOG

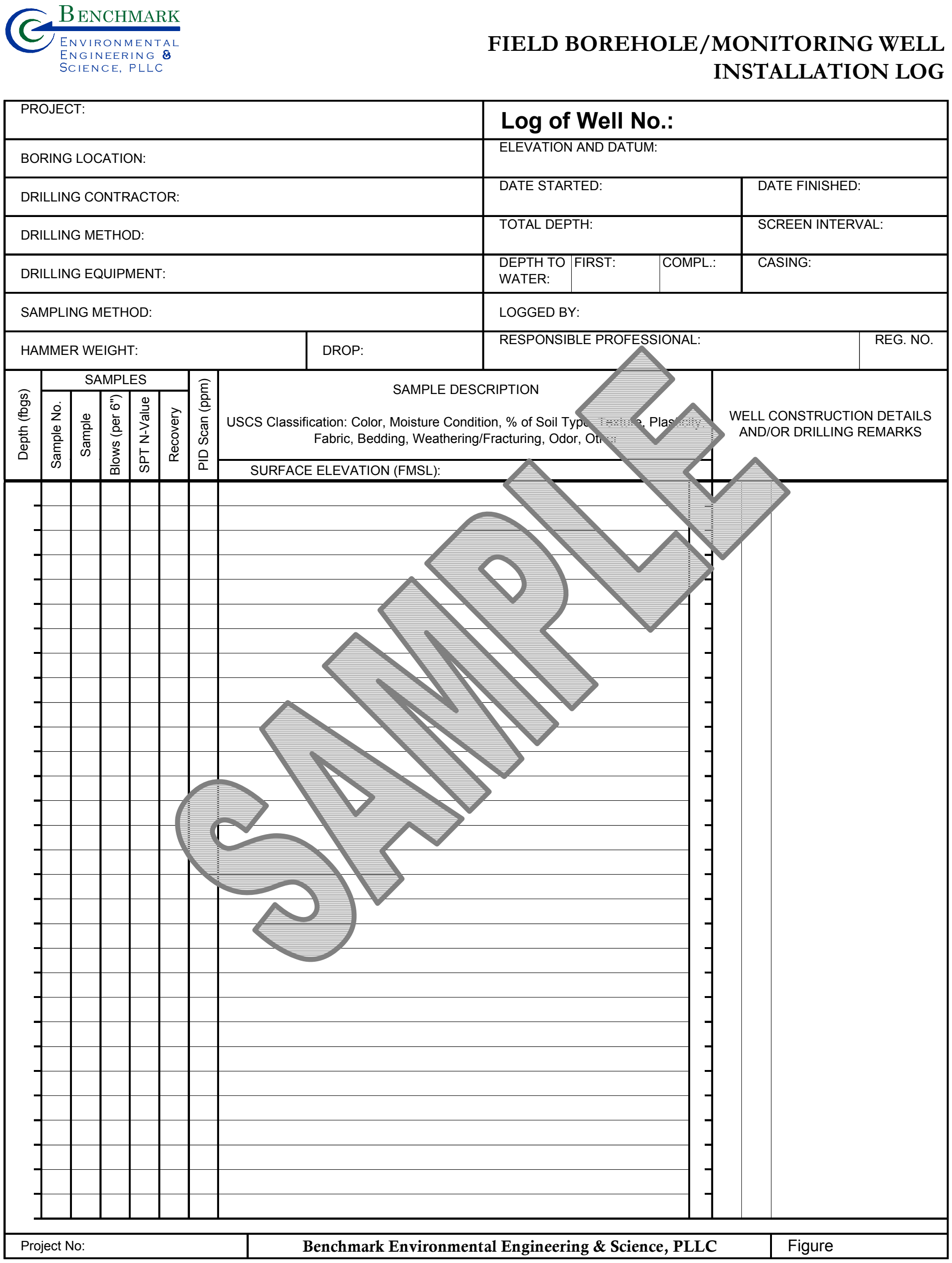
PROJECT:		**Log of Boring No.:**			
BORING LOCATION:		ELEVATION AND DATUM:			
DRILLING CONTRACTOR:		DATE STARTED:			DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:			SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER:	FIRST:	COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:			
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:			REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

ABANDONMENT:

Volume of cement/bentonite grout required:	V = πr^2 x 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:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

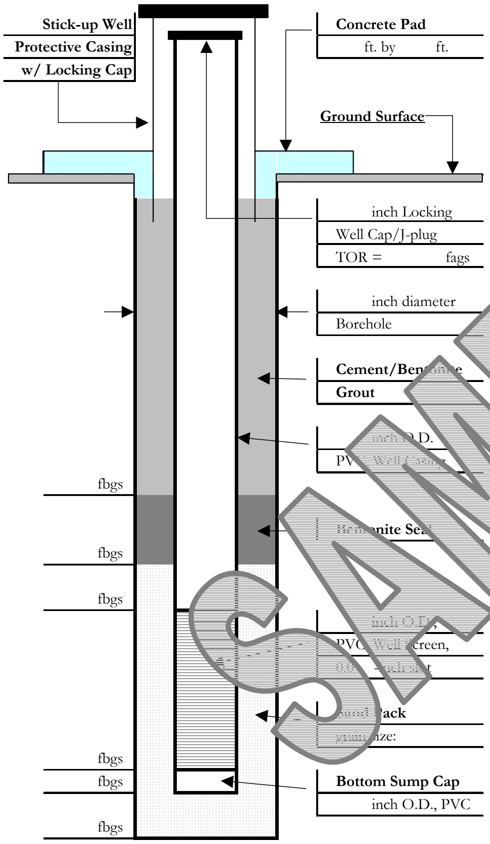
PROJECT:		**Log of Well No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

STICK-UP WELL/PIEZOMETER COMPLETION DETAIL

Project Name: WELL NUMBER:
Client: Date Installed:
Boring Location: Project Number:



Driller Information	
Company:	
Driller:	
Helper:	
Permit Number:	
Drill Rig Type:	

Well Information	
Land Surface Elevation:	fmsl (approximate)
Drilling Method:	
Soil Sample Collection Method:	
Drilling Fluid:	
Fluid Loss During Drilling:	gallons (approximate)

Material of Well Construction
Casing:
Screen:
Sump:
Sand Pack:
Annular Seal:

Well Development	
Well Purpose:	
Techneque(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	fbTOR
Pump Depth:	
Purge Duration:	minutes
Yeild:	gpm
Specific Capacity:	gpm/ft

Comments:

PREPARED BY: DATE:

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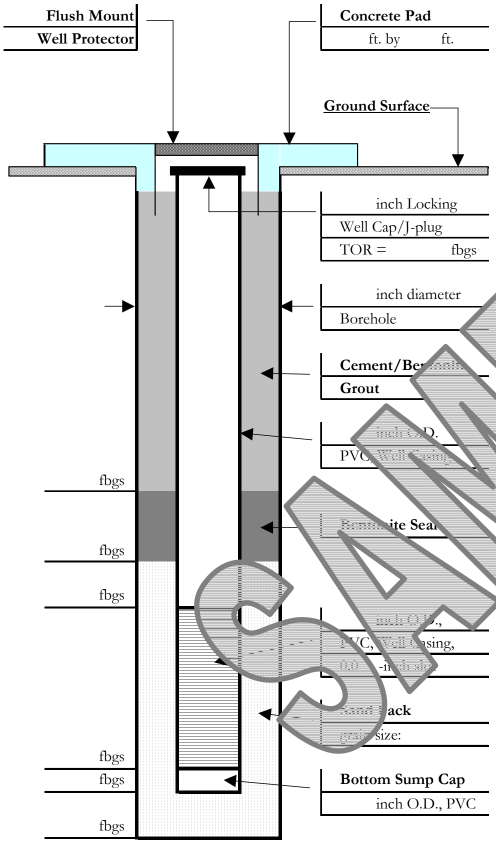
FLUSHMOUNT WELL/PIEZOMETER COMPLETION DETAIL

Project Name:	WELL NUMBER:
Client:	Date Installed:
Boring Location:	Project Number:



Driller Information

Company:
Driller:
Helper:
Permit Number:
Drill Rig Type:

Well Information

Land Surface Elevation: fmsl (approximate)
Drilling Method:
Soil Sample Collection Method:
Drilling Fluid:
Fluid Loss During Drilling: gallons (approximate)

Material of Well Construction

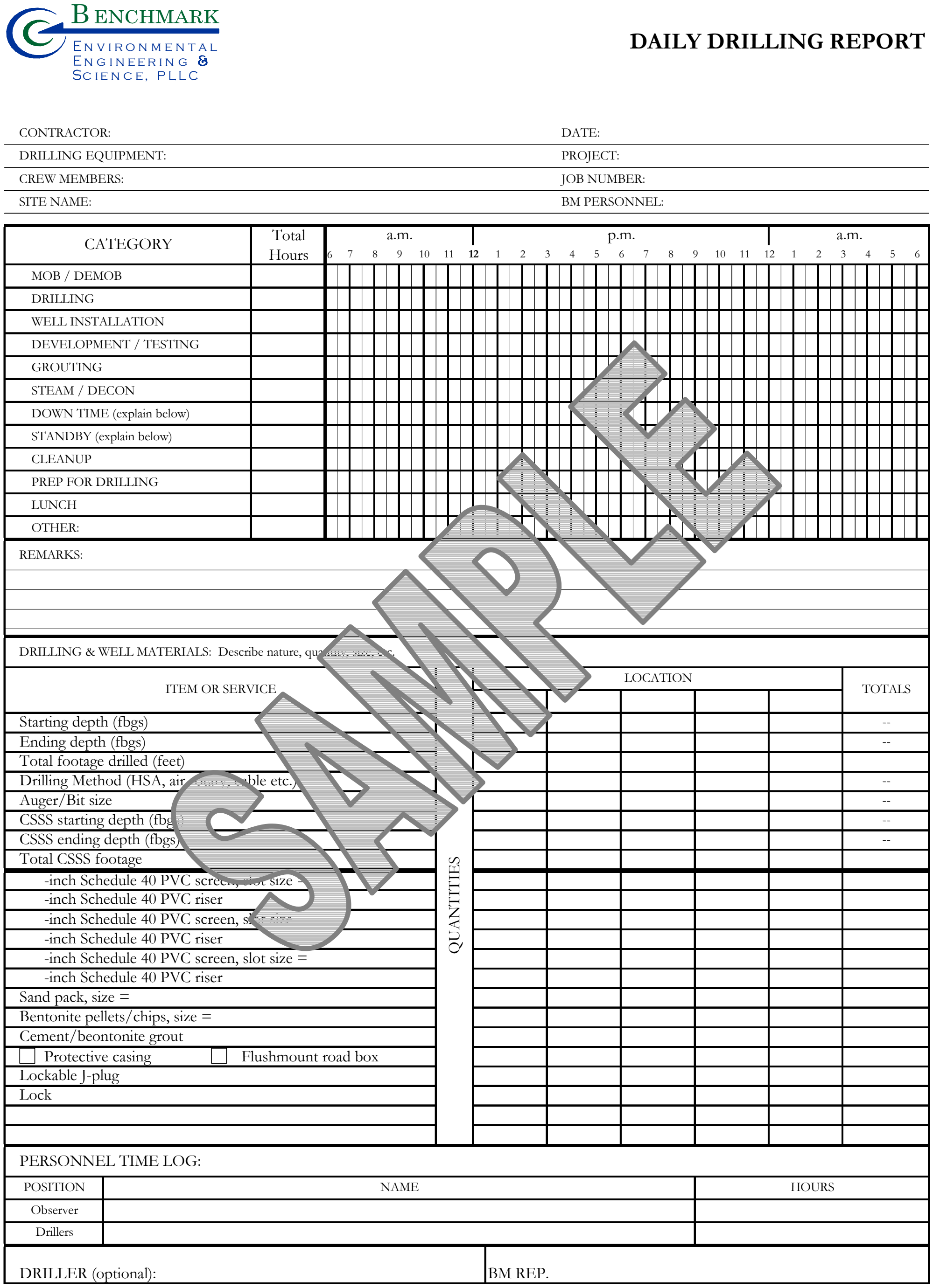
Casing:
Screen:
Sump:
Sand Pack:
Annular Seal:

Well Development

Well Purpose:
Techneque(s):
Date Completed:
BM/TK Personnel:
Total Volume Purge: gallons
Static Water Level: fbTOR
Pump Depth:
Purge Duration: minutes
Yeild: gpm
Specific Capacity: gpm/ft

Comments:

PREAPRED BY: DATE:



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DAILY DRILLING REPORT

CONTRACTOR:
DATE:
DRILLING EQUIPMENT:
PROJECT:
CREW MEMBERS:
JOB NUMBER:
SITE NAME:
BM PERSONNEL:

CATEGORY	Total Hours	a.m.						p.m.												a.m.						
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
MOB / DEMOB																										
DRILLING																										
WELL INSTALLATION																										
DEVELOPMENT / TESTING																										
GROUTING																										
STEAM / DECON																										
DOWN TIME (explain below)																										
STANDBY (explain below)																										
CLEANUP																										
PREP FOR DRILLING																										
LUNCH																										
OTHER:																										

REMARKS:

DRILLING & WELL MATERIALS: Describe nature, quantity, size, etc.

ITEM OR SERVICE	QUANTITIES	LOCATION					TOTALS
Starting depth (fbgs)							--
Ending depth (fbgs)							--
Total footage drilled (feet)							
Drilling Method (HSA, air rotary, cable etc.)							--
Auger/Bit size							--
CSSS starting depth (fbgs)							--
CSSS ending depth (fbgs)							--
Total CSSS footage							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
Sand pack, size =							
Bentonite pellets/chips, size =							
Cement/beontonite grout							
☐ Protective casing ☐ Flushmount road box							
Lockable J-plug							
Lock							

PERSONNEL TIME LOG:

POSITION	NAME	HOURS
Observer		
Drillers		

DRILLER (optional):
BM REP.

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FIELD OPERATING PROCEDURES

Drill Site Selection Procedure

FOP 017.0

DRILL SITE SELECTION PROCEDURE

PURPOSE

This procedure presents a method for selecting a site location for drilling. Drill site selection should be based on the project objectives, ease of site access, freedom from obstructions and buried metallic objects (drums) and site safety (appropriate set backs from overhead and buried services).

PROCEDURE

The following procedure outlines procedures prior to drilling activities:

1. Review project objectives and tentatively select drilling locations that provide necessary information for achieving objectives (i.e., Work Plan).

2. Clear locations with property owner/operator to ensure that drilling activities will not interfere with site operations and select appropriate access routes.

3. Stake locations in the field, measure distance from locations to recognizable landmarks, such as building or fence lines and plot locations on site plan. Ensure location is relatively flat, free of overhead wires and readily accessible. Survey location if property ownership is in doubt.

4. Obtain clearances from appropriate utilities and if buried waste/metallic objects are suspected, screen location with appropriate geophysical method.

5. Establish a secure central staging area for storage of drilling supplies and for equipment decontamination. Locate a secure storage area for drilling samples, as necessary.

ATTACHMENTS

none

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FIELD OPERATING PROCEDURES

Drilling and Excavation Equipment Decontamination Procedures

FOP 018.0

DRILLING AND EXCAVATION EQUIPMENT DECONTAMINATION PROCEDURES

PURPOSE

This procedure is to be used for the decontamination of drilling and excavation equipment (i.e., drill rigs, backhoes, augers, drill bits, drill rods, buckets, and associated equipment) used during a subsurface investigation. The purpose of this procedure is to remove chemical constituents associated with a particular drilling or excavation location from this equipment. This prevents these constituents from being transferred between drilling or excavation locations, or being transported out of controlled areas.

PROCEDURE

The following procedure will be utilized prior to the use of drilling or excavation equipment at each location, and prior to the demobilization of such equipment from the site:

1. Remove all loose soil and other particulate materials from the equipment at the survey site.
2. Wrap augers, tools, plywood, and other reusable items with a plastic cover prior to transport from the site of use to the decontamination facility.
3. Transport equipment to the decontamination facility. All equipment must be decontaminated at an established decontamination facility. This facility will be placed within a controlled area, and will be equipped with necessary features to contain and collect wash water and entrained materials.
4. Wash equipment thoroughly with pressurized low-volume water or steam, supplied by a pressure washer or steam cleaner.
5. If necessary, use a brush or scraper to remove visible soils adhering to the equipment, and a non-phosphate detergent to remove any oils, grease, and/or hydraulic fluids adhering to the equipment. Continue pressure washing until all visible contaminants are removed.

6. Allow equipment to air dry.

7. Store equipment in a clean area or wrap the equipment in new plastic sheeting as necessary to ensure cleanliness until ready for use.

8. Manage all wash waters and entrained solids as described in the Benchmark Field Operating Procedure for Management of Investigation-Derived Waste.

ATTACHMENTS

none

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FIELD OPERATING PROCEDURES

Establishing Horizontal and Vertical Control

FOP 021.0

ESTABLISHING HORIZONTAL AND VERTICAL CONTROL

PURPOSE

This guideline presents a method for establishing horizontal and vertical controls at a project site. It is imperative that this procedure be performed accurately, as all topographic and site maps, monitoring well locations and test pit locations will be based on these controls.

PROCEDURE

A. Establishing Horizontal Primary and Project Control

1. Research the State Plan Coordinate, USGS or project site applicable horizontal control monuments.
2. At the project site, recover the above-mentioned monuments, two markers minimum being recovered.
3. Establish control points on the project site by bringing in the primary control points recovered in the field.
4. All control points will be tied into a closed traverse to assure the error of closure.
5. Compute closures for obtaining degree of accuracy to adjust traverse points.

B. Establishing Vertical Primary and Project Control

1. Research project or USGS datum for recovering monument(s) for vertical control if different than those previously found.
2. Recover the monuments in the field, two markers minimum being found.
3. Set the projects benchmarks.
4. Run a level line from the monuments to the set project benchmarks and back, setting turning points on all benchmarks set on site.

5. Reduce field notes and compute error of closure to adjust benchmarks set on site.

6. Prepare the recovery sketches and tabulate a list for horizontal and vertical control throughout project site.

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FIELD OPERATING PROCEDURES

Groundwater Level Measurement

FOP 022.0

GROUNDWATER LEVEL MEASUREMENT

PURPOSE

This procedure describes the methods used to obtain accurate and consistent water level measurements in monitoring wells, piezometers and well points. Water levels will be measured at monitoring wells and, if practicable, in supply wells to estimate purge volumes associated with sampling, and to develop a potentiometric surface of the groundwater in order to estimate the direction and velocity of flow in the aquifer. Water levels in monitoring wells will be measured using an electronic water level indicator (e-line) that has been checked for operation prior to mobilization.

PROCEDURE

1. Decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Unlock and remove the well protective cap or cover and place on clean plastic.

3. Lower the probe slowly into the monitoring well until the audible alarm sounds. This indicates the depth to water has been reached.

4. Move the cable up and down slowly to identify the depth at which the alarm just begins to sound. Measure this depth against the mark on the lip of the well riser used as a surveyed reference point (typically the north side of the riser).

5. Read depth from the graduated cable to the nearest 0.01 foot. Do not use inches. If the e-line is not graduated, use a rule or tape measure graduated in 0.01-foot increments to measure from the nearest reference mark on the e-line cable.

6. Record the water level on a Water Level Monitoring Record (sample attached).

7. Remove the probe from the well slowly, drying the cable and probe with a clean paper wipe. Be sure to repeat decontamination before use in another well.

8. Replace well plug and protective cap or cover. Lock in place as appropriate.

ATTACHMENTS

Water Level Monitoring Record (sample)

REFERENCES

Benchmark FOPs:
040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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WATER LEVEL MONITORING RECORD

Project Name: Client:
Project No.: Location:
Field Personnel: Date:
Weather:

Well No.	Time	Top of Riser Elevation (fmsl)	Static Depth to Water (fbTOR)	Groundwater Elevation (fmsl)	Total Depth (fbTOR)	Last Total Depth Measurement (fbTOR)

Comments/Remarks:

PREAPRED BY: DATE:

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FIELD OPERATING PROCEDURES

Groundwater Purging Procedures Prior to Sample Collection

FOP 023.1

GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

PURPOSE

This procedure describes the methods for monitoring well/piezometer purging prior to groundwater sample collection in order to collect representative groundwater samples. The goal of purging is to remove stagnant, non-representative groundwater from the well and/or prevent stagnant water from entering collected samples. Purging involves the removal of at least three to five volumes of water in wells with moderate yields and at least one well volume from wells with low yields (slow water level recovery).

Purge and sample wells in order of least-to-most contaminated (this is not necessary if dedicated or disposable equipment is used). If you do not know this order, sample the upgradient wells first, then the furthest down-gradient or side-gradient wells, and finally the wells closest to, but down-gradient of the most contaminated area. Sampling should commence immediately following purging or as soon as the well has adequately recharged and not more than 24-hours following end time of evacuation.

PROCEDURE

1. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Inspect the interior and exterior of the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form and/or Groundwater Well Inspection Form (samples attached). Specifically, inspect

the integrity of the following: concrete surface seal, lock, protective casing and well cover, well riser and J-plug/cap. Report any irregular findings to the Project Manager.

3. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

4. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

5. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

6. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement.

7. Following static water level determinations, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Continue with purging activities observing purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following field activities.

8. Calculate the volume of water in the well based on the water level below the top of riser and the total depth of the well using the following equation:

$$V = 0.0408[(B)^2 \text{ x } \{(A) - (C)\}]$$

Where,

A = Total Depth of Well (feet below measuring point)
B = Casing diameter (inches)
C = Static Water Level (feet below measuring point)

9. **For wells where the water level is 20 feet or less below the top of riser**, a peristaltic pump may be used to purge the well. Measure the purged volume using a calibrated container (i.e., graduated 5-gallon bucket) and record measurements on the attached Groundwater Well Development and Purge Log. Use new and dedicated tubing for each well. During the evacuation of shallow wells, the intake opening of the pump tubing should be positioned just below the surface of the water. As the water level drops, lower the tubing as needed to maintain flow. For higher yielding wells, the intake level should not be lowered past the top of the screen. Pumping from the top of the water column will ensure proper flushing of the well. Continue pumping until the required volumes are removed (typically three well volumes). For higher yielding wells, adjust the purging rate to maintain the water level above the screen. For lower yielding wells or wells where the screen straddles the water table, maintain purging at a rate that matches the rate of recovery of the well (well yield). If the well purges to dryness and is slow to recharge (greater than 15 minutes), terminate evacuation. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.**

10. **For wells where the water level is initially below 20 feet,** or drawn down to this level because of slow recharge rate, conduct purging using one of three devices listed below:

    - Bailer – A bottom filling dedicated polyethylene bailer attached to a length of dedicated hollow-braid polypropylene rope. Purging a well utilizing a bailer should be conducted smoothly and slowly as not to agitate the groundwater or damage the well.

    - Well Wizard Purge Pump (or similar) – This pneumatic bladder pump uses compressed air to push water to the surface. Groundwater is not in contact with the drive air during the pumping process, therefore the pump may be used for sample collection.

- Submersible Pump (12 or 24 volt, or similar) – These submersible pumps are constructed of PVC or stainless steel and are capable of pumping up to 70 feet from ground surface using a 12 volt battery (standard pump) and standard low flow controller. For depths up to 200 feet from ground surface, a high performance power booster controller is used with a 12 volt battery. Unless these pumps are dedicated to the monitoring well location, decontamination between locations is necessary and an equipment blank may be required.

- Waterra™ Pump – This manually operated pump uses dedicated polyethylene tubing and a check valve that can be used as an optional method for purging deeper wells. The pump utilizes positive pressure to evacuate the well, therefore the pump may be used for sample collection, and however over-agitation groundwater should be avoided.

Prior to use in a well, non-dedicated bailers, exterior pump bodies and pump tubing should be cleaned in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Dedicated and/or disposable equipment should be contained within the sealed original manufacturers packaging and certified pre-cleaned by the manufacturer with a non-phosphate laboratory detergent and rinsed using de-ionized water.

8. Purging will continue until a predetermined volume of water has been removed (typically three well volumes) or to dryness. Measurements for pH, temperature, specific conductance, dissolved oxygen (optional), Eh (optional), and turbidity will be recorded following removal of each well volume. Purge the well to dryness or until the readings for indicator parameters listed above (or well-specific indicator parameters) stabilize within the following limits for each parameter measured:

Field Parameter	Stabilization Criteria
Dissolved Oxygen	± 0.3 mg/L
Turbidity	± 10 %
Specific Conductance	± 3 %
Eh	± 10 mV
PH	± 0.1 unit

Stabilization criteria presented within the project Work Plan will take precedence.

DOCUMENTATION AND SAMPLE COLLECTION

This section pertains to the documentation of collected field data during and following purging activities and sample collection.

1. Record all data including the final three stable readings for each indicator parameter on the attached Groundwater Well Purge & Sample Log.
2. Record, at a minimum, the "volume purged," "purging stop-time," "purged dry (Y/N)," "purged below sand pack (Y/N)," and any problems purging on the attached Groundwater Well Purge & Sample Log.
3. Collect groundwater samples in accordance with the Benchmark Field Operating Procedure for Groundwater Sample Collection. Record "sample flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event on the attached Groundwater Well Purge & Sample Log.
4. Restore the well to its capped/covered and locked condition.

ALTERNATIVE METHODS

Alternative purging and sampling methods and equipment, other than those described herein are acceptable if they provide representative groundwater samples. The purging and sampling method and equipment must not adversely affect sample integrity, chemistry, temperature, and turbidity. In addition, alternative equipment must have minimal or no effect on groundwater geochemistry, aquifer permeability and well materials. Equipment materials must also minimize sorption and leaching. The field team is responsible for documenting and describing any alternative equipment and procedures used to purge a well and collect samples.

ATTACHMENTS

Groundwater Field Form
Groundwater Well Inspection Form

REFERENCES

Benchmark FOPs:

011	*Calibration and Maintenance of Portable Photoionization Detector*
022	*Groundwater Level Measurement*
024	*Groundwater Sample Collection Procedures*
040	*Non-disposable and Non-dedicated Sampling Equipment Decontamination*

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GROUNDWATER FIELD FORM

Project Name:		Date:
Location:	Project No.:	Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose:		☐ Development	☐ Sample
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose:		☐ Development	☐ Sample
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

Note: All water level measurements are in feet, distance from top of riser.

Volume Calculation

Diam.	Vol. (g/ft)
1"	0.041
2"	0.163
4"	0.653
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	± 0.1 unit
SC	± 3%
Turbidity	± 10%
DO	± 0.3 mg/L
ORP	± 10 mV

PREPARED BY:

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GROUNDWATER WELL INSPECTION FORM

Project:
Client:
Job No.:
Date:
Time:

WELL I.D.:

EXTERIOR INSPECTION

Protective Casing:
Lock:
Hinge/Lid:
Concrete Surface Seal:
Bollards:
Label/I.D.:
Other:

INTERIOR INSPECTION

Well Riser:
Annular Space:
Well Cap:
Water Level (fbTOR):
Total Depth (fbTOR):
Other:

Comments/Corrective Actions:

PREPARED BY: DATE:

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FIELD OPERATING PROCEDURES

Groundwater Sample Collection Procedures

FOP 024.1

GROUNDWATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting groundwater samples from monitoring wells and domestic supply wells following purging and sufficient recovery. This procedure also includes the preferred collection order in which water samples are collected based on the volatilization sensitivity or suite of analytical parameters required.

PROCEDURE

Allow approximately 3 to 10 days following well development before performing purge and sample activities at any well location. Conversely, perform sampling as soon as practical after sample purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. If the well takes longer than 24 hours to recharge, the Project Manager should be consulted. The following two procedures outline sample collection activities for monitoring and domestic type wells.

Monitoring Wells

1. Purge the monitoring well in accordance with the Benchmark FOPs for Groundwater Purging Procedures Prior to Sample Collection or Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures. Perform sampling as soon as practical after purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. Analyses will be prioritized in the order of the parameters volatilization sensitivity. After volatile organics have been collected, field parameters

must be measured from the next sample collected. If a well takes longer than 24 hours to recharge, the Project Manager should be consulted.

2. Sampling equipment that is not disposable or dedicated to the well will be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

3. Calibrate all field meters (i.e., pH/Eh, turbidity, specific conductance, dissolved oxygen, PID etc.) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of the specific field meter.

4. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

5. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

6. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

7. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

8. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on a well-specific Groundwater Field Form (sample attached).

9. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Field Form (sample attached).

10. Groundwater samples will be collected directly from the sampling valve on the flow through cell (low-flow), discharge port of a standard pump assembly (peristaltic, pneumatic, submersible, or Waterra™ pump) or bailer (stainless steel, PVC or polyethylene) into appropriate laboratory provided containers. In low-yielding wells at which the flow through cell is not used, the samples may be collected using a disposable bailer. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.**

11. If disposable polyethylene bailers are used, the bailer should be lowered *slowly* below the surface of the water to minimize agitation and volatilization. For wells that are known to produce turbid samples (values greater than 50 NTU), the bailer should be lowered and retrieved at a rate that limits surging of the well.

12. Sampling data will be recorded on a Groundwater Field Form (sample attached).

13. Pre-label all sample bottles in the field using a waterproof permanent marker in accordance with the Benchmark Sample Labeling, Storage, and Shipment FOP. The following information, at a minimum, should be included on the label:

    - Project Number;
    - Sample identification code (as per project specifications);
    - Date of sample collection (mm, dd, yy);
    - Time of sample collection (military time only) (hh:mm);
    - Specify "grab" or "composite" sample type;
    - Sampler initials;
    - Preservative(s) (if applicable); and
    - Analytes for analysis (if practicable).

14. Collect a separate sample of approximately 200 ml into an appropriate container prior to collecting the first and following the last groundwater sample collected to measure the following field parameters:

Parameter	Units
Dissolved Oxygen	parts per million (ppm)
Specific Conductance	μmhos/cm or μS or mS
pH	pH units
Temperature	°C or °F
Turbidity	NTU
Eh (*optional*)	mV
PID VOCs (*optional*)	ppm

Record all field measurements on a Groundwater Field Form (sample attached).

15. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

16. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Field Form (sample attached).

17. The samples will be labeled, stored, and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage, and Shipment Procedures.

Domestic Supply Wells

1. Calculate or estimate the volume of water in the well. It is desirable to purge at least one casing volume before sampling. This is controlled, to some extent, by the depth of the well, well yield and the rate of the existing pump. If the volume of water in the well cannot be calculated, the well should be purged continuously for no less than 15 minutes.

2. Connect a sampling tap to an accessible fitting between the well and the pressure tank where practicable. A hose will be connected to the device and the hose discharge located 25 to 50 feet away. The well will be allowed to pump until the lines and one

well volume is removed. Flow rate will be measured with a container of known volume and a stopwatch.

3. Place a clean piece of polyethylene or Teflon™ tubing on the sampling port and collect the samples in the order designated below and in the sample containers supplied by the laboratory for the specified analytes. ***DO NOT*** use standard garden hose to collect samples.

4. Sampling results and measurements will be recorded on a Groundwater Field Form (sample attached) as described in the previous section.

5. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

6. The samples will be labeled, stored, and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage, and Shipment Procedures.

SAMPLE COLLECTION ORDER

All groundwater samples, from monitoring wells and domestic supply wells, will be collected in accordance with the following.

1. Samples will be collected preferentially in recognition of volatilization sensitivity. The preferred order of sampling if no free product is present is:

    - Field parameters
    - Volatile Organic Compounds (VOCs)
    - Purgeable organic carbons (POC)
    - Purgeable organic halogens (POH)
    - Total Organic Halogens (TOX)
    - Total Organic Carbon (TOC)
    - Extractable Organic Compounds (i.e., BNAs, SVOCs, etc.)
    - Total petroleum hydrocarbons (TPH) and oil and grease

- PCBs and pesticides
- Total metals (Dissolved Metals)
- Total Phenolic Compounds
- Cyanide
- Sulfate and Chloride
- Turbidity
- Nitrate (as Nitrogen) and Ammonia
- Preserved inorganics
- Radionuclides
- Unpreserved inorganics
- Bacteria
- Field parameters

2. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Field Form (sample attached).
3. 1,4-dioxane will be analyzed via the 8270 SIM method.

DOCUMENTATION

The three words used to ensure adequate documentation for groundwater sampling are accountability, controllability, and traceability. Accountability is undertaken in the sampling plan and answers the questions who, what, where, when, and why to assure that the sampling effort meets its goals. Controllability refers to checks (including QA/QC) used to ensure that the procedures used are those specified in the sampling plan. Traceability is documentation of what was done, when it was done, how it was done, and by whom it was done, and is found in the field forms, Project Field Book, and chain-of-custody forms. At a minimum, adequate documentation of the sampling conducted in the field consists of an entry in the Project Field Book (with sewn binding), field data sheets for each well, and a chain-of-custody form.

As a general rule, if one is not sure whether the information is necessary, it should nevertheless be recorded, as it is impossible to over-document one's fieldwork. Years may go by before the documentation comes under close scrutiny, so the documentation must be capable of defending the sampling effort without the assistance or translation of the sampling crew.

The minimum information to be recorded daily with an indelible pen in the Project Field Book and/or field data sheets includes date and time(s), name of the facility, name(s) of the sampling crew, site conditions, the wells sampled, a description of how the sample shipment was handled, and a QA/QC summary. After the last entry for the day in the Project Field Book, the Field Team Leader should sign the bottom of the page under the last entry and then draw a line across the page directly under the signature.

PRECAUTIONS/RECOMMENDATIONS

The following precautions should be adhered to prior to and during sample collection activities:

- Field vehicles should be parked downwind (to avoid potential sample contamination concerns) at a minimum of 15 feet from the well and the engine turned off prior to PID vapor analysis and VOC sample collection.

- Ambient odors, vehicle exhaust, precipitation, or windy/dusty conditions can potentially interfere with obtaining representative samples. These conditions should be minimized and should be recorded in the field notes. Shield sample bottles from strong winds, rain, and dust when being filled.

- The outlet from the sampling device should discharge below the top of the sample's air/water interface, when possible. The sampling plan should specify how the samples will be transferred from the sample collection device to the sample container to minimize sample alterations.

- The order of sampling should be from the least contaminated to the most contaminated well to reduce the potential for cross contamination of sampling equipment (see the Sampling Plan or Work Plan).
- Samples should not be transferred from one sampling container to another.
- Sampling equipment must not be placed on the ground, because the ground may be contaminated and soil contains trace metals. Equipment and supplies should be removed from the field vehicle only when needed.
- Smoking and eating should not be allowed until the well is sampled and hands are washed with soap and water, due to safety and possibly sample contamination concerns. These activities should be conducted beyond a 15-foot radius of the well.
- No heat-producing or electrical instruments should be within 15 feet of the well, unless they are intrinsically safe, prior to PID vapor analysis.
- Minimize the amount of time that the sample containers remain open.
- Do not touch the inside of sample bottles or the groundwater sample as it enters the bottle. Disposable gloves may be a source of phthalates, which could be introduced into groundwater samples if the gloves contact the sample.
- Sampling personnel should use a new pair of disposable gloves for each well sampled to reduce the potential for exposure of the sampling personnel to contaminants and to reduce sample cross contamination. In addition, sampling personnel should change disposable gloves between purging and sampling operations at the same well.
- Sampling personnel should not use perfume, insect repellent, hand lotion, etc., when taking groundwater samples. If insect repellent must be used, then sampling personnel should not allow samples or sampling equipment to contact the

repellent, and it should be noted in the documentation that insect repellent was used.

- Complete the documentation of the well. A completed assemblage of paperwork for a sampling event includes the completed field forms, entries in the Project Field Book (with a sewn binding), transportation documentation (if required), and possibly chain-of-custody forms.

ATTACHMENTS

Groundwater Field Form (sample)

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

<u>Benchmark FOPs:</u>

007	*Calibration and Maintenance of Portable Dissolved Oxygen Meter*
008	*Calibration and Maintenance of Portable Field pH/Eh Meter*
009	*Calibration and Maintenance of Portable Field Turbidity Meter*
011	*Calibration and Maintenance of Portable Photoionization Detector*
012	*Calibration and Maintenance of Portable Specific Conductance Meter*
022	*Groundwater Level Measurement*
023	*Groundwater Purging Procedures Prior to Sample Collection (optional)*
031	*Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures (optional)*
040	*Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
046	*Sample Labeling, Storage and Shipment Procedures*

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GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.	Diameter (inches):	Sample Time:
Product Depth (fbTOR):	Water Column (ft):	DTW when sampled:
DTW (static) (fbTOR):	Casing Volume:	Purpose: ☐ Development ☐ Sample
Total Depth (fbTOR):	Purge Volume (gal):	Purge Method:

Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.	Diameter (inches):	Sample Time:
Product Depth (fbTOR):	Water Column (ft):	DTW when sampled:
DTW (static) (fbTOR):	Casing Volume:	Purpose: ☐ Development ☐ Sample
Total Depth (fbTOR):	Purge Volume (gal):	Purge Method:

Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

Note: All water level measurements are in feet, distance from top of riser.

Volume Calculation

Diam.	Vol. (g/ft)
1"	0.041
2"	0.163
4"	0.653
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	± 0.1 unit
SC	± 3%
Turbidity	± 10%
DO	± 0.3 mg/L
ORP	± 10 mV

PREPARED BY:

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FIELD OPERATING PROCEDURES

PFAS Groundwater/Surface Water Sample Collection Procedures

FOP 024.3

PFAS GROUNDWATER/ SURFACE WATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting per-and polyfluoroalkyl substances (PFAS) groundwater samples from monitoring wells, following purging and sufficient recovery, and surface water locations. This procedure is specific to sites where PFAS sample analysis is required, and analysis specific collection and handling procedures are needed. PFAS sample analysis will be completed when Site analysis requires sampling of the full TAL/TCL analyte list. This field operating procedure (FOP) describes the personal protective equipment (PPE) and sampling equipment/materials appropriate for PFAS sample collection. PFAS laboratory analysis is performed using extremely low detection limits (parts per trillion). Therefore, cross contamination from potential sources (i.e., field equipment, consumer products) must be minimized to the extent possible.

PROCEDURE

Prior to sampling, discuss with the Site's Project Manager whether the monitoring wells that are to be sampled for the PFAS analytical parameters are new monitoring wells or existing monitoring wells. The specific handing and collection procedures for PFAS sampling are solely based on job preparation and sampling equipment used for the job. The standard practice of a 10 volume surge and purge of a newly installed monitoring well for development as discussed in Benchmark's FOP 036.0 – Monitoring Well Development Procedures and three volume well purge and/or low flow sampling that are discussed in Benchmark's FOP 023.1 – Groundwater Procedures Prior to Sample Collection remain the same. FOP 064.0 – Surface Water Sampling Procedures remains the same with the exceptions made in this FOP for PFAS sampling. The field sampling personnel must be prepared with appropriate clothing, equipment, and sampling containers for PFAS sampling as discussed below.

FIELD CLOTHING

Unacceptable Field Clothing

- No Gore-Tex®, this includes but not limited to boots, gloves, coveralls, hats, and coats.
- No Tyvex®, this includes but not limited to coveralls, boots, hoods and head coverings. Tyvex® is also found in everyday items such as envelopes, receipts, and adhesives.
- No clothes, jackets, boots, or gloves that have been pretreated with Teflon® water proofing. Teflon® can be found in everyday items such as scissors, plumbers' tape, adhesive tapes, Teflon ® paper for crafting and cookware utensils.
- No clothing that has been waterproofed with PFAS materials
- No brand-new unwashed cotton clothing.
- Clothing that has been washed with fabric softeners prior to sampling.

Acceptable Field Clothing

- Well-worn, washed clothes, jackets, hats, and coveralls without fabric softener usage.
- Rain Gear made from PVC, polyurethane, or rubber only (it cannot contain any of the products listed above).
- Disposable powder free nitrile gloves.

FIELD EQUIPMENT

Unacceptable Field Equipment

- Sampling Equipment containing Teflon® or Low-Density Polyethylene (LDPE). Sampling equipment that may contain these materials include submersible pumps, bailers, tubing, braided poly rope or cord, fishing line.

- No LDPE or glass lined sampling containers, or Teflon®-lined caps.
- Waterproof field books, binders, plastic clip boards, spiral hard cover notebooks.
- No adhesives or permanent makers can be used (i.e., Post-It® notes and Sharpies).
- No Aluminum foil or sampling tins.
- No blue ice packs
- Avoid using paper towels

Acceptable Field Equipment

- Sampling Equipment made from High Density Polyethylene (HDPE), stainless steel, acetate, silicon, or polypropylene.
- Sampling Containers made from HDPE polypropylene

Acceptable Field Equipment (continued)

- Sampling Equipment (i.e. bailers) made from Poly Vinyl Chloride (PVC)
- Nylon rope/twine
- Ice
- Alconox

ADDITIONAL PROCEDURES

- Keep all bottle ware in a dedicated cooler containing only PFAS sample containers.
- Avoid consumption of food or drink prior to and during the sampling event.
- Do not apply cosmetics or moisturizers prior to sampling.

- Do not use standard commercial sunscreen or insect repellents. Use only all natural or organic products.
- Collect PFAS sample from each location prior to collecting other samples for analysis to avoid contact with other sample containers and packing materials.
- New disposable nitrile gloves will be donned at each sampling location.
- Don new disposable nitrile gloves while handling empty sample containers, filling sampling containers, sealing sample containers, and placing containers into sampling coolers.
- Single use (dedicated) or disposable sampling equipment is preferred when multiple locations are sampled.
- Perform a standard two-step decontamination using Alconox detergent and laboratory provided PFAS-free water for all non-dedicated sampling equipment.
- Equipment blanks should be comprised of laboratory provided PFAS-free water. The water should be poured over and/or brought into direct contact with all sampling equipment (bailer, rope, tubing, gloves, water level meter, etc.). The equipment blank will then be sealed and returned to the sample cooler. One equipment blank will be collected each day PFAS samples are collected, or once every 20 samples, whichever is more frequent. Additional equipment blanks may be collected as needed.
- One field duplicate and one matrix spike/matrix spike duplicate (MS/MSD) will be collected for every 20 samples.
- Field blanks should be comprised of laboratory provided PFAS-free water. The field blank should be uncapped and placed near the field crew while purging/sampling preparations take place (i.e. prepare bottle set, calibrate groundwater quality meters, prepare bailers for sampling, etc.). The intent of the uncapped blank is to capture any ambient PFAS compounds that may emanate from the field crew or equipment during typical preparations associated with groundwater/surface water sampling. The field blank will then be capped and returned to the sample cooler.

ATTACHMENTS

Groundwater Field Form (sample)
Surface Water Quality Field Collection Log (Sample)

REFERENCES

<u>Benchmark FOPs:</u>
036.0 Monitoring Well Development Procedures
023.1 Groundwater Purging Procedures Prior to Sample Collection
064.0 Surface Water Sampling Procedures

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GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.	Diameter (inches):	Sample Time:
Product Depth (fbTOR):	Water Column (ft):	DTW when sampled:
DTW (static) (fbTOR):	Casing Volume:	Purpose: ☐ Development ☐ Sample
Total Depth (fbTOR):	Purge Volume (gal):	Purge Method:

Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.	Diameter (inches):	Sample Time:
Product Depth (fbTOR):	Water Column (ft):	DTW when sampled:
DTW (static) (fbTOR):	Casing Volume:	Purpose: ☐ Development ☐ Sample
Total Depth (fbTOR):	Purge Volume (gal):	Purge Method:

Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

Note: All water level measurements are in feet, distance from top of riser.

Volume Calculation

Diam.	Vol. (g/ft)
1"	0.041
2"	0.163
4"	0.653
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	± 0.1 unit
SC	± 3%
Turbidity	± 10%
DO	± 0.3 mg/L
ORP	± 10 mV

PREPARED BY:

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SURFACE WATER QUALITY FIELD COLLECTION LOG

PROJECT INFORMATION

Project Name:
Project No.:
Client:

SAMPLE DESCRIPTION

I.D.:
Matrix:
Location:

SAMPLE INFORMATION

Date Collected:
Time Collected:
Date Shipped to Lab:
Collected By:
Sample Collection Method:

LABORATORY ANALYSIS

SAMPLING INFORMATION

Weather:
Air Temperature:
Depth of Sample:

Parameter	First	Last	Units
pH			units
Temp.			°C
Cond.			mS
Turbidity			NTU
Eh			mV
D.O.			ppm
Odor			olfactory
Appearance			visual

LOCATION SKETCH

(not to scale, dimensions are approximate)

EXACT LOCATION (if applicable)

Northing (ft)	Easting (ft)	Surface Elevation (fmsl)

ADDITIONAL LABORATORY ANALYSIS:

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

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Field Operating Procedures

Hand Augering Procedures

FOP 025.0

HAND AUGERING PROCEDURES

PURPOSE

This guideline presents a method for hand augering, which enables the recovery of representative surface and shallow subsurface samples for classification and sample collection (ASTM D1452).

PROCEDURE

1. Review project objectives and the Project Health and Safety Plan (HASP).
2. Follow Benchmark's FOP: Drill Site Selection Procedure prior to implementing any hand augering activity.
3. Establish a central staging area for storage of augering supplies and for equipment decontamination (include plastic-covered work bench/table as necessary). Locate a secure storage area for augered samples.
4. Assemble auger and decontaminate in accordance with Benchmark's FOP: Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
5. Cover the area to be sampled with plastic sheeting, as determined by the Project Work Plan.
6. Make the auger boring through the plastic sheeting by rotating and advancing the auger to the desired depth below ground surface.
7. Withdraw the auger from the hole and remove soil for examination, soil classification, on-site testing (if applicable) and laboratory physical/chemical sample collection (if applicable) in accordance with specific Benchmark FOPs (Soil Description Procedures Using the Unified Soil Classification System; Composite Sample Collection Procedure for Non-Volatile Organic Analysis; and/or Soil Sample Handling for VOC Analysis) and as directed by the Project Work Plan.

8. Document all properties and sample locations in the Project Field Book and Hand Auger Borehole Log (sample attached). Specifically, total depth, borehole diameter, depth of sample collection, personnel, etc. should be recorded.

9. Place sample in appropriate container(s), label and store for future reference or ship to laboratory for analysis in accordance with Benchmark's Field Operating Procedure for Sample Labeling, Storage and Shipment.

10. Decontaminate auger in accordance with Benchmark's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

11. Advance auger to next sample interval and repeat steps 7 through 12 as necessary.

12. Backfill auger holes in accordance with approved procedures outlined in the Project Work Plan.

ATTACHMENTS

Hand Auger Borehole Log (sample)

REFERENCES

Benchmark FOPs:

013 *Composite Sample Collection Procedure for Non-Volatile Organic Analysis*
017 *Drill Site Selection Procedure*
040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
046 *Sample Labeling, Storage and Shipment*
054 *Soil Description Procedures Using the Unified Soil Classification System*
057 *Soil Sample Handling for Volatile Organic Compound Analysis – Encore Sampling*

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HAND AUGER BOREHOLE LOG

Project:	BOREHOLE I.D.:
Project No.:	Excavation Date:
Client:	Excavation Method:
Location:	Logged / Checked By:

Hand Auger Location: *NOT TO SCALE*

Hand Auger Cross Section:

Grade - 0'
2'
4'
6'
8'
10'

TIME	BOREHOLE DIMENSIONS
Start:	Diameter: (approx.)
End:	Depth: (approx.)

Depth (fbgs)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	PID Scan (ppm)	Photos Y / N	Samples Collected (fbgs)

COMMENTS:

GROUNDWATER ENCOUNTERED:	yes	no	If yes, depth to GW:
VISUAL IMPACTS:	yes	no	Describe:
OLFACTORY OBSERVATIONS:	yes	no	Describe:
NON-NATIVE FILL ENCOUNTERED:	yes	no	
OTHER OBSERVATIONS:	yes	no	Describe:
SAMPLES COLLECTED:	yes	no	Sample I.D.:
			Sample I.D.:
			Sample I.D.:

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FIELD OPERATING PROCEDURES

Hollow Stem Auger Drilling Procedures

FOP 026.1

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

PURPOSE

This guideline presents a method for drilling a borehole through unconsolidated materials, including soils or overburden, and consolidated materials, including bedrock.

PROCEDURE

The following procedure will be used to drill a borehole for sampling and/or well installation, using hollow-stem auger methods and equipment.

1. Follow Benchmark's Field Operating Procedure for Drill Site Selection Procedure prior to implementing any drilling activity.
2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).
3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form.
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures (i.e., PID, FID, combustible gas meter) or manufacturer's recommendations for calibration of field meters (i.e., DataRAM 4 Particulate Meter).
5. Ensure all drilling equipment (i.e., augers, rods, split-spoons) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with Benchmark's FOP: Drilling and Excavation Equipment Decontamination Procedures.
6. Mobilize the auger rig to the site and position over the borehole.
7. Level and stabilize the rig using the rig jacks, and recheck the rig location against the planned drilling location. If necessary, raise the jacks and adjust the rig position.

8. Place a metal or plywood auger pan over the borehole location to collect the auger cuttings. This auger pan will be equipped with a 12-inch nominal diameter hole for auger passage. As an alternative, a piece of polyethylene tarp may be used as a substitute.

9. Advance augers into the subsurface. For sampling or pilot-hole drilling, nominal 8-inch outside diameter (OD) augers should be used. The boring diameter will be approved by the Benchmark field supervisor.

10. Collect soil samples via split spoon sampler in accordance with Benchmark's Field Operating Procedure for Split Spoon Sampling.

11. Check augers periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.

12. Continue drilling until reaching the assigned total depth, or until auger refusal occurs. Auger refusal is when the drilling penetration drops below 0.1 feet per 10 minutes, with the full weight of the rig on the auger bit, and a center bit (not center plug) in place.

13. Plug and abandon boreholes not used for well installation in accordance with Benchmark's Field Operating Procedure for Abandonment of Borehole.

OTHER PROCEDURAL ISSUES

- Slip rings may be used for lifting a sampling or bit string. The string will not be permitted to extend more than 15 feet above the mast crown.

- Borings will not be over drilled (rat holed) without the express permission of the Benchmark field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.

- Potable water may be placed in the auger stem if critically necessary for borehole control or to accomplish sampling objectives and must be approved by the Benchmark Project Manager and/or NYSDEC Project Manager. Upon approval, the potable water source and quantity used will be documented in the Project Field Book and subsequent report submittal.

ATTACHMENTS

Drilling Safety Checklist (sample)
Tailgate Safety Meeting Form (sample)

REFERENCES

Benchmark FOPs:

001	*Abandonment of Borehole Procedures*
010	*Calibration and Maintenance of Portable Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
017	*Drill Site Selection Procedure*
018	*Drilling and Excavation Equipment Decontamination Procedures*
058	*Split Spoon Sampling Procedures*

DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**	Date:
Project No.: **0041-009-500**	Drilling Company:
Client: **RealCo., Inc.**	Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, either swaged Coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or load side? Clamps should not be alternated and should be of the correct size and number for the cable size to which it is installed. Clamps are complete with no missing parts?		
Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation?		
Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load?		
Drive shafts, belts, chain drives and universal joints shall be guarded to prevent accidental insertion of hands and fingers or tools.		
Outriggers shall be extended prior to and whenever the boom is raised off its cradle. Hydraulic outriggers must maintain pressure to continuously support and stabilize the drill rig even while unattended.		
Outriggers shall be properly supported on the ground surface to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement. Controls should not be blocked or locked in an action position.		
Safeties on any device shall not be bypassed or neutralized.		
Controls shall be operated smoothly and cables and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		

ITEMS TO CHECK	OK	ACTION NEEDED

Benchmark Environmental Engineering & Science, PLLC

DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**
Date:
Project No.: **0041-009-500**
Drilling Company:
Client: **RealCo., Inc.**
Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
The work area around the borehole shall be kept clear of trip hazards and walking surfaces should be free of slippery material.		
Workers shall not proceed higher than the drilling deck without a fall restraining device and must attach the device in a manner to restrict fall to less than 6 feet.		
A fire extinguisher of appropriate size shall be immediately available to the drill crew. The drill crew shall have received annual training on proper use of the fire extinguisher.		
29 CFR 1910.333 © (3) Except where electrical distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to, under, by, or near power lines only in accordance with the following: .333 © (3) (ii) 50 kV or less -minimum clearance is 10 ft. For 50 kV or over - 10ft. Plus ½ in. For each additional kV **Benchmark Policy: Maintain 20 feet clearance**		
29 CFR 1910.333 © (3) (iii) While the rig is in transit with the boom in the down position, clearance from energized power lines will be maintained as follows: Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 720 kV - 16 feet		

Name: (printed)

Signed:
Date:

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

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FIELD OPERATING PROCEDURES

Low-Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure

FOP 031.2

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods used for performing low flow (minimal drawdown) purging, also referred to as micro-purging, at a well prior to groundwater sampling to obtain a representative sample from the water-bearing zone. This method of purging is used to minimize the turbidity of the produced water. This may increase the representativeness of the groundwater samples by avoiding the necessity of filtering suspended solids in the field prior to preservation of the sample.

Well purging is typically performed immediately preceding groundwater sampling. The sample should be collected as soon as the parameters measured in the field (i.e., pH, specific conductance, dissolved oxygen, Eh, temperature, and turbidity) have stabilized.

PROCEDURE

Allow approximately 3 to 10 days following well development for groundwater to return to static conditions before performing low-flow purge and sample activities at any well location. Conversely, perform low-flow sampling as soon as purged groundwater has stabilized. If the well does not yield sufficient volume (i.e., cannot maintain a constant water level during purging) for low-flow purge and sampling, then an alternative method must be performed in accordance with Benchmark's Groundwater Purging Procedures Prior to Sample Collection FOP.

1. Water samples should not be taken immediately following well development. Sufficient time should be allowed to stabilize the groundwater flow regime in

the vicinity of the monitoring well. This lag time will depend on site conditions and methods of installation but may exceed one week.

2. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark's Groundwater Level Measurement FOP and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

3. Calibrate all sampling devices and monitoring equipment in accordance with manufacturer's recommendations, the site Quality Assurance Project Plan (QAPP) and/or Field Sampling Plan (FSP). Calibration of field instrumentation should be followed as specified in Benchmark's Calibration and Maintenance FOP for each individual meter.

4. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

5. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

6. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

7. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in Benchmark's Groundwater Level Measurement FOP. Refer to the construction diagram for the well to identify the screened depth.

8. Decontaminate all non-dedicated pump and tubing equipment following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP.

9. Lower the purge pump or tubing (i.e., low-flow electrical submersible, peristaltic, etc.) slowly into the well until the pump/tubing intake is approximately in the middle of the screened interval. Rapid insertion of the pump will increase the turbidity of well water, and can increase the required purge time. This step can be eliminated if dedicated tubing is already within the well.

   Placement of the pump close to the bottom of the well will cause increased entrainment of solids, which may have settled in the well over time. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval. The objective of low-flow purging is to maintain a purging rate, which minimizes stress (drawdown) of the water level in the well. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen.

10. Lower the e-line back down the well as water levels will be frequently monitored during purge and sample activities.

11. Begin pumping to purge the well. The pumping rate should be between 100 and 500 milliliters (ml) per minute (0.03 to 0.13 gallons per minute) depending on site hydrogeology. Periodically check the well water level with the e-line adjusting the flow rate as necessary to stabilize drawdown within the well. If possible, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). If the water level exceeds 2 feet below static and declining, slow the purge rate until the water level generally stabilizes. Record each pumping rate and water level during the event. If the water level continues to drop and will not stabilize, the monitoring location is not conducive to low-flow sampling and conventional purge and sample methods should be performed.

The low flow rate determined during purging will be maintained during the collection of analytical samples. At some sites where geologic heterogeneities are sufficiently different within the screened interval, high conductivity zones may be preferentially sampled.

12. Measure and record field parameters (pH, specific conductance, Eh, dissolved oxygen (DO), temperature, and turbidity) during purging activities. In lieu of measuring all of the parameters, a minimum subset could be limited to pH, specific conductance, and turbidity or DO. A reduction in the field parameter list must be approved by the Project Manager and/or the NYSDEC Project Manager.

    Water quality indicator parameters should be used to determine purging needs prior to sample collection in each well. Stabilization of indicator parameters should be used to determine when formation water is first encountered during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by Eh, DO and turbidity. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. An in-line flow through cell to continuously measure the above parameters may be used. The in-line device should be disconnected or bypassed during sample collection.

13. Purging will continue until parameters of water quality have stabilized or at least a minimum of three (3) well volumes have been removed. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.

14. Record well purging and sampling data in the Project Field Book or on the Groundwater Field Form (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.

15. Purging is complete when field indicator parameters stabilize. Stabilization is achieved after all field parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 units for pH, ± 3% for specific conductance, ± 10 mV for Eh, and ± 10% for turbidity and dissolved oxygen. These stabilization guidelines are provided for rough estimates only, actual site-specific knowledge may be used to adjust these requirements higher or lower.

    An in-line water quality measurement device (e.g., flow-through cell) should be used to establish the stabilization time for several field parameters on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

16. Collect all project-required samples from the discharge tubing at the flow rate established during purging in accordance with Benchmark's Groundwater Sample Collection Procedures FOP. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.** Continue to maintain a constant flow rate such that the water level is not drawn down as described above. Fill sample containers with minimal turbulence by allowing the ground water to flow from the tubing along the inside walls of the container.

17. If field filtration is recommended as a result of increased turbidity greater than 50 NTU, an in-line filter equipped with a 0.45-micron filter should be utilized. Collection of a filtered sample must be accompanied by an unfiltered sample.

18. Replace the dedicated tubing down the well taking care to avoid contact with the ground surface.

19. Restore the well to its capped/covered and locked condition.

20. Upon purge and sample collection completion, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-

foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Record observations of purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following project field activities.

ATTACHMENTS

Groundwater Field Form (sample)

REFERENCES

United States Environmental Protection Agency, 540/S-95/504, 1995. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*

<u>Benchmark FOPs:</u>

007 Calibration and Maintenance of Portable Dissolved Oxygen Meter
008 Calibration and Maintenance of Portable Field pH/Eh Meter
009 Calibration and Maintenance of Portable Field Turbidity Meter
011 Calibration and Maintenance of Portable Photoionization Detector
012 Calibration and Maintenance of Portable Specific Conductance Meter
022 Groundwater Level Measurement
024 Groundwater Sample Collection Procedures
040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
046 Sample Labeling, Storage and Shipment Procedures

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GROUNDWATER FIELD FORM

Project Name: Date:

Location: Project No.: Field Team:

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

Well No.			Diameter (inches):			Sample Time:			
Product Depth (fbTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (fbTOR):			Casing Volume:			Purpose: ☐ Development ☐ Sample			
Total Depth (fbTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (fbTOR)	Acc. Volume (gallons)	pH (units)	Temp. (deg. C)	SC (uS)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	0 Initial								
	1								
	2								
	3								
	4								
	5								
	6								
	7								
	8								
	9								
	10								
Sample Information:			Date: (if different from above)						
	S1								
	S2								

REMARKS:

Note: All water level measurements are in feet, distance from top of riser.

Volume Calculation

Diam.	Vol. (g/ft)
1"	0.041
2"	0.163
4"	0.653
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	± 0.1 unit
SC	± 3%
Turbidity	± 10%
DO	± 0.3 mg/L
ORP	± 10 mV

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FIELD OPERATING PROCEDURES

Management of Investigative-Derived Waste (IDW)

FOP 032.1

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 Benchmark 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 Benchmark'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 Property Owner, Project Manager, and/or 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

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INVESTIGATION DERIVED WASTE CO

Project Name:
Location:
Project Number:
Personnel:

Container		Contents	Date		Staging Location	Date Sampled	Co
Number	Description		Started	Ended			

Prepared By:
Signed:

IDW Container Label (sample):

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Project Name:

Project Number:

Container I.D.:

Contents/Matrix:

Estimated Quantity:

Date of Generation:

Date of Sample Collection:

Contact Name:

Contact Phone Number:

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FIELD OPERATING PROCEDURES

Monitoring Well Construction for Hollow Stem Auger Boreholes

FOP 033.0

MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

PURPOSE

Wells will be installed within selected boreholes for the purpose of evaluating groundwater characteristics. Well installation procedures depend upon the drilling method. This procedure describes well construction and installation for boreholes drilled using the hollow stem auger method. Refer to the Benchmark's Hollow Stem Auger Drilling Procedures FOP. Nominal dimensions and materials for the well are shown in the attached well construction diagram.

PROCEDURE

1. Advance borehole in accordance with the Benchmark's Hollow Stem Auger Drilling Procedure FOP to the required depth. The nominal inside diameter (ID) of the auger stem used should be at least 2 inches larger than the outside diameter (OD) of the riser and screen selected for the well installation. Record the monitoring well construction on the Field Borehole/Monitoring Well Installation Log (sample attached) (see Documentation Requirements for Drilling and Well Installation FOP).

2. Remove the drill rods and center bit/plug from the auger stem and verify borehole depth using weighted measuring tape.

3. In the event of an over drill (i.e. borehole depth is more than one foot greater than desired base of screen depth), use bentonite chips poured through the auger stem to seal the over drilled portion of the borehole. Be sure to note bentonite chip thickness on Field Borehole/Monitoring Well Installation Log.

4. Add a maximum of 6 inches of filter pack material through the auger stem to the base of the borehole. (Note: This step may be avoided if dense non-aqueous phase liquids are suspected to be present and it is desirable to have the screen and/or sump at the base of the borehole.)

5. Measure the length of the well string (i.e. riser and screen), and lower the well string into the well assembly to the desired depth. All measurements during the well installation process will be accurate to 0.1 foot.

6. Surface pour filter pack material into the annulus between the well and the auger stem as the augers are gradually withdrawn from the borehole. Use a weighted tape to confirm that the level of sand is maintained within the augers at all times. Record material volumes used.

7. After filter pack materials are brought to the required level, surface pour bentonite chips or pellets into the annulus between the well and the auger stem to form the filter pack seal. If necessary to avoid bridging, delayed hydration (coated) pellets may be used. Record the volume of material used.

8. Allow the bentonite chips/pellets to adequately hydrate for approximately 30 to 45-minutes. Cap or cover the well top of riser.

9. Mix cement/bentonite grout to a smooth consistency using a centrifugal or reciprocating pump. Do not hand mix. All water used must be potable quality. Record the volume of water used.

10. Fill the remaining annulus between the well and the auger stem with grout by surface pouring or pumping, and begin withdrawal of the auger string. Periodically top the auger string off with additional grout. If groundwater is present within the annulus above the bentonite chip/pellet seal, cement/bentonite grout will be pressure tremie grouted from bottom to top in order to displace groundwater from the borehole.

11. When the auger string is withdrawn, center the upper portion of the well riser within the borehole, and place drums or barricades around the well for protection while the grout cures. Place and lock a security cap (i.e., J-plug) in the opening of the well riser.

12. Leave the well undisturbed for at least 24 hours to allow the grout to cure. If excessive grout fallback occurs, top off as necessary with bentonite chips or additional grout.

13. Construct the surface completion as shown in the attached Typical Monitoring Well Detail (Figure 1). Select flush completions for all locations in active operational or high traffic areas, or in other areas where an above grade completion would be undesirable. Use aboveground completions in all other areas.

14. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.

15. Permanently label the well with the appropriate well identifier as determined by the Project Manager or specified in the Work Plan.

16. Permanently mark a survey location on the north side at the top of the casing with a saw cut. Survey all wells for horizontal location and elevation, using a surveyor licensed by the State of New York. Coordinates and elevations will be provided in a coordinate system consistent with previous well surveys at the Site. Information obtained will include location (*x* and *y*) of the well, and elevation (*z*) of the ground surface, the pad, and the top of riser.

17. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.

18. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

ATTACHMENTS

Field Borehole/Monitoring Well Installation Log (sample)
Typical Monitoring Well Detail (Figure 1)

REFERENCES

<u>Benchmark FOPs:</u>

015	*Documentation Requirements for Drilling and Well Installation*
026	*Hollow Stem Auger Drilling Procedures*
032	*Management of Investigation Derived Waste*
036	*Monitoring Well Development Procedures*

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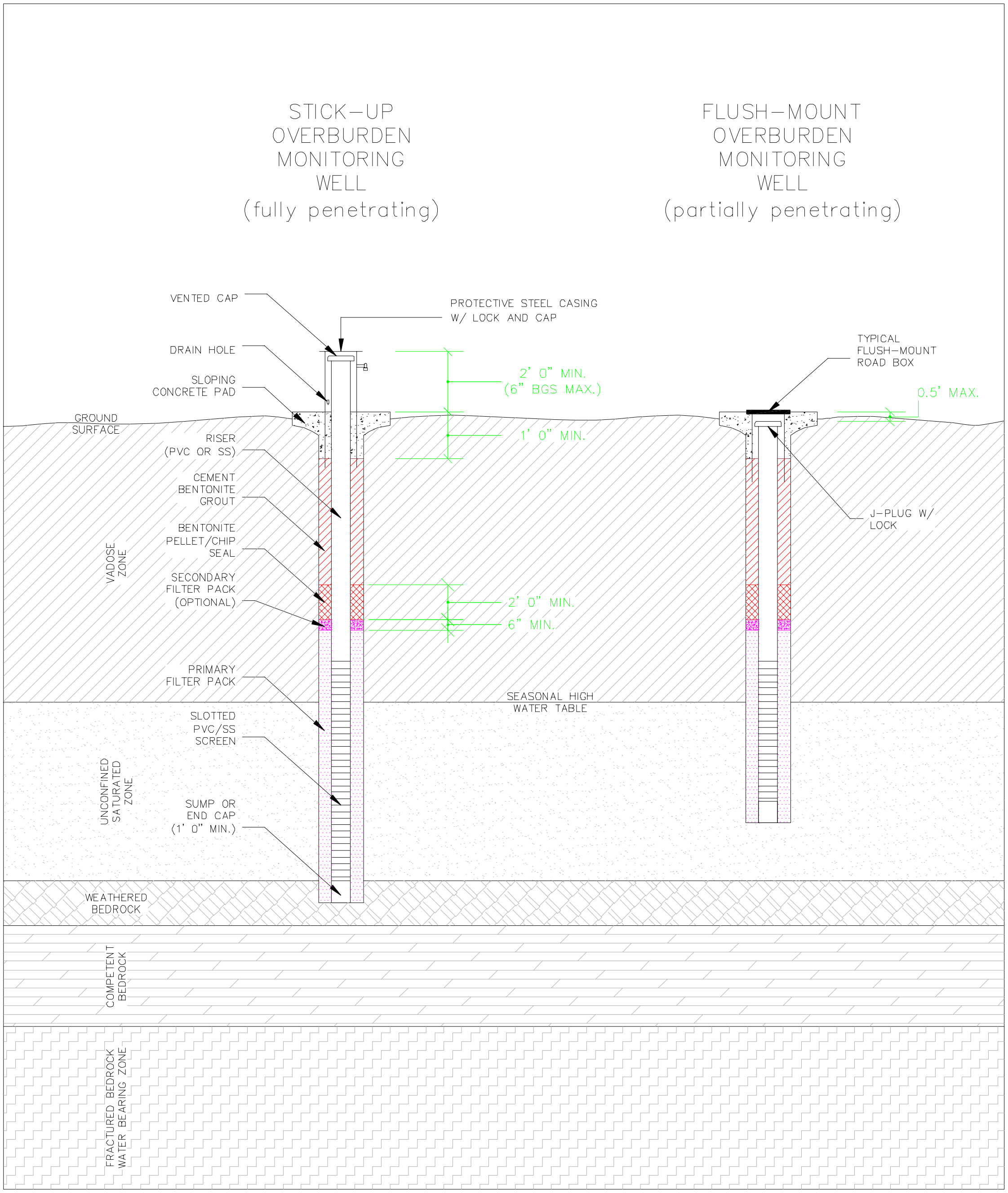
FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:	**Log of Well 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					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

FIGURE 1


STICK–UP OVERBURDEN MONITORING WELL (fully penetrating)
FLUSH–MOUNT OVERBURDEN MONITORING WELL (partially penetrating)
VENTED CAP
PROTECTIVE STEEL CASING W/ LOCK AND CAP
DRAIN HOLE
SLOPING CONCRETE PAD
GROUND SURFACE
RISER (PVC OR SS)
CEMENT BENTONITE GROUT
BENTONITE PELLET/CHIP SEAL
SECONDARY FILTER PACK (OPTIONAL)
PRIMARY FILTER PACK
SLOTTED PVC/SS SCREEN
SUMP OR END CAP (1' 0" MIN.)
2' 0" MIN. (6" BGS MAX.)
1' 0" MIN.
2' 0" MIN.
6" MIN.
SEASONAL HIGH WATER TABLE
TYPICAL FLUSH–MOUNT ROAD BOX
0.5' MAX.
J–PLUG W/ LOCK
VADOSE ZONE
UNCONFINED SATURATED ZONE
WEATHERED BEDROCK
COMPETENT BEDROCK
FRACTURED BEDROCK WATER BEARING ZONE

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FIELD OPERATING PROCEDURES

Monitoring Well Development Procedures

FOP 036.0

MONITORING WELL DEVELOPMENT PROCEDURES

PURPOSE

This procedure describes the methods for the development of newly installed monitoring wells and re-development of existing monitoring wells that have been inactive for an extended period of time (i.e., one year or more). Monitoring wells are developed after installation in order to remove introduced water and drilling fluids, reduce the turbidity of the water, and improve the hydraulic communication between the well and the water-bearing formation. Well development will not commence until the annular grout seal has cured, but will be performed within ten calendar days of well installation.

PROCEDURE

1. All well development will include surge blocking or false bailing with one or more of the following fluid removal methods. Well development activities may include:
   - Bailing
   - Air Lifting
   - Submersible Pumping
   - Other methods as approved by the Benchmark Field Team Leader.
   - The appropriate water removal method will be selected based on water level depth and anticipated well productivity.
2. Assemble and decontaminate equipment (if necessary), and place in the well. Reference the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
3. Alternate the use of agitation methods with water removal methods, using the former to suspend solids in the well water, and the latter to remove the turbid water. For example, use a vented surge block to agitate the well, moving up and down within the screened interval and then use a pump to clear the well. A bailer may be used for both purposes, by surging with the bailer (false

bailing) for a period within the screened interval, then bailing a volume of water from the well.

4. When using surging methods, initiate this activity gradually, with short (2 to 3 feet) strokes. After several passes across the screened interval, increase the speed and length of the surge strokes.

5. Continue development until the following objectives are achieved:

    - Field parameters stabilize to the following criteria:
        - Dissolved Oxygen: ± 0.3 mg/L
        - Turbidity: ± 10%
        - Specific Conductance: ± 3%
        - ORP: ± 10 mV
        - pH: ± 0.1 units
    - The well will generate non-turbid water during continued pumping typically less than 50 NTU.
    - A minimum of 10 well volumes has been evacuated from the well.
    - In the case of lost water during drilling activities, the volume of water removed exceeds twice the volume of water lost to the formation during the drilling process, as indicated by the water balance.

6. Document the development methods, volumes, field parameter measurements, and other observations on the attached Benchmark Groundwater Well Development Log (sample attached).

ATTACHMENTS

Groundwater Well Development Log (sample)

REFERENCES

<u>Benchmark FOPs:</u>
040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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GROUNDWATER WELL DEVELOPMENT LOG

Project Name:
WELL NUMBER:
Project Number:
Sample Matrix:
Client:
Weather:

WELL DATA:
DATE:
TIME:

Casing Diameter (inches):	Casing Material:
Screened interval (fbTOR):	Screen Material:
Static Water Level (fbTOR):	Bottom Depth (fbTOR):
Elevation Top of Well Riser (fmsl):	Datum Ground Surface: Mean Sea Level
Elevation Top of Screen (fmsl):	Stick-up (feet):

PURGING DATA:
DATE:
START TIME:
END TIME:

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): $V = 0.0408\ [\ (B)^2\ \times \{\ (A) - (C)\ \}\ ]$	

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469
8"	2.611

Stabilization Criteria

Parameter	Criteria
DO	+/- 0.3 mg/L
Turbidity	+/- 10%
SC	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

*Use the table to the right to calculate one well volume.

Field Personnel:

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (uS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor

REMARKS:

PREPARED BY:

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FIELD OPERATING PROCEDURES

Non-Aqueous Phase Liquid (NAPL) Detection and Sample Collection Procedure

FOP 039.1

NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

PURPOSE

This procedure describes the methods to detect the presence and sample collection of Non-Aqueous Phase Liquid (NAPL) in groundwater monitoring wells prior to purging activities. If NAPL is suspected, all activities should be performed with proper personnel protective equipment (PPE).

DETECTION PROCEDURE

Groundwater monitoring wells suspected of containing NAPL will be sounded with an interface probe, or similar device, in accordance with the following.

1. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Field Form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

2. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

3. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

4. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on the Groundwater Field Form (sample attached).

5. Slowly lower the interface probe down the well, avoiding contact with the well casing. Upon contact with the static liquid level in the well, the interface

probe will signal contact with an audible tone and/or a visible light mounted inside the reel.

Note:

- If the signal is constant, the probe is in contact with groundwater; and
- If the signal oscillates, the probe is in contact with NAPL.

6. Record the depth, type of liquid encountered (if applicable) and any other related information in the Project Field Book and on a Groundwater Field Form (sample attached).

7. Slowly lower the interface probe to the well bottom. Record the depth(s) and type(s) of any additional phases encountered.

8. Slowly raise the interface probe to the surface, avoiding contact with the well casing.

9. Place the interface probe and storage reel in a plastic bag for subsequent decontamination in accordance with the Benchmark's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

SAMPLE COLLECTION PROCEDURE

All NAPL samples collected from groundwater monitoring wells will be collected in accordance with the following.

1. Place plastic sheeting on the ground around the well to prevent equipment from coming in contact with soil and also to prevent the surface transmission of NAPL.

2. All sampling personnel will don the appropriate PPE in accordance with the site health and safety plan.

3. Measure the static water level and NAPL level(s) using an interface probe as described in the previous section.

4. Determine depth to NAPL layer and thickness. Record appropriate data in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

DNAPL SAMPLE COLLECTION

The following procedure should be used in sampling dense, heavier than water NAPL (i.e., with a high specific gravity) (DNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer until it contacts the well bottom.

3. Slowly raise and lower the bailer to create a gentle surging action thereby inducing DNAPL into the bailer past the bottom ball valve.

4. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.

5. Observe the DNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.

6. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and discharge the DNAPL gently down the side of the sample bottle to minimize turbulence.

7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.

8. Cap the sample bottle and label, preserve and ship samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.

10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

LNAPL SAMPLE COLLECTION

The following procedure should be used in sampling lighter than water NAPL (i.e., with a low specific gravity) (LNAPL).

1. Collect samples using a translucent double check valve bailer (i.e., a bailer with a ball valve on both the top and bottom) constructed of Teflon, polyethylene or PVC which is connected to polypropylene rope for lowering into the well. All non-dedicated equipment shall be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

2. Remove wrapping (i.e., aluminum foil, manufacturers packaging etc.), attach bailer to new polypropylene rope and slowly lower the bailer down the well into the immiscible phase of LNAPL. Care should be taken to lower the bailer just through the LNAPL layer, but not significantly down into the underlying groundwater.

3. Slowly raise the bailer to the surface. Avoid contact of the bailer line with the well casing and/or ground surface.

4. Observe the LNAPL through the translucent wall of the bailer and check if the immiscible phases have separated. If not, allow the bailer to stand upright until the phases have separated.

5. Carefully attach a bottom-emptying device with stopcock to the bottom of the bailer and decant the denser groundwater portion of the bailer contents into a DOT-approved 55-gallon drum for proper disposal.

6. Discharge the LNAPL gently down the side of the sample bottle to minimize turbulence.

7. Repeat steps 2 through 6 until a sufficient sample volume is obtained.

8. Cap the sample bottle and label, preserve and ship samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

9. Place the used plastic sheeting, bailer and polyethylene rope in a plastic bag for subsequent decontamination or disposal.

10. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Sample Collection Log form (sample attached).

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

Benchmark FOPs:

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*

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GROUNDWATER WE
PURGE & SAMPLE COLLECTION L

Project Name:
WELL NUMBER:
Project Number:
Sample Matrix:
Client:
Weather:

WELL DATA: DATE: TIME:

Casing Diameter (inches):	Casing Material:
Screened interval (fbTOR):	Screen Material:
Static Water Level (fbTOR):	Bottom Depth (fbTOR):
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):
Elevation Top of Screen (fmsl):	Stick-up (feet):

PURGING DATA: DATE: START TIME: END TIME:

Method:	Is purge equipement dedicated to sample location?	yes
No. of Well Volumes Purged:	Was well purged to dryness?	yes
Standing Volume (gallons):	Was well purged below top of sand pack?	yes
Volume Purged (gallons):	Condition of Well:	
Purge Rate (gal/min):	Field Personnel:	

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): $V = 0.0408 [(B)^2 \times \{ (A) - (C) \}]$	

* Use the table to the right to calculate one well volume by subtracting C from A, then multiplying by the volume calculation in the table per well diamter.

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

Stabilization Criteria

Parameter	Criteria	
pH	+/-	0.1 ur
SC	+/-	3%
Turbidity	+/-	10%
DO	+/-	0.3 m
ORP	+/-	10 m

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance ($\mu S/cm$)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance Odor
		initial							

SAMPLING DATA: DATE: START TIME: END TIME:

Method:	Is sampling equipement dedicated to sample location?	yes
Initial Water Level (fbTOR):	Was well sampled to dryness?	yes
Final Water Level (fbTOR):	Was well sampled below top of sand pack?	yes
Air Temperature (°F):	Field Personnel:	
Source and type of water used in the field for QC purposes:		

PHYSICAL & CHEMICAL DATA:

DESCRIPTION OF WATER SAMPLE		
Odor		
Color		
NAPL		
Contains Sediment?	yes no	

WATER QUALITY MEASUREMENTS

Sample	Time	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORI (mV)
initial							
final							

REMARKS:

PREPARED BY:

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FIELD OPERATING PROCEDURES

Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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 Benchmark 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

Benchmark FOPs:

032 Management of Investigation-Derived Waste

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FIELD OPERATING PROCEDURES

Overburden Casing Installation Procedure

FOP 041.0

OVERBURDEN CASING INSTALLATION PRCEDURES

PURPOSE

This guideline presents a method for the installation of casing to prevent downhole contamination of hazardous compounds from shallow overburden material. This method is particularly applicable where contaminated strata overlie uncontaminated strata of lower permeability. The method can be used with hollow stem auger drilling or rotary wash drilling (where temporary casing is used). This guideline also presents a method for the evaluation of the integrity of the grout seal around an overburden casing, which has been positioned into a confining layer.

CASING INSTALLATION PROCEDURE

1. Advance boring by appropriate drilling methods, through the contaminated strata a short distance (1 to 2 feet) into an underlying lower permeable unit.

2. Calculate the volume of the borehole base on the bit/auger head or steel casing diameter plus 10% and determine the volume of grout to be emplaced. Generally, the total mixed volume is the borehole volume plus 20%.

3. Identify the equipment to be used for the preparation and mixing of the grout. Ensure the volume of the tanks to be used for mixing has been measured adequately. Document these volumes on the Field Borehole/Monitoring Well Installation Log (sample attached).

4. Identify the source of the water to be used for the grout and determine its suitability for use. In particular, water with high sulfate, or chloride levels or heated water should not be used. These types of waters can cause operational difficulties or modify the set-up for the grout.

5. Identify the equipment to be used for emplacing the grout. Ensure that the pump to be used has adequate pressure to enable complete return to surface.

6. Identify the volumes to be pumped at each stage or in total if only one stage is to be used.

7. Begin mixing the grout to be emplaced. Grout specifications generally have mixture ratios as follows:

   Grout Slurry Composition (% Weight)

1.5 to 3.0%	-	Bentonite (Quick Gel)
40 to 60 %	-	Cement (Portland Type I)
40 to 60 %	-	Potable Water

8. Record the type and amount of materials used during the mixing operation. Ensure the ratios are within specifications tolerance.

9. Begin pumping the grout through the return line bypass system to confirm all pump and surface fittings are secure.

10. Remove drill rods and center plug (or clean out temporary casing) and insert a tremie pipe to the bottom of the boring. Pump the cement/bentonite grout slurry through the tremie pipe until grout return is observed at grade and no bridging of the slurry is evident. Slowly withdraw the augers (or casing) from the boring while maintaining the grout level at grade. Record the times and volumes emplaced on the Field Borehole/Monitoring Well Installation Log (sample attached).

11. Document the return circulation of grout. This may be facilitated by using a colored dye or other tagging method if a mudded borehole condition exists prior to grout injection.

12. Place a drillable plug (preferably untreated wood) at the downhole end of black steel or other appropriate casing, insert the casing through the slurry, and seat it into the underlying formation.

13. Allow grout to set for 24 to 48 hours.

HYDROSTATIC TESTING OF CASING PROCEDURE

1. Following adequate setting time for the grout, drill through the grout inside the casing until the top of the confining layer has been reached (refer to Field Borehole/Monitoring Well Installation Log during casing installation).

2. Fill the casing with potable water and measure the water level within the casing with a water level indicator to the nearest 0.01-foot and record the measurement on the Pipe Leakage Testing Log (sample attached).

3. Monitor the water level for 30 minutes and record the final water level within the casing with a water level indicator to the nearest 0.01-foot and record the measurement on the Pipe Leakage Testing Log (sample attached).

4. Should the water level drop more than the allowable volume calculated using the following equation, the seal shall be regrouted at the Subcontractor's expense.

   $$Q_{(allowable)} = 2.75\ DKH$$

   Where:
   $Q_{(allowable)}$ = Flow rate during a 30 minute test
   D = Inside diameter of overburden casing
   K = Confining layer hydraulic conductivity (see Table 1)
   H = Head of water applied

   Note: Be sure to use consistent units of measure.

ATTACHMENTS

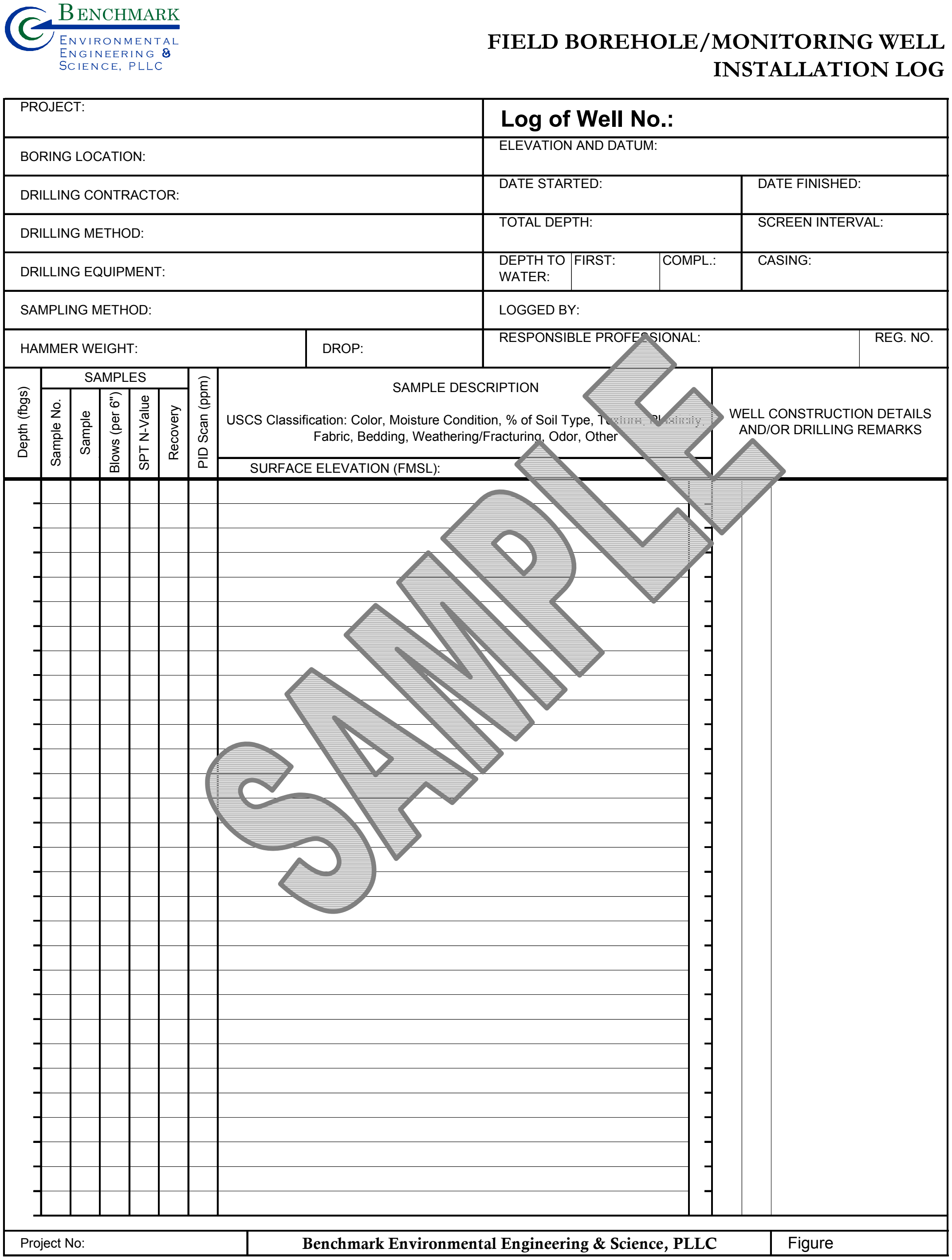
Field Borehole/Monitoring Well Installation Log (sample)
Pipe Leakage Testing Log (sample)

Table 1 – Range of Values of Hydraulic Conductivity and Permeability

REFERENCES

Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc., Englewood, New Jersey, 604 p.

Benchmark FOPs:
018 Drilling and Excavation Equipment Decontamination Protocols



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		Log of Well 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					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		SURFACE ELEVATION (FMSL):	

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

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PIPE LEAKAGE TESTING LOG

Project: Location:
Client: Date:
Job No: BM Personnel:

Location Description	Test Procedure (Air or Hydrostatic)	QC Initials	Readings				Elapsed Time (minutes)	Change in Pressure/ Water Level (psi/fbMP)	Pass/Fail	Passing Retest Date	Comments/Notes
			Start		End						
			Pressure or Water Level	Time	Pressure or Water Level	Time					

Prepared By: Date:

TABLE 1: (From Freeze and Cherry, page 29.)

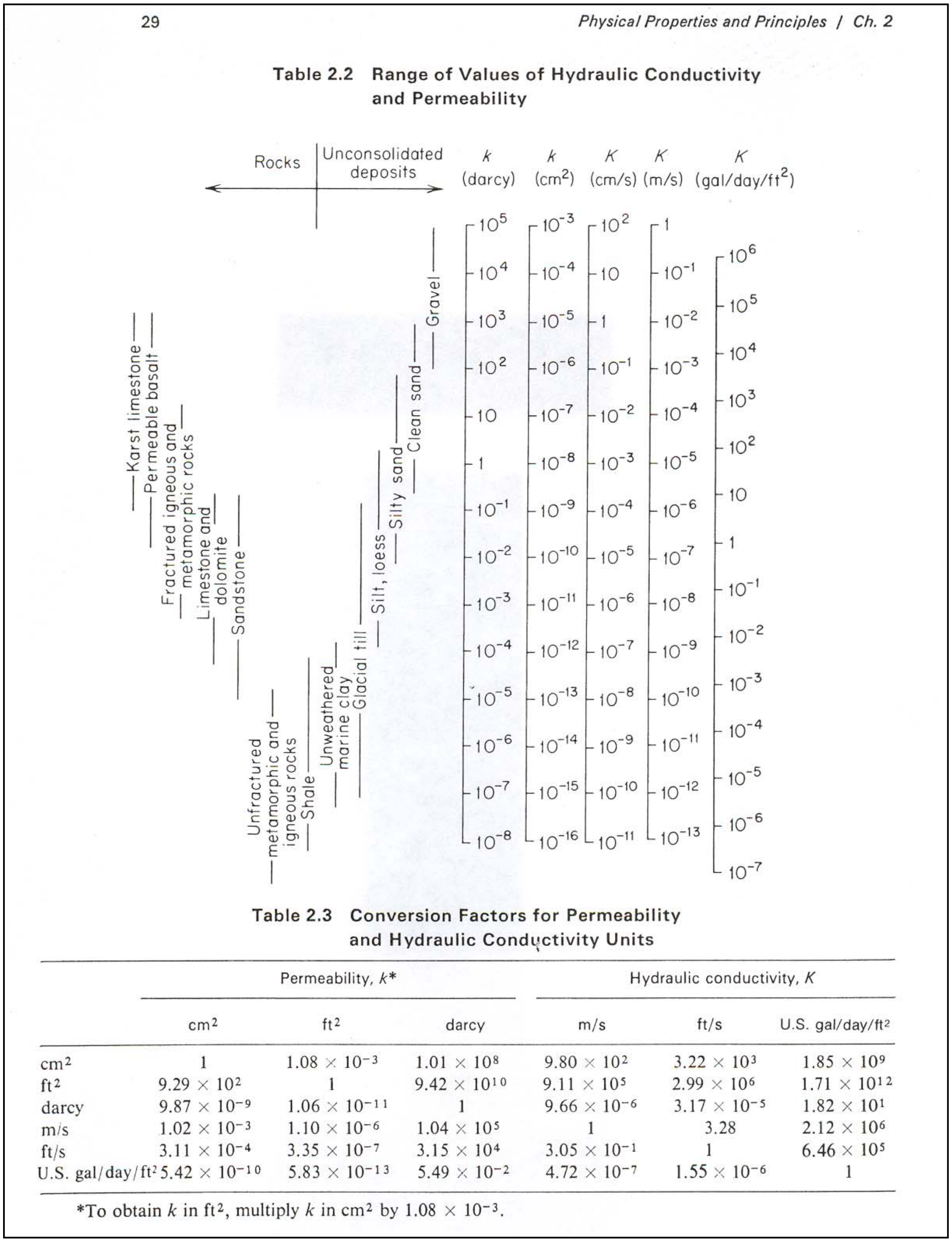

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, *k**			Hydraulic conductivity, *K*		
	cm^2	ft^2	darcy	m/s	ft/s	U.S. gal/day/ft^2
cm^2	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft^2	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft^2	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain *k* in ft^2, multiply *k* in cm^2 by 1.08×10^{-3}.

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FIELD OPERATING PROCEDURES

Sample Labeling, Storage, and Shipment Procedures

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 Benchmark 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 Benchmark 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

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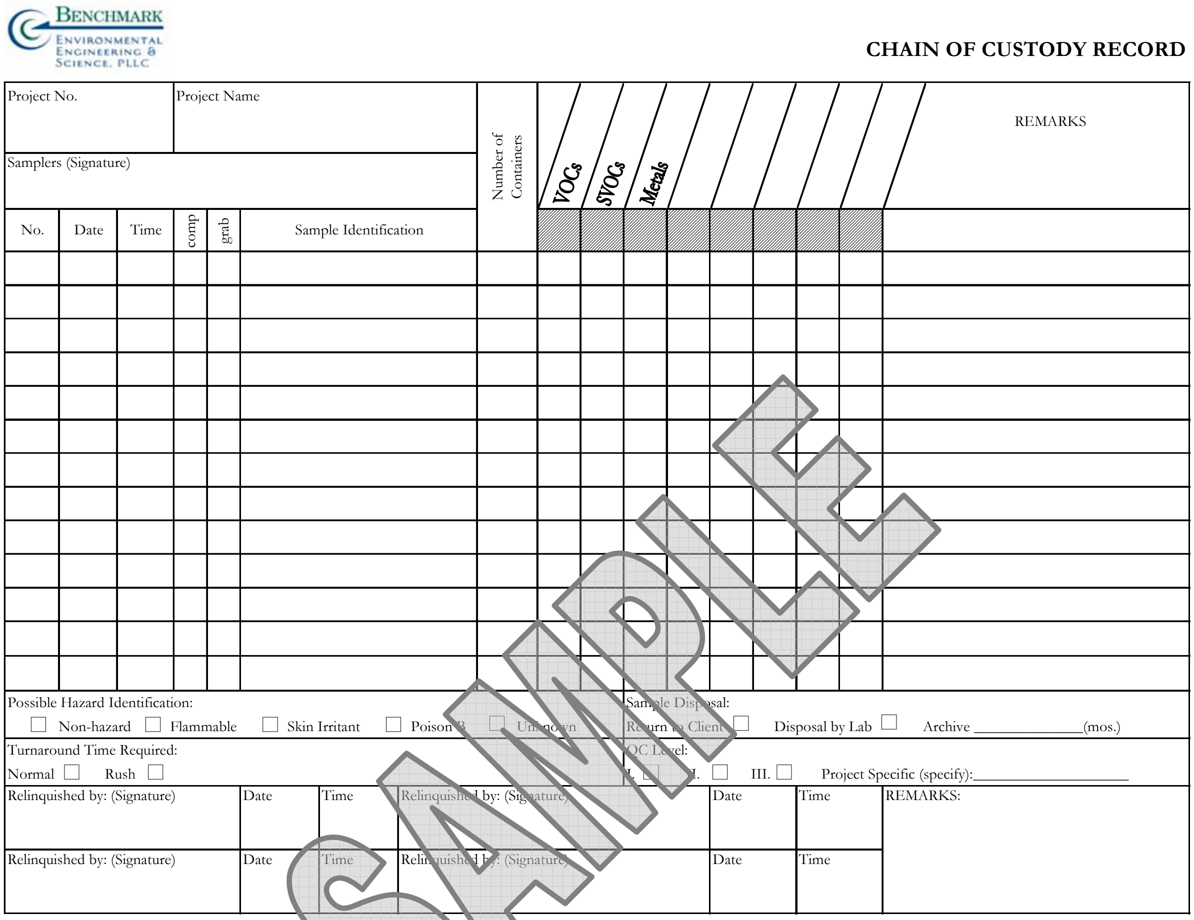
AIR SAMPLE COLLECTION SUMMARY LOG

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.



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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	

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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

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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.

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CHAIN OF CUSTODY RECORD

Project No.

Project Name

Samplers (Signature)

No.	Date	Time	comp	grab	Sample Identification	Number of Containers	VOCs	SVOCs	Metals						REMARKS
							▨	▨	▨	▨	▨	▨	▨	▨	

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	

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FIELD OPERATING PROCEDURES

Screening of Soil Samples for Organic Vapors During Drilling Activities

FOP 047.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. These meters will be either photoionization detector (PID) or flame-ionization detector (FID) type. This screening is performed at the drilling and sampling location as a procedure for ensuring the health and safety of personnel at the site and to identify potentially contaminated soil samples for laboratory analysis. All soil samples will be field screened to provide a vertical profile of soil contamination by volatile organic substances.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect split-spoon (or other sampler) samples in accordance with Benchmark's Split Spoon Sampling Procedure FOP.

3. When the split-spoon or other sampler is opened or accessed, shave a thin layer of material from the entire length of the core.

4. Scan the core visually and with the PID or FID noting stratification, visible staining, or other evidence of contamination.

5. Based on this initial scan of the sample, collect approximately 100 milliliters (ml) of soil using a decontaminated or dedicated stainless steel spatula, scoop, or equivalent. Place this soil into a labeled wide-mouth glass jar approximately ½ to ¾ full and seal with aluminum foil and a screw top cap. Alternatively, the soil may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave some headspace above the soil sample within the sealed container.

6. Place field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit.

7. Leave the field screening sample bag for at least 30 minutes, but no more than 60 minutes.

8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.

9. Record the maximum reading in parts per million by volume (ppmv) on the Field Borehole Log or Field Borehole/Monitoring Well Installation Log form (see attached samples) (see Documentation Requirements for Drilling and Well Installation FOP), at the depth interval corresponding to the depth of sample collection.

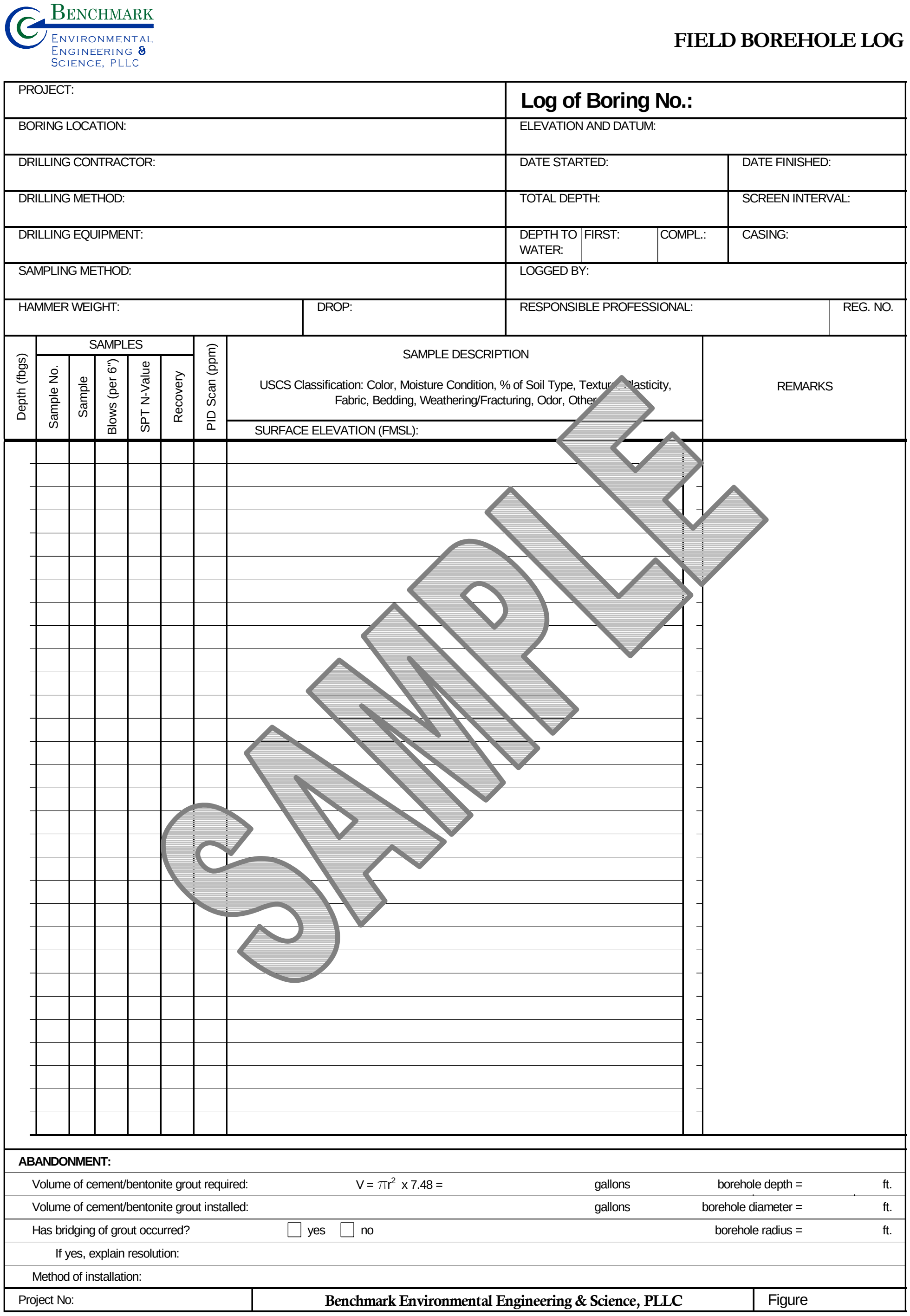
ATTACHMENTS

Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)

REFERENCES

Benchmark 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*
058	*Split Spoon Sampling Procedures*



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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					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

ABANDONMENT:

Volume of cement/bentonite grout required: $V = \pi r^2 \times 7.48 =$ gallons borehole depth = ft.

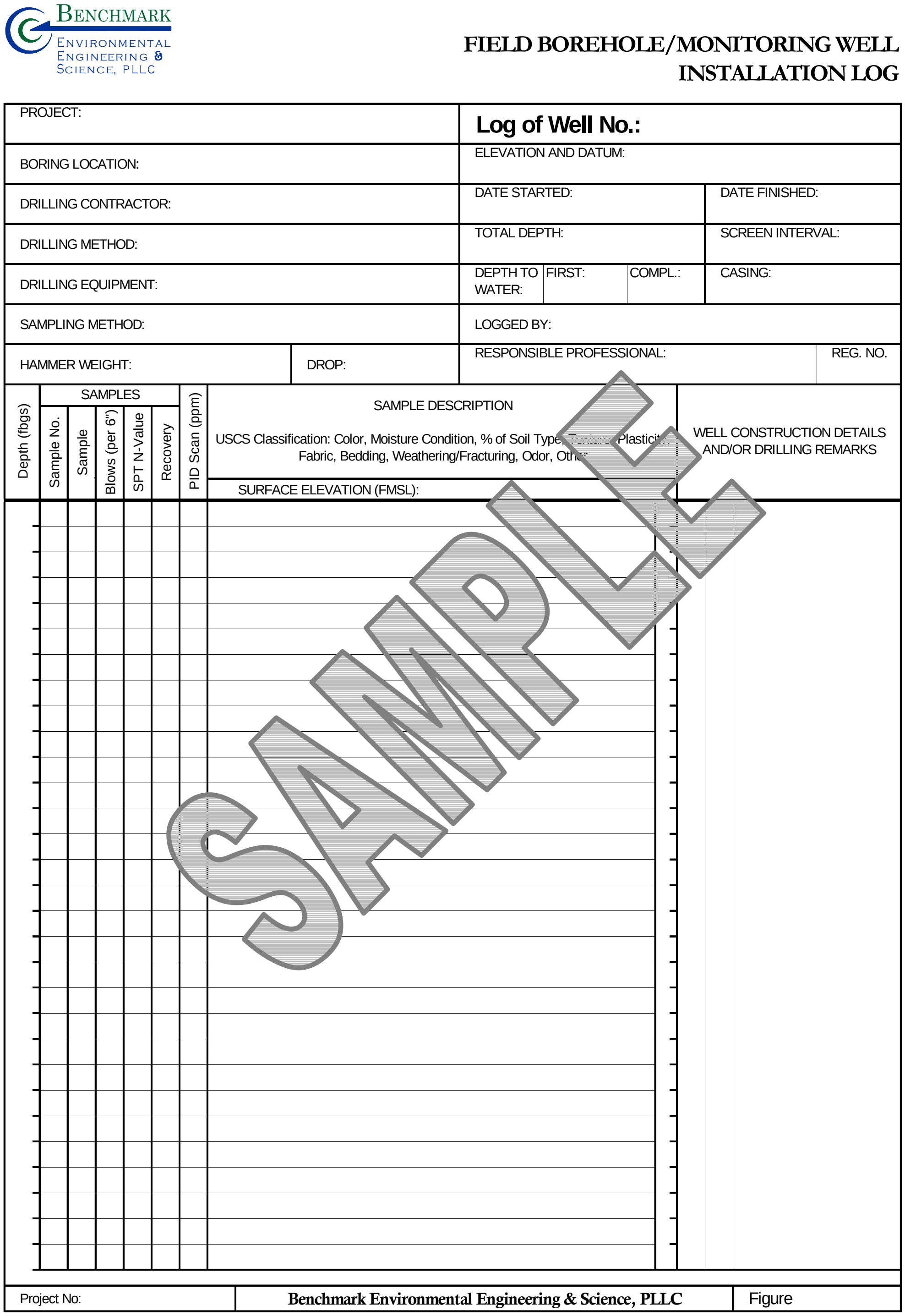
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		**Log of Well 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 USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

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FIELD OPERATING PROCEDURES

Screening of Soil Samples for Organic Vapors During Impacted Soil Removal Activities

FOP 048.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING IMPACTED SOIL REMOVAL ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. The field meter should either be a photoionization detector (PID) or flame-ionization detector (FID) type. This type of screening is generally performed during underground storage tank (UST) and/or impacted soil removal activities as a procedure for ensuring the health and safety of the community and personnel at the site as well as to identify potential VOC-impacted soil samples for laboratory analysis (i.e., confirmatory or verification samples). Soil samples are also screened in the field to provide assessment criteria to determine horizontal and vertical extents of VOC-impacts in order to ensure soils that may have been impacted by volatile organic substances are removed.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Perform community air monitoring in accordance with the Project Work Plan and/or Benchmark's FOP: Real-Time Air Monitoring During Intrusive Activities.

3. Upon proper removal of any identified UST in accordance with NYSDEC Division of Environmental Remediation, Spill Response Unit or Bulk Storage Unit guidelines and/or Benchmark's FOP: Underground Storage Tank Removal Procedures; examine the four sidewalls and bottom of the excavation for visually impacted (i.e., stained) soils.

4. If visually impacted soils are identified, direct the excavating equipment operator to scrape the impacted area (i.e., sidewall or bottom of the excavation) and present the scraped soil for evaluation. NOTE: Under no circumstances should anyone enter an excavation greater than 4 feet in depth, unless absolutely necessary. Excavation entry may only occur under strict confined space entry procedures following implementation of specific engineering controls (i.e., continuous air monitoring, excavation shoring, trench box installation, benching).

5. Visually inspect and perform an open air PID/FID scan of the scraped soil sample noting stratification, visible staining, or other evidence of impact (i.e., presence of non-aqueous phase liquid, NAPL).

6. Collect a representative sample (approximately 100 milligrams (mg)) of soil using a decontaminated or dedicated stainless steel sampling tool (i.e., spoon, spatula, scoop, or approved equivalent), for field headspace determination of VOC-impact. Place the representative soil sample into a labeled wide-mouth glass jar approximately ½ to ¾ full and seal with aluminum foil and a screw top cap. Alternatively, the soil sample may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave adequate headspace above the soil sample within either sealed container.

7. Place the field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit for at least 15 minutes, but no more than 60 minutes.

8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.

9. Record the depth, sample location (i.e., sidewall, bottom) and <u>maximum</u> reading in parts per million by volume (ppmv) in the Project Field Book and Impacted Soil Excavation Log (sample attached), at the depth interval corresponding to the depth of sample collection.

10. The representative soil samples collected from the excavation will be used to assess the vertical and horizontal limits of VOC-impact and guide the impacted soil removal activities in accordance with project requirements (i.e., PID scans less than 20 ppm will not require removal unless laboratory analytical results exceed regulatory limits).

11. Collect verification/confirmation samples in accordance with NYSDEC Division of Environmental Remediation, Spill Response Unit or Bulk Storage Unit guidelines and/or Benchmark's FOP: Surface and Subsurface Soil Sampling Procedures.

ATTACHMENTS

Impacted Soil Excavation Log (sample)

REFERENCES

<u>Benchmark FOPs:</u>
010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
063 *Surface and Subsurface Soil Sampling Procedures*
073 *Real-Time Air Monitoring During Intrusive Activities*
074 *Underground Storage Tank Removal Procedures*

FOP 048.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING IMPACTED SOIL REMOVAL ACTIVITIES

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IMPACTED SOIL EXCAVATION LOG

Project:	EXCAVATION I.D.:
Project No.:	Excavation Date:
Client:	Excavation Method:
Location:	CQA Observer:

Excavation Location: *NOT TO SCALE* *(approximate)*	Excavation Cross Section: Grade - 0' 2' 4' 6' 8' 10' 12' 14' 16' 18' 20'

TIME		
Start:	Length:	(approx.)
End:	Width:	(approx.)
	Depth:	(approx.)

Verification Sample I.D.	Depth (fbgs)	Location Within Excavation (sidewall/bottom)	PID Scan (ppm)	PID Headspace (ppm)	Photos Y / N	

COMMENTS:

UST ENCOUNTERED:	☐ yes	☐ no	If yes, Describe (type, material, size, capacity etc.):
GROUNDWATER ENCOUNTERED:	☐ yes	☐ no	If yes, depth to GW:
VISUAL IMPACTS:	☐ yes	☐ no	Describe:
OLFACTORY OBSERVATIONS:	☐ yes	☐ no	Describe:
NON-NATIVE FILL ENCOUNTERED:	☐ yes	☐ no	
OTHER OBSERVATIONS:	☐ yes	☐ no	Describe:

QUANTITY OF IMPACTED SOIL REMOVED:

FINAL DESTINATION OF IMPACTED SOIL:

TYPE OF BACKFILL:

SURFACE COMPLETION:

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FIELD OPERATING PROCEDURES

Soil Description Procedures Using The Visual-Manual Method

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 Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect desired soil sample in accordance with appropriate Benchmark 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 Benchmark'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 Benchmark's Sample Labeling, Storage and Shipment Procedures FOP.

9. All remaining soil from soil sample collection activities shall be containerized in accordance with Benchmark'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^{o} C (140^{o} 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, <u>low</u> 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, Benchmark 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).*

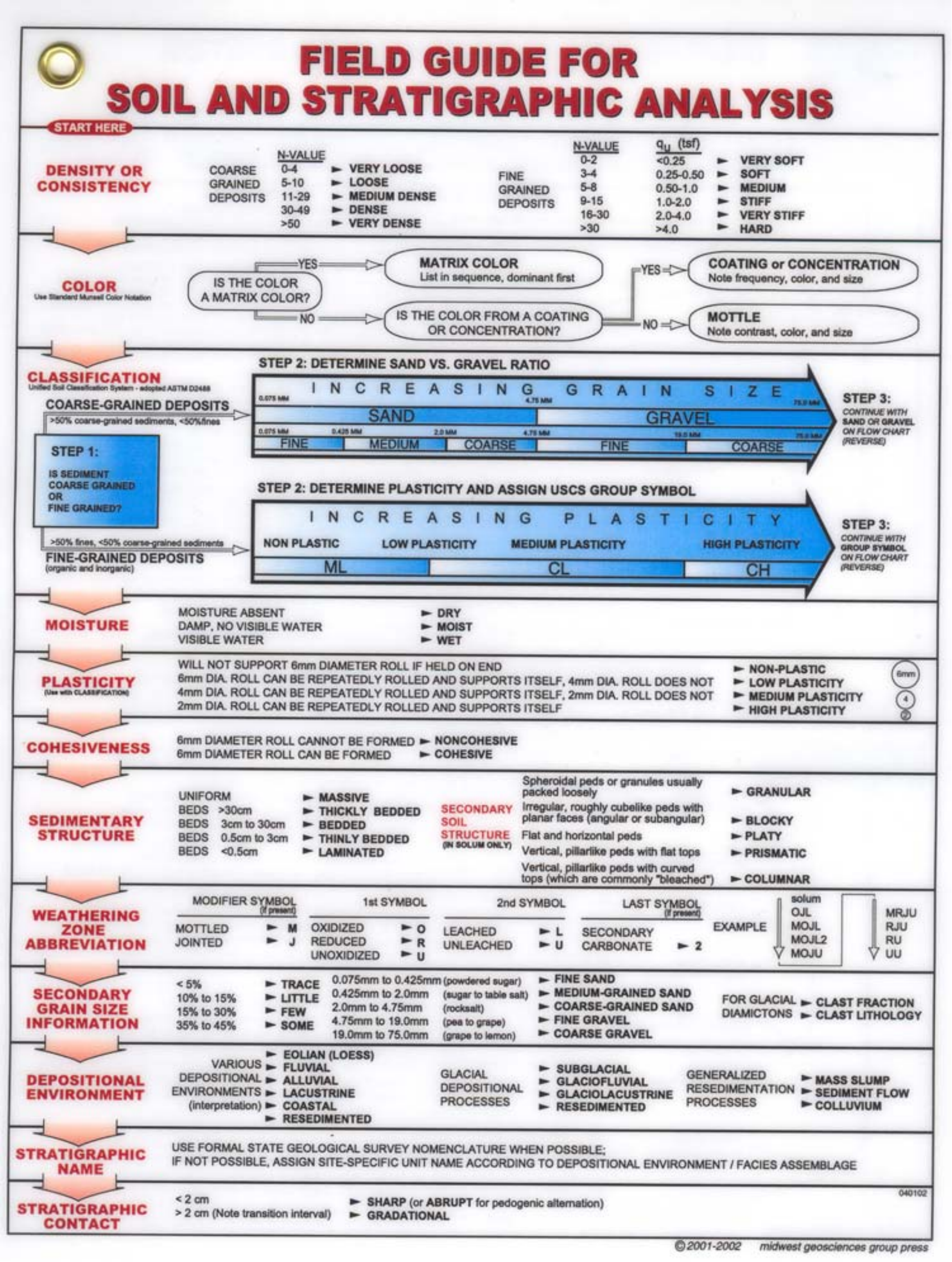
State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1996. *Soil & Rock Logging Classification Manual (Field Guide), by Joseph C. de Larios.*

Benchmark 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*

FIGURE 1

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS

START HERE

DENSITY OR CONSISTENCY

COARSE GRAINED DEPOSITS N-VALUE		FINE GRAINED DEPOSITS N-VALUE	q_u (tsf)	
0-4	► VERY LOOSE	0-2	<0.25	► VERY SOFT
5-10	► LOOSE	3-4	0.25-0.50	► SOFT
11-29	► MEDIUM DENSE	5-8	0.50-1.0	► MEDIUM
30-49	► DENSE	9-15	1.0-2.0	► STIFF
>50	► VERY DENSE	16-30	2.0-4.0	► VERY STIFF
		>30	>4.0	► HARD

COLOR
Use Standard Munsell Color Notation

IS THE COLOR A MATRIX COLOR?
YES ► MATRIX COLOR — List in sequence, dominant first
NO ► IS THE COLOR FROM A COATING OR CONCENTRATION?
YES ► COATING or CONCENTRATION — Note frequency, color, and size
NO ► MOTTLE — Note contrast, color, and size

CLASSIFICATION
Unified Soil Classification System - adopted ASTM D2488

STEP 1: IS SEDIMENT COARSE GRAINED OR FINE GRAINED?

COARSE-GRAINED DEPOSITS
>50% coarse-grained sediments, <50%fines

STEP 2: DETERMINE SAND VS. GRAVEL RATIO

INCREASING GRAIN SIZE

0.075 MM — SAND — 4.75 MM — GRAVEL — 75.0 MM

0.075 MM FINE 0.425 MM MEDIUM 2.0 MM COARSE 4.75 MM FINE 19.0 MM COARSE 75.0 MM

STEP 3: *CONTINUE WITH SAND OR GRAVEL ON FLOW CHART (REVERSE)*

FINE-GRAINED DEPOSITS
(organic and inorganic)
>50% fines, <50% coarse-grained sediments

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL

INCREASING PLASTICITY

NON PLASTIC — LOW PLASTICITY — MEDIUM PLASTICITY — HIGH PLASTICITY

ML — CL — CH

STEP 3: *CONTINUE WITH GROUP SYMBOL ON FLOW CHART (REVERSE)*

MOISTURE

MOISTURE ABSENT ► DRY
DAMP, NO VISIBLE WATER ► MOIST
VISIBLE WATER ► WET

PLASTICITY
(Use with CLASSIFICATION)

WILL NOT SUPPORT 6mm DIAMETER ROLL IF HELD ON END ► NON-PLASTIC
6mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 4mm DIA. ROLL DOES NOT ► LOW PLASTICITY
4mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 2mm DIA. ROLL DOES NOT ► MEDIUM PLASTICITY
2mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF ► HIGH PLASTICITY

6mm
4
2

COHESIVENESS

6mm DIAMETER ROLL CANNOT BE FORMED ► NONCOHESIVE
6mm DIAMETER ROLL CAN BE FORMED ► COHESIVE

SEDIMENTARY STRUCTURE

UNIFORM ► MASSIVE
BEDS >30cm ► THICKLY BEDDED
BEDS 3cm to 30cm ► BEDDED
BEDS 0.5cm to 3cm ► THINLY BEDDED
BEDS <0.5cm ► LAMINATED

SECONDARY SOIL STRUCTURE (IN SOLUM ONLY)

Spheroidal peds or granules usually packed loosely ► GRANULAR
Irregular, roughly cubelike peds with planar faces (angular or subangular) ► BLOCKY
Flat and horizontal peds ► PLATY
Vertical, pillarlike peds with flat tops ► PRISMATIC
Vertical, pillarlike peds with curved tops (which are commonly "bleached") ► COLUMNAR

WEATHERING ZONE ABBREVIATION

MODIFIER SYMBOL (if present)		1st SYMBOL		2nd SYMBOL		LAST SYMBOL (if present)	
MOTTLED	► M	OXIDIZED	► O	LEACHED	► L	SECONDARY CARBONATE	► 2
JOINTED	► J	REDUCED	► R	UNLEACHED	► U		
		UNOXIDIZED	► U				

EXAMPLE
solum
OJL
MOJL
MOJL2
MOJU
MRJU
RJU
RU
UU

SECONDARY GRAIN SIZE INFORMATION

< 5% ► TRACE
10% to 15% ► LITTLE
15% to 30% ► FEW
35% to 45% ► SOME

0.075mm to 0.425mm (powdered sugar) ► FINE SAND
0.425mm to 2.0mm (sugar to table salt) ► MEDIUM-GRAINED SAND
2.0mm to 4.75mm (rocksalt) ► COARSE-GRAINED SAND
4.75mm to 19.0mm (pea to grape) ► FINE GRAVEL
19.0mm to 75.0mm (grape to lemon) ► COARSE GRAVEL

FOR GLACIAL DIAMICTONS ► CLAST FRACTION ► CLAST LITHOLOGY

DEPOSITIONAL ENVIRONMENT

VARIOUS DEPOSITIONAL ENVIRONMENTS (interpretation)
► EOLIAN (LOESS)
► FLUVIAL
► ALLUVIAL
► LACUSTRINE
► COASTAL
► RESEDIMENTED

GLACIAL DEPOSITIONAL PROCESSES
► SUBGLACIAL
► GLACIOFLUVIAL
► GLACIOLACUSTRINE
► RESEDIMENTED

GENERALIZED RESEDIMENTATION PROCESSES
► MASS SLUMP
► SEDIMENT FLOW
► COLLUVIUM

STRATIGRAPHIC NAME

USE FORMAL STATE GEOLOGICAL SURVEY NOMENCLATURE WHEN POSSIBLE;
IF NOT POSSIBLE, ASSIGN SITE-SPECIFIC UNIT NAME ACCORDING TO DEPOSITIONAL ENVIRONMENT / FACIES ASSEMBLAGE

STRATIGRAPHIC CONTACT

< 2 cm ► **SHARP** (or **ABRUPT** for pedogenic alternation)
> 2 cm (Note transition interval) ► **GRADATIONAL**

040102

FIGURE 2

USCS SOIL CLASSIFICATION FLOW CHART
(MODIFIED FROM ASTM D2488)

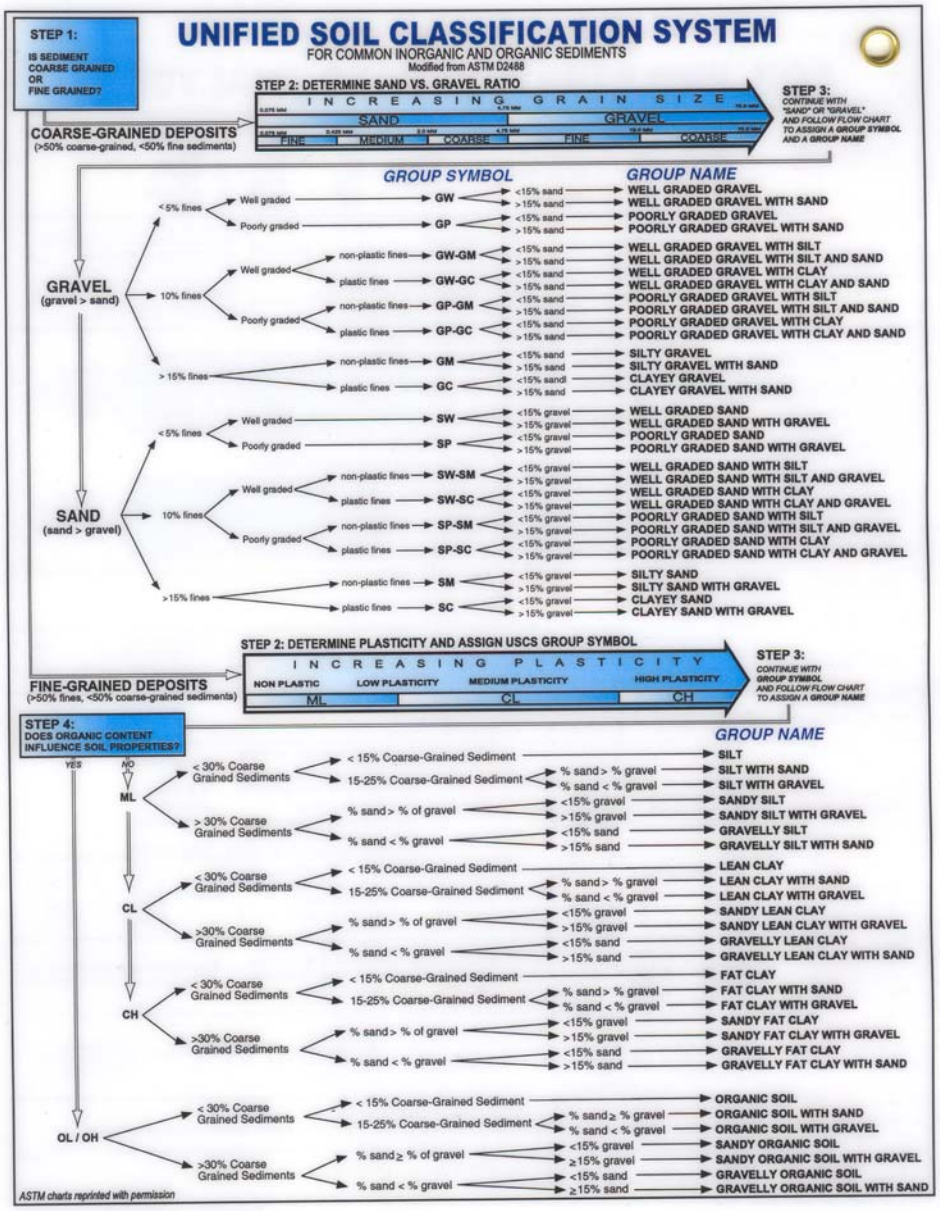


FIGURE 3

ILLUSTRATION OF PARTICLE SIZES

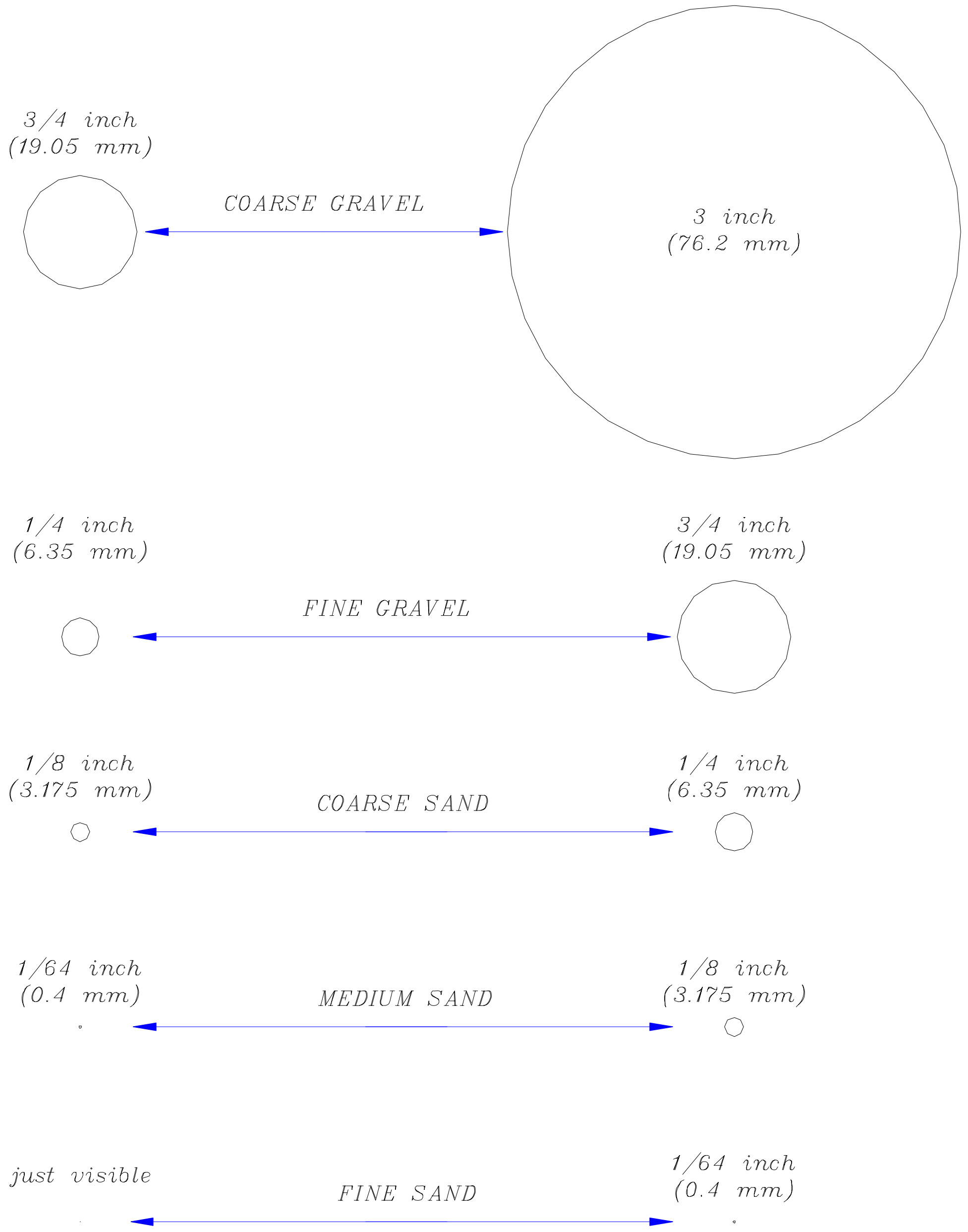


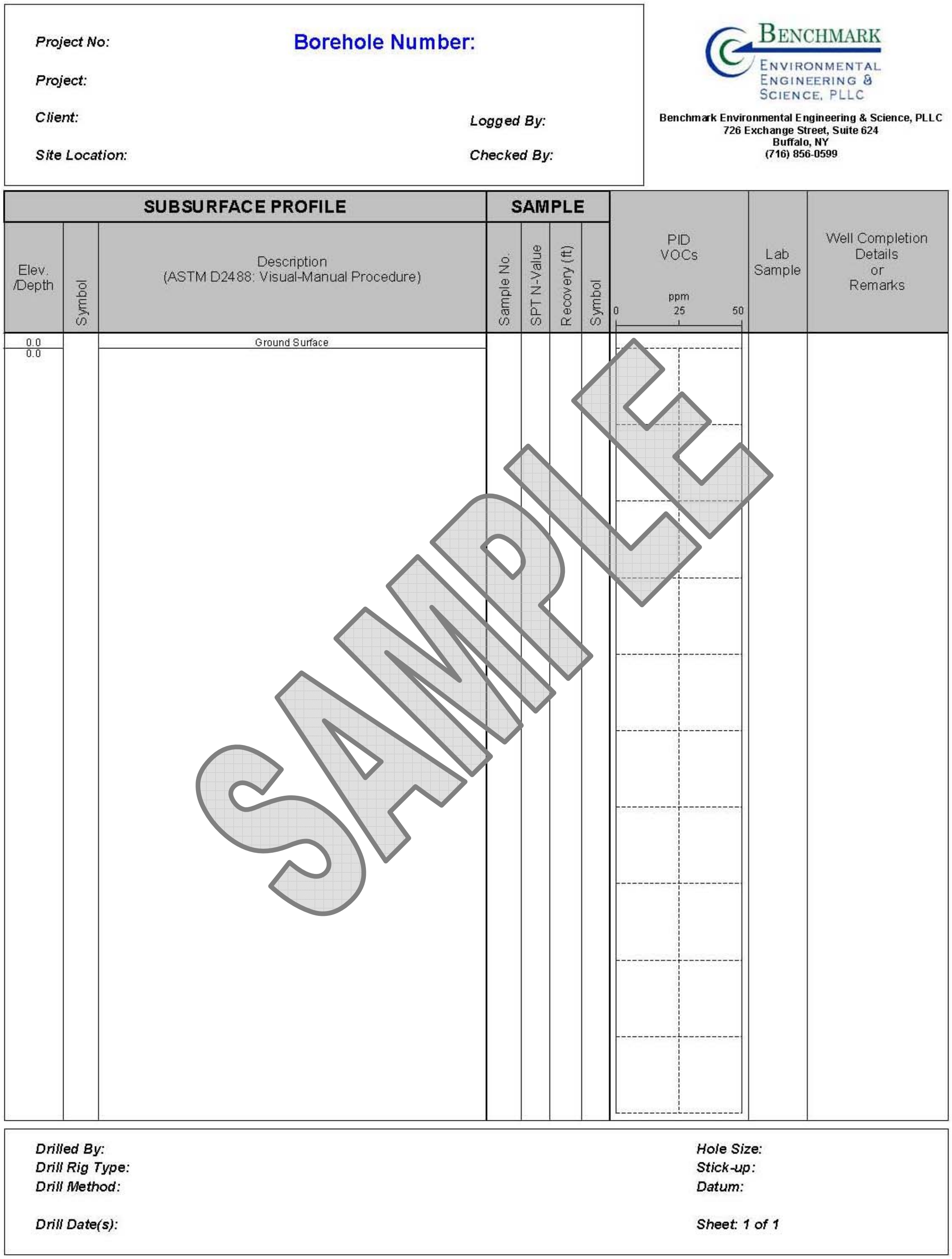
FIGURE 4

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).



Project No: **Borehole Number:**

Project:

Client: Logged By:

Site Location: Checked By:

Benchmark Environmental Engineering & Science, PLLC
726 Exchange Street, Suite 624
Buffalo, NY
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE				PID VOCs ppm 0 25 50	Lab Sample	Well Completion Details or Remarks
Elev. /Depth	Symbol	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol			
0.0 0.0		Ground Surface							

Drilled By:
Drill Rig Type:
Drill Method:

Drill Date(s):

Hole Size:
Stick-up:
Datum:

Sheet: 1 of 1

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Soil Sample Collection for VOC Analysis (EnCore Sampling)

FOP 057.0

SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

BACKGROUND AND PURPOSE

This procedure describes the methods for collecting soil samples for VOC analysis to ensure that the sample adequately represents the VOC concentrations in the soil in accordance with SW-846 Method 5035A (effective July 1, 2002). These compounds tend to volatilize from the soil after disturbance or introduction to the atmosphere. Therefore, care must be exercised to ensure that the sample collected is not altered during the collection and storage procedures. A variety of sampling options are allowed and Appendix A of Method 5035A provides details regarding the many options available for sample collection. The collection and preservation procedures are intended to prevent loss of VOCs during sample transport, handling and analysis.

Method 5035A is a method designed for volatile sample collection and analysis of soils and solid wastes for volatile organic compounds. This method is described in Update III to the Third Edition of SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, and is required for all analytical methods using purge and trap techniques (8021, 8015B, and 8260B). Alternative protocols may be used in some states (including New York), however this method is strongly recommended.

The volatile analysis is performed over two ranges:

	GC/MS (µg/kg)	GC (µg/kg)
Low Level	5 – 300	Not Available
High Level	>250	>20

The different levels require different sampling techniques. The low level method can only handle samples within a specific concentration range (these samples CANNOT be diluted), therefore a high level sample MUST be collected to ensure that all the target analytes can be quantified.

Naturally occurring carbonates in some soils may cause effervescence (foaming) on contact with the sodium bisulfate (NaHSO4) solution used as preservative for the low-level preparation. This interference makes it necessary for the laboratory to use the high-level prep or an alternative technique for low level. Check with the NYSDEC to discuss acceptable options.

Typically, analytical laboratories will support the following options for the two levels:

Option	No. of Containers	Sample Size (g)	Holding Time (days)
A – Low Level EnCore™ Samplers	3*	5	14**
B – High Level EnCore™ Sampler	1*	5	14**
C – High Level Methanol vial w/syringe	1	10	14

* Additional EnCore™ Samplers are required for MS/MSD.

** The sample MUST be extracted and preserved in sodium bisulfate or methanol within 48 hours of collection.

NOTE: The EnCore™ Sampler is disposable – it can only be used ONCE. It CANNOT be cleaned and/or reused. The samplers MUST be used in conjunction with an EnCore™ T-handle.

PROCEDURE

The preferred method for collecting and storing a soil sample for VOC analysis is using the EnCore™ method. This field procedure is described in this FOP.

1. The sampling team should reference the manufacturers' directions prior to sample collection (attached).
    a. Ensure that the EnCore™ Sampler is present at the sampling location before collecting the sample from the borehole or surface sample location. The necessary parts of the EnCore™ Sampler will consist of three disposable coring bodies, three disposable caps, and a reusable stainless steel T-handle.
    b. Retrieve the sampling tool from the borehole or sample location.
    c. Expose a surface of the soil sample. For Shelby tube samples, this would require the extrusion of the sample. For split spoon samples, this would require the spoon be disassembled and opened. If liners are being used in conjunction with a split spoon or solid barrel sampler, this would require the removal of the liners from the sampler, so that the soil at the liner's end is exposed.
    d. Following the manufacturer's directions for the use of the EnCore™ Sampler (attached), collect three aliquots of soil from the exposed soil surface, using the three coring bodies. After the collection of each aliquot, cap and label each aliquot. The manufacturer's direction for use of the EnCore™ Sampler are attached

2. If the use of the EnCore™ Sampler is not possible due to soil texture (e.g. gravels) the sample must be field preserved with acid and methanol in accordance with SW-846 Method 5035A.

3. If the soil material is too coarse for sampling with the EnCore™ Sampler and contains excessive calcium carbonate material that reacts with the acid preservative, the sample will be retained in the brass or stainless steel liner of the split-spoon sampler or similar device. The ends of these liners will be covered with Teflon™ rounds, capped and sealed with tape.

4. Record all information associated with sample collection in the Project Field Book.

5. The samples will be labeled, stored and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

EnCore™ Sampling Procedure (manufacturers instructions)

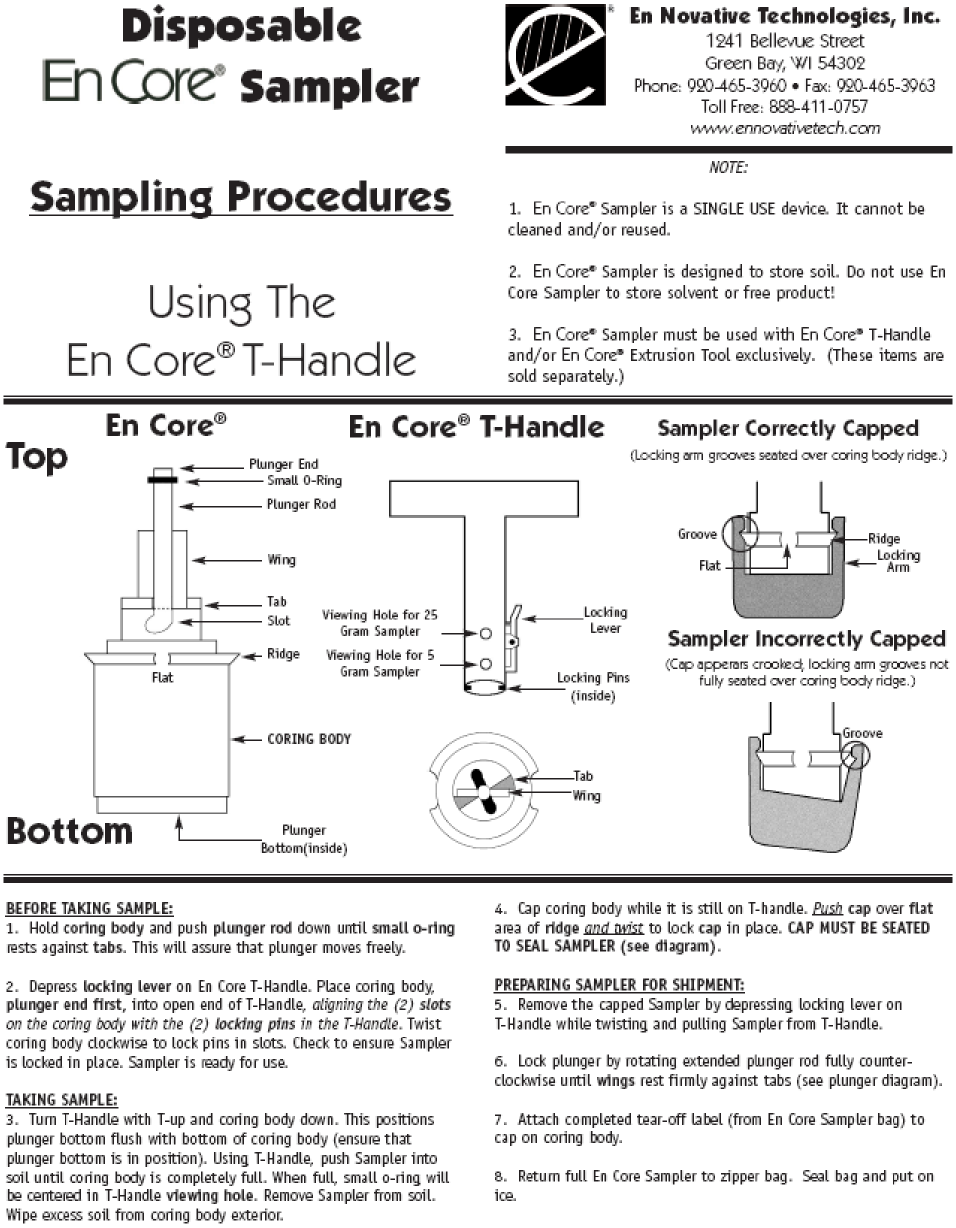
REFERENCES

Benchmark FOPs:

046 Sample Labeling, Storage and Shipment Procedures

ATTACHMENT

EnCore™ Sampling Procedure (manufacturers instructions)



Disposable En Core® Sampler

En Novative Technologies, Inc.
1241 Bellevue Street
Green Bay, WI 54302
Phone: 920-465-3960 • Fax: 920-465-3963
Toll Free: 888-411-0757
www.ennovativetech.com

Sampling Procedures

Using The En Core® T-Handle

NOTE:

1. En Core® Sampler is a SINGLE USE device. It cannot be cleaned and/or reused.
2. En Core® Sampler is designed to store soil. Do not use En Core Sampler to store solvent or free product!
3. En Core® Sampler must be used with En Core® T-Handle and/or En Core® Extrusion Tool exclusively. (These items are sold separately.)

<u>BEFORE TAKING SAMPLE:</u>

1. Hold **coring body** and push **plunger rod** down until **small o-ring** rests against **tabs**. This will assure that plunger moves freely.

2. Depress **locking lever** on En Core T-Handle. Place coring body, **plunger end first**, into open end of T-Handle, *aligning the (2) slots on the coring body with the (2)* ***locking pins*** *in the T-Handle.* Twist coring body clockwise to lock pins in slots. Check to ensure Sampler is locked in place. Sampler is ready for use.

<u>TAKING SAMPLE:</u>

3. Turn T-Handle with T-up and coring body down. This positions plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push Sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-Handle **viewing hole**. Remove Sampler from soil. Wipe excess soil from coring body exterior.

4. Cap coring body while it is still on T-handle. *<u>Push</u>* **cap** over **flat** area of **ridge** *<u>and twist</u>* to lock cap in place. **CAP MUST BE SEATED TO SEAL SAMPLER (see diagram).**

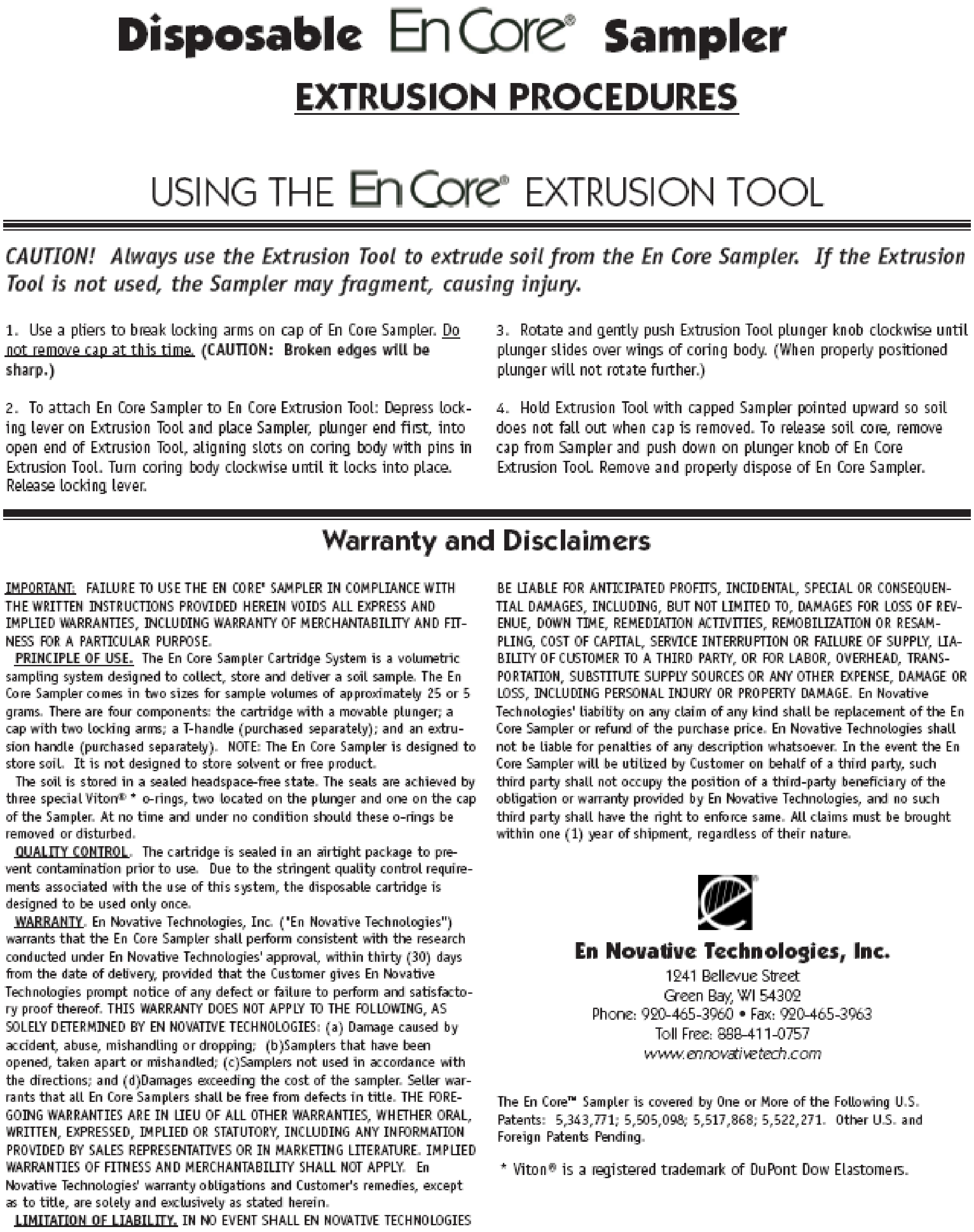
<u>PREPARING SAMPLER FOR SHIPMENT:</u>

5. Remove the capped Sampler by depressing locking lever on T-Handle while twisting and pulling Sampler from T-Handle.

6. Lock plunger by rotating extended plunger rod fully counter-clockwise until **wings** rest firmly against tabs (see plunger diagram).

7. Attach completed tear-off label (from En Core Sampler bag) to cap on coring body.

8. Return full En Core Sampler to zipper bag. Seal bag and put on ice.



Disposable En Core® Sampler

EXTRUSION PROCEDURES

USING THE En Core® EXTRUSION TOOL

CAUTION! Always use the Extrusion Tool to extrude soil from the En Core Sampler. If the Extrusion Tool is not used, the Sampler may fragment, causing injury.

1. Use a pliers to break locking arms on cap of En Core Sampler. Do not remove cap at this time. **(CAUTION: Broken edges will be sharp.)**
2. To attach En Core Sampler to En Core Extrusion Tool: Depress locking lever on Extrusion Tool and place Sampler, plunger end first, into open end of Extrusion Tool, aligning slots on coring body with pins in Extrusion Tool. Turn coring body clockwise until it locks into place. Release locking lever.
3. Rotate and gently push Extrusion Tool plunger knob clockwise until plunger slides over wings of coring body. (When properly positioned plunger will not rotate further.)
4. Hold Extrusion Tool with capped Sampler pointed upward so soil does not fall out when cap is removed. To release soil core, remove cap from Sampler and push down on plunger knob of En Core Extrusion Tool. Remove and properly dispose of En Core Sampler.

Warranty and Disclaimers

IMPORTANT: FAILURE TO USE THE EN CORE® SAMPLER IN COMPLIANCE WITH THE WRITTEN INSTRUCTIONS PROVIDED HEREIN VOIDS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

PRINCIPLE OF USE. The En Core Sampler Cartridge System is a volumetric sampling system designed to collect, store and deliver a soil sample. The En Core Sampler comes in two sizes for sample volumes of approximately 25 or 5 grams. There are four components: the cartridge with a movable plunger; a cap with two locking arms; a T-handle (purchased separately); and an extrusion handle (purchased separately). NOTE: The En Core Sampler is designed to store soil. It is not designed to store solvent or free product.

The soil is stored in a sealed headspace-free state. The seals are achieved by three special Viton® * o-rings, two located on the plunger and one on the cap of the Sampler. At no time and under no condition should these o-rings be removed or disturbed.

QUALITY CONTROL. The cartridge is sealed in an airtight package to prevent contamination prior to use. Due to the stringent quality control requirements associated with the use of this system, the disposable cartridge is designed to be used only once.

WARRANTY. En Novative Technologies, Inc. ("En Novative Technologies") warrants that the En Core Sampler shall perform consistent with the research conducted under En Novative Technologies' approval, within thirty (30) days from the date of delivery, provided that the Customer gives En Novative Technologies prompt notice of any defect or failure to perform and satisfactory proof thereof. THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING, AS SOLELY DETERMINED BY EN NOVATIVE TECHNOLOGIES: (a) Damage caused by accident, abuse, mishandling or dropping; (b)Samplers that have been opened, taken apart or mishandled; (c)Samplers not used in accordance with the directions; and (d)Damages exceeding the cost of the sampler. Seller warrants that all En Core Samplers shall be free from defects in title. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY INFORMATION PROVIDED BY SALES REPRESENTATIVES OR IN MARKETING LITERATURE. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. En Novative Technologies' warranty obligations and Customer's remedies, except as to title, are solely and exclusively as stated herein.

LIMITATION OF LIABILITY. IN NO EVENT SHALL EN NOVATIVE TECHNOLOGIES BE LIABLE FOR ANTICIPATED PROFITS, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF REVENUE, DOWN TIME, REMEDIATION ACTIVITIES, REMOBILIZATION OR RESAMPLING, COST OF CAPITAL, SERVICE INTERRUPTION OR FAILURE OF SUPPLY, LIABILITY OF CUSTOMER TO A THIRD PARTY, OR FOR LABOR, OVERHEAD, TRANSPORTATION, SUBSTITUTE SUPPLY SOURCES OR ANY OTHER EXPENSE, DAMAGE OR LOSS, INCLUDING PERSONAL INJURY OR PROPERTY DAMAGE. En Novative Technologies' liability on any claim of any kind shall be replacement of the En Core Sampler or refund of the purchase price. En Novative Technologies shall not be liable for penalties of any description whatsoever. In the event the En Core Sampler will be utilized by Customer on behalf of a third party, such third party shall not occupy the position of a third-party beneficiary of the obligation or warranty provided by En Novative Technologies, and no such third party shall have the right to enforce same. All claims must be brought within one (1) year of shipment, regardless of their nature.

En Novative Technologies, Inc.
1241 Bellevue Street
Green Bay, WI 54302
Phone: 920-465-3960 • Fax: 920-465-3963
Toll Free: 888-411-0757
www.ennovativetech.com

The En Core™ Sampler is covered by One or More of the Following U.S. Patents: 5,343,771; 5,505,098; 5,517,868; 5,522,271. Other U.S. and Foreign Patents Pending.

* Viton® is a registered trademark of DuPont Dow Elastomers.

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FIELD OPERATING PROCEDURES

Split-Spoon Sampling Procedures

FOP 058.0

SPLIT-SPOON SAMPLING PROCEDURES

PURPOSE

This guideline presents the methods for using a split-spoon sampler for collecting soil samples from a boring and for estimating the relative in-situ compressive strength of subsurface materials (ASTM D 1586). Representative samples for lithologic description, geochemical analysis, and geotechnical testing will be collected from the subsurface materials using the split-spoon sampler.

PROCEDURE

1. Place plastic sheeting on a sturdy surface to prevent the split-spoon and its contents from coming in contact with the surface (several layers of sheeting may be placed on the surface so that they may be removed between each sample or as needed).

2. Lower the sampling string to the base of the borehole. Measure the portion of the sampling string that extends above surrounding grade (i.e. the stickup). The depth of sampling will equal the total length of the string (sampler plus rods) minus the stickup length.

3. Measure sampling depths to an accuracy of 0.1 feet. If field measurements indicate the presence of more than 0.3 feet of disturbed materials in the base of the borehole (i.e. slough), the sampler will be used to remove this material, after which a second sampling trip will be made.

4. Select additional sampler components as required (i.e., leaf spring core retainer for clays or a sand trap for non-cohesive sands). If a retainer or trap is not used, a spacer ring will be used to hold the liners in position inside the sampler.

5. For driving samples, attach the drive head sub and hammer to the drill rods without the weight resting on the rods. For pushing samples using the rig hydraulics, skip to Step 9.

6. Mark four 6-inch intervals on the drill rods relative to a reference point on the drill rig. With the sampler resting on the bottom of the hole, drive the sampler with the 140 lb. hammer falling freely over a 30-inch fall until 24 inches have been penetrated or 50 blows applied.

7. Record the number of blows per 6 inches. Determine the "N" value by adding the blows for the 6 to 12-inch and 12 to 18-inch intervals of each sample drive.

8. After penetration is complete, remove the sampling string. Avoid removing sampling string by hitting up on the string with the hammer as this can cause the sample to fall from the bottom of the split-spoon sampler. The sampling string should be removed via cable lifting or rig hydraulics. If sample retention has been poor, let the sampling string rest in place for at least 3 minutes, then rotate clockwise at least 3 times before removing from the borehole.

9. For pushed samples (i.e., using rig hydraulics), mark four 6-inch intervals on the drill rods relative to a reference point on the rig. Use the rig pull-down to press the sampler downward until 24 inches have been penetrated or no further progress can be made with the full weight of the rig on the sampler.

10. Remove the split-spoon sampler from the sampling string and place on the plastic-covered surface.

11. Open the split-spoon sampler only when the Benchmark field geologist is prepared to describe and manage the sample.

12. Describe the sample in accordance with the Unified Soil Classification System in accordance with the Benchmark FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).

13. Record all information in accordance with Benchmark's FOP: Documentation Requirements for Drilling and Well Installation.

14. Collect a portion of the sample for field screening as described in the Benchmark FOP: Screening of Soil Samples for Organic Vapors During Drilling Activities.

15. If applicable, collect soil samples for volatile organic constituents (VOCs). If applicable, collect sample for semi-volatile, metals, geotechnical, or other off-site analysis.

16. The samples will be labeled, stored and shipped in accordance with the Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

none

REFERENCES

<u>Benchmark FOPs:</u>

015	*Documentation Requirements for Drilling and Well Installation*
046	*Sample Labeling, Storage and Shipment Procedures*
047	*Screening of Soil Samples for Organic Vapors During Drilling Activities*
054	*Soil Description Procedures Using the Unified Soil Classification System (USCS)*

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FIELD OPERATING PROCEDURES

Surface and Subsurface Soil Sampling Procedures

FOP 063.2

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 Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
4. Commence intrusive activities in accordance with specific Benchmark 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 Benchmark's FOP Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).
6. Decontaminate all <u>non-dedicated</u> stainless steel (or Pyrex glass) equipment in accordance with Benchmark'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 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 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/SUBSURFACE SOIL SAMPLING PROCEDURES

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

   Surface soil samples are typically collected from 0 to 6 inches below ground surface (bgs). 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 Benchmark'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 Benchmark 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): 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

<u>Benchmark FOPs:</u>

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*

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D

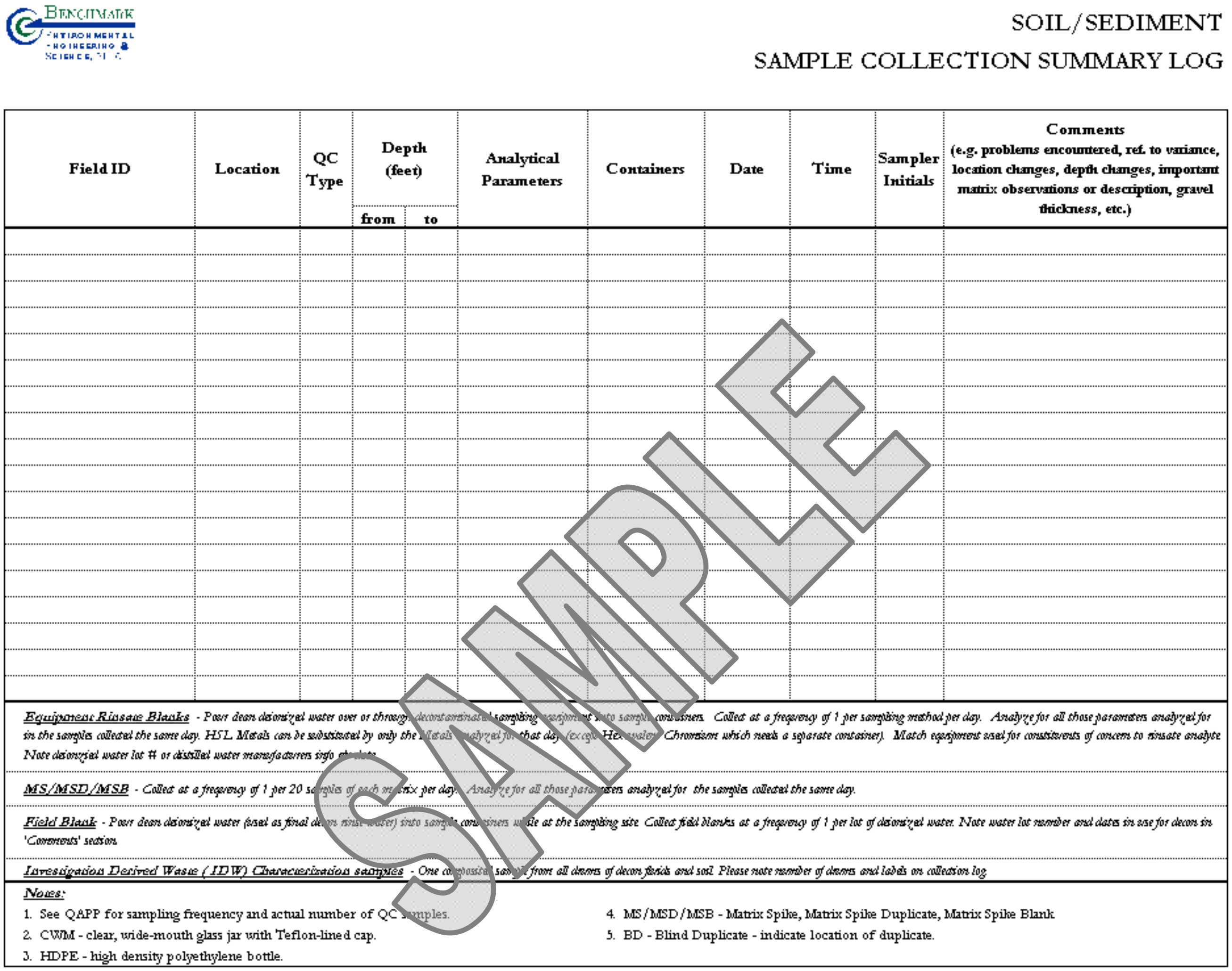
New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:



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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 and 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 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 composite 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. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
5. BD - Blind Duplicate - indicate location of duplicate.

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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 (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

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FIELD OPERATING PROCEDURES

Test Pit Excavation and Logging Procedures

FOP 065.1

TEST PIT EXCAVATION & LOGGING PROCEDURES

PURPOSE

This procedure describes the methods for completing test pits, trenches, and other excavations that may be performed to expose subsurface soils or materials. In most cases, these pits will be mechanically excavated, using a backhoe, trackhoe, or other equipment. Because pits and other excavations can represent a substantial physical hazard, it requires a particular focus on safety procedures. The Project Health and Safety Plan identifies practices related to excavation permits, entry, and control that must be incorporated into excavation activities.

EXCAVATION PROCEDURE

1. Review project objectives and the Project Health and Safety Plan (HASP).
2. Perform excavation equipment safety checks with the operator. Specific concerns should include, but not limited to, no leaking hydraulic lines, fire extinguisher on board of the excavation equipment, operator experience etc.
3. Conduct tailgate health and safety meeting with project team and excavation operator(s) by completing the Tailgate Safety Meeting Form (sample attached).
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Conduct air monitoring as required by the HASP and/or Project Work Plan. Record all results on the Real Time Air Monitoring Log (sample attached).
6. Mobilize the excavation equipment to the site and position over the required location.
7. Select excavation locations, which provide necessary information for achieving objectives. Check locations with owner/operator to ensure excavation

operations will not interfere with site operations, and select appropriate access routes.

8. Stake locations in the field and measure distance from locations to nearest landmarks. Survey location, if required.

9. Obtain clearances from appropriate utilities and, if buried waste/metallic objects are suspected, screen location with appropriate geophysical methods, as necessary.

10. Decontaminate excavation equipment in accordance with Benchmark's Drilling and Excavation Equipment Decontamination procedures.

11. Excavate pits. In uncontrolled areas, excavate only as many test pits as can be backfilled during the same day. Generally, allow equal time for excavation and backfilling. To the extent practicable, no pits should be left open overnight in an uncontrolled area. If sudden weather changes or other unforeseen events necessitate this, pits will be covered and/or barricaded and flagged with caution/hazard tape. These pits should be backfilled as soon as possible.

12. The Benchmark field geologist or experienced professional should determine the depth of excavation. The depth is generally limited by the safe reach of the selected equipment, but may also be limited by the stability of the excavated materials (i.e. wall stability).

13. Excavate the test pits in compliance with applicable safety regulations. In no case should a pit deeper than 4 feet be entered without first stabilizing the sidewalls by using forms, or by terracing or sloping (2:1 slope maximum) the sidewalls.

14. Excavated spoils must be placed no closer than 2 feet from the open excavation.

15. Collect soil samples from pit sidewalls in accordance with Benchmark's Surface and Subsurface Soil Sampling Procedures. If the test pit is greater than 4 feet in depth, it will not be entered for sampling. In this event, collect

samples using the backhoe bucket, then fill sample containers from the center of the bucket using the stainless steel sampling equipment (i.e., spoon, spade, trowel etc.) or drive a Shelby tube or EnCore™ sampler for VOCs.

16. Record excavation observations in the Project Field Book or Test Pit Excavation Log form (sample attached). Information recorded should include:

    - Physical dimension of the pit;
    - A scaled sketch of one side of the pit showing any lithologic contacts, zones of groundwater seepage, other special features (jointing, boulders, cobbles, zones of contamination, color abnormalities, etc.)
    - General information such as project number, pit designation number, depth, date, name of responsible professional (i.e., geologist), type of excavating equipment utilized, time of excavation and backfilling, method of collecting samples and amount of sample collected (if applicable);
    - Rate of groundwater inflow, depth to groundwater and time of measurement; and
    - Unified Soil Classification System (USCS) designation of each distinctive unit.

17. Photograph each excavation, highlighting unique or important features. Use a ruler or other suitable item for scale. Include a label with the pit designation so the developed picture will be labeled.

18. Backfill pit to match the existing grade compacting in 2 to 3 foot lifts. Since the excavated material should be cover soil, the excess soil will be placed back into the hole. The Benchmark Field Team Leader will provide direction on whether excavated soils may be used as fill, or these materials are to be containerized as investigation derived waste.

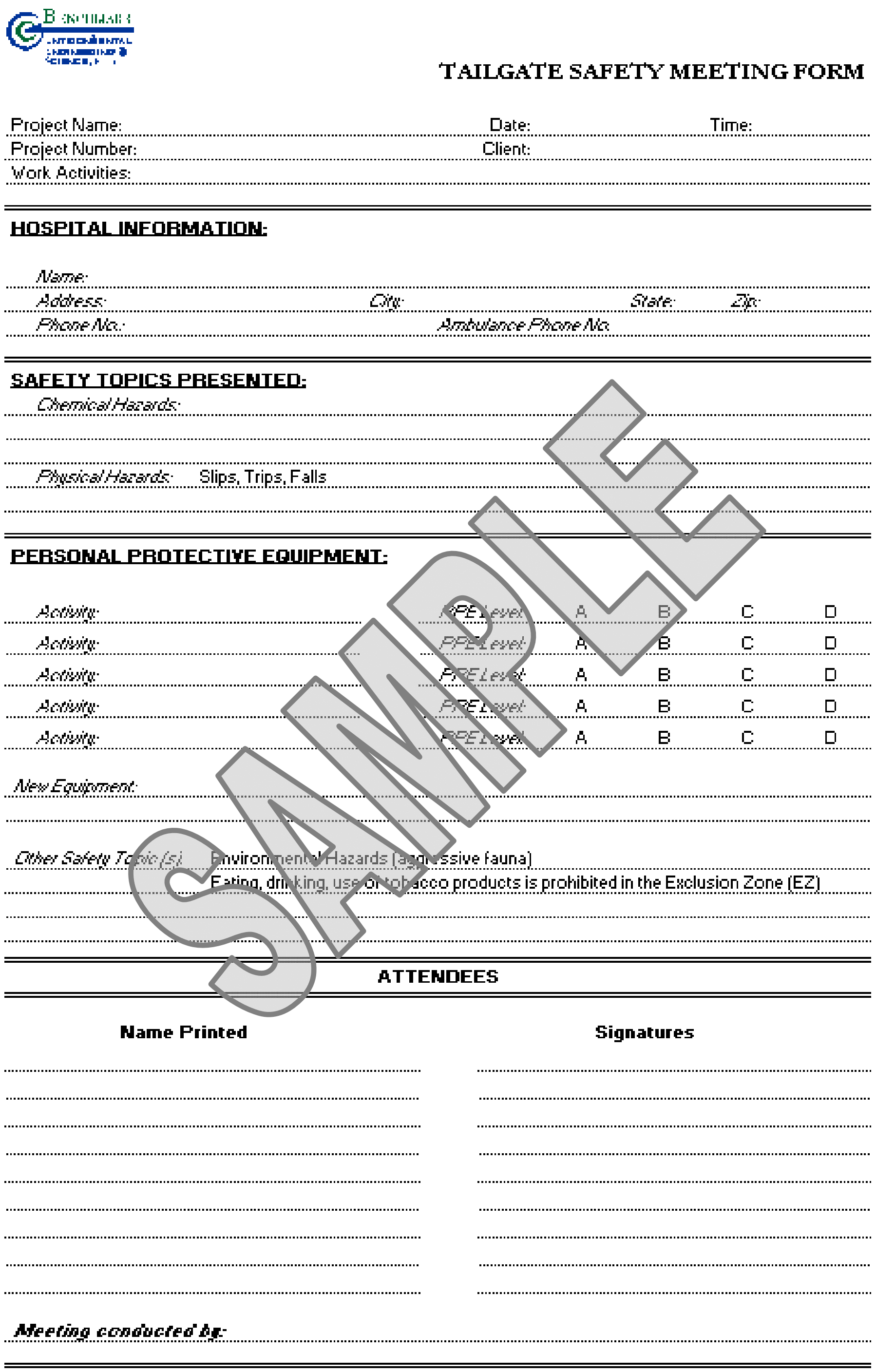
ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Real Time Air Monitoring Log (sample)
Test Pit Excavation Log (sample)

REFERENCES

Benchmark 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*
018	*Drilling and Excavation Equipment Decontamination*
063	*Surface and Subsurface Soil Sampling Procedures*



TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

Benchmark Environmental Engineering & Science, PLLC

REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

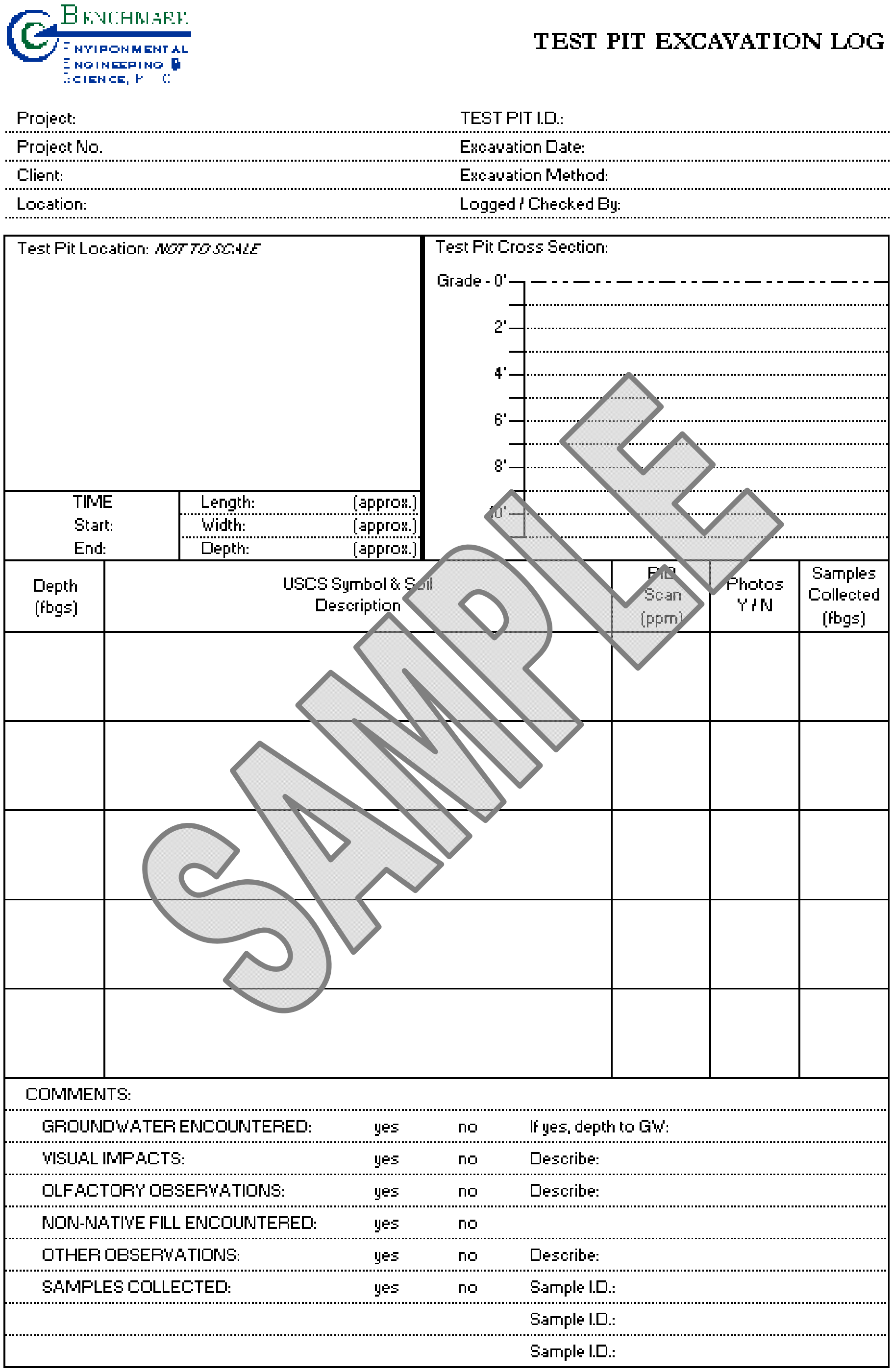
WEATHER CONDITIONS:

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 (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:



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TEST PIT EXCAVATION LOG

Project:
TEST PIT I.D.:
Project No.
Excavation Date:
Client:
Excavation Method:
Location:
Logged / Checked By:

Test Pit Location: *NOT TO SCALE*

Test Pit Cross Section:

TIME	Length:	(approx.)
Start:	Width:	(approx.)
End:	Depth:	(approx.)

Depth (fbgs)	USCS Symbol & Soil Description	PID Scan (ppm)	Photos Y / N	Samples Collected (fbgs)

COMMENTS:

GROUNDWATER ENCOUNTERED:	yes	no	If yes, depth to GW:
VISUAL IMPACTS:	yes	no	Describe:
OLFACTORY OBSERVATIONS:	yes	no	Describe:
NON-NATIVE FILL ENCOUNTERED:	yes	no	
OTHER OBSERVATIONS:	yes	no	Describe:
SAMPLES COLLECTED:	yes	no	Sample I.D.:
			Sample I.D.:
			Sample I.D.:

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FIELD OPERATING PROCEDURES

Well/Piezometer Construction Materials and Design

FOP 070.0

WELL/PIEZOMETER CONSTRUCTION MATERIALS AND DESIGN

PURPOSE

This guideline presents construction materials and design requirements for monitoring well/piezometer installations in accordance with NYSDEC recommended specifications (6NYCRR Part 360).

CONSTRUCTION MATERIALS

1. Well Screen and Riser – Only new flush threaded screen and riser materials will be used. Screen and riser materials, well dimensions, screen slot opening size and length to be determined based on formation characteristics and suspect water quality or as specified by the project geologist/hydrogeologist. A vented cap or J-plug should be placed over the riser. A V-slot cut in the riser or permanent marking, both placed on the north side of the riser, will act as a monitoring reference point.

2. Bentonite Well Seal – The bentonite should be from a commercial source free of chemical additives (granular or powdered for grout and pelletized for seal).

3. Concrete – Low heat of hydration concrete should be used for grout and cementing protective casing if well construction materials are composed of PVC (ASTM Type II or Type IV Portland Cement).

4. Water – Water should be from a potable source of known chemistry and free of chemical constituents which may compromise integrity of installation.

5. Grout – Mixture of bentonite, cement and water in accordance with the following specifications. Premix bentonite and water prior to adding cement.

   <u>Grout Slurry Composition (% Weight)</u>

   1.5 to 3.0% - Bentonite (Quick Gel)
   40 to 60 % - Cement (Portland Type I)
   40 to 60 % - Potable Water

6. Filter Pack – The filter pack should consist of clean, inert, siliceous, rounded to subrounded particles. Filter pack particle size is dependent on the formation and the slot size of the screen.

   A secondary filter about 6-inches thick may be placed between filter pack and the bentonite seal and potentially between the bentonite seal and the grout backfill, to minimize grout penetration of the seal. A uniformly graded fine sand (100% passing No. 30 sieve) should be used as a secondary filter.

7. Protective Casing, Locking Cap and Lock – Protective casing with a lockable cap should be cemented in place around the riser. The inside diameter of the protective casing should be a minimum of 2-inches larger than the outside diameter of the well riser. The annular space between the casing and the riser should be filled with pea gravel or coarse sand. A weep hole should be drilled near the base of the casing to facilitate drainage of standing water. If more than one well is installed, all locks should be keyed alike.

8. A sample of all cement, bentonite and sand used in well construction should be saved in a labeled, Teflon-sealed, precleaned glass jar.

REFERENCES

New York State Department of Environmental Conservation, July 1988, *Drilling and Monitoring Well Installation Guidance Manual.*

Driscoll, F.G., 1987, *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota, p. 1089.

Sara, M. N., *Proposed Recommended Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers: ASTM Subcommittee D18.21.*

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FIELD OPERATING PROCEDURES

Real-Time Air Monitoring During Intrusive Activities

FOP 073.2

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

PURPOSE

This guideline presents requirements for real-time community air monitoring and required responses during all project required intrusive activities, such as drilling, test pitting, earthwork construction etc. This procedure is consistent with the requirements for community air monitoring for all intrusive projects, including projects conducted at remediation sites, as established by the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC). Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 (May 2010) Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

This FOP requires real-time monitoring for constituents of concern (COC) (i.e., volatile organic compounds (VOCs), lower explosive limit (% LEL), particulates (i.e., dust) etc.) at the upwind and downwind perimeter as well as the exclusion zone of a project site during all intrusive activities. This FOP is not intended for use in establishing action levels for worker respiratory protection (see Project Health and Safety Plan (HASP) for worker protection action levels). Rather, its intent is to provide a measure of protection for the surrounding community from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The community, as referenced in this document, includes any off-site residences, public buildings/grounds and commercial or industrial establishments adjacent to the project site. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, this FOP helps to confirm that work activities did not spread contamination off-site through via air transport mechanisms. Community air monitoring shall be integrated with the construction worker personal exposure-monitoring program contained in the project and site-specific HASP.

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for volatile organic compounds (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 NYSDEC/NYSDOH staff.

MONITORING & MITIGATION PROCEDURE

Real-time air monitoring perimeter locations for monitoring stations will be established based on the location of the exclusion zone (i.e., immediate work area) and wind direction. Where wind direction is shifting or winds are calm, the downwind monitoring location will default to the perimeter location nearest the most sensitive receptor (i.e., residential property). All downwind receptors being equal, the downwind monitoring location will default to the perimeter location downwind of the prevailing winds at the site. Although additional site specific COCs may be monitored during real-time air monitoring activities, the most common COCs are discussed in this FOP, including organic vapors (i.e., VOCs), airborne particulates (i.e., fugitive dust) and combustible gases (i.e., methane) and oxygen.

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

ORGANIC VAPORS

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. 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.

- 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.

- 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.

- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

- All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

o **<u>Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures</u>**

  - When work areas are within 20 feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and particulates must reflect the nearest potentially exposed individuals and the location of ventilation system intakes for nearby structures. The use of engineering controls such as vapor/dust barriers, temporary negative-pressure enclosures, or special ventilation devices should be considered to prevent exposures related to the work activities and to control dust and odors. Consideration should be given to implementing the planned activities when potentially exposed populations are at a minimum, such as during weekends or evening hours in non-residential settings.

- If total VOC concentrations opposite the walls of occupied structures or next to intake vents exceed 1 ppm, monitoring should occur within the occupied structure (s). Background readings in the occupied spaces must be taken prior to commencement of the planned work. Any unusual background readings should be discussed with NYSDOH prior to commencement of the work.

- If total particulate concentrations opposite the walls of occupied structures or next to intake vents exceed 150 mcg/m3, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 mcg/m3 or less at the monitoring point.

- Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen SUlfide, carbon monoxide) may also need to be monitored Response levels and actions should be pre-determined, as necessary, for each site.

Additionally, if following the cessation of work and efforts to abate the emission source are unsuccessful, and if sustained organic vapor levels exceed 25 ppm above background within the 20-foot zone for more than 30 minutes, then the **Major Vapor Emission Response Plan** (see below) will automatically be placed into effect.

Major Vapor Emission Response Plan

Upon activation of Major Vapor Emission Response Plan, the following activities will be undertaken:

1. All Emergency Response Contacts as listed below and in the Site-Specific Health and Safety Plan will be contacted.

2. The local police authorities will immediately be contacted by the Site Safety and Health Officer and advised of the situation.

3. The Site Safety and Health Officer will determine if site workers can safely undertake source abatement measures. Abatement measures may include covering the source area with clean fill or plastic sheeting, or consolidating contaminated materials to minimize surface area. The Site Safety and Health Officer will adjust worker personal protective equipment as necessary to protect workers from over-exposure to organic vapors.

The following personnel are to be notified by the Site Safety and Health Officer in the listed sequence if the Major Vapor Emission Response Plan is activated:

Contact	**Phone**
Police/Fire Department	911
New York State DOH	(518) 402-7860
New York State DEC Region 8	(585) 226-2466, switchboard

New York State DEC Region 9	(716) 851-7220
State Emergency Response Hotline	(800) 457-7362

In addition, the Site Safety and Health Officer will provide these authorities with a description of the apparent source of the contamination and abatement measures being taken by the contractor, if any.

AIRBORNE PARTICULATES

Fugitive dust suppression and airborne particulate monitoring shall be performed during any intrusive activities involving disturbance or handling of site soil/fill materials. Fugitive dust suppression techniques will include the following minimum measures:

- Spraying potable water on all excessively dry work areas and roads.
- All fill materials leaving the site will be hauled in properly covered containers or haul trailers.
- Additional dust suppression efforts may be required as discussed below.

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.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (μg/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 μg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 μg/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 μg/m^3 of the upwind level and in preventing visible dust migration.

- All readings must be recorded and be available for State (DEC and DOH) personnel to review.

Visual Assessment

In conjunction with the real-time monitoring program, TurnKey personnel and any subcontractors thereof will be responsible for visually assessing fugitive dust migration from the site. If airborne dust is observed leaving the site, the work will be stopped until supplemental dust suppression techniques are employed in those areas.

Supplemental Dust Suppression

Supplemental dust suppression techniques may include but are not necessarily limited to the following measures:

- Reducing the excavation size, number of excavations or volume of material handled.
- Restricting vehicle speeds.
- Applying water on buckets during excavation and dumping.
- Wetting equipment and excavation faces.
- Wetting haul roads.
- Restricting work during extreme wind conditions.
- Use of a street sweeper on paved haul roads, where feasible.

Work can resume using supplemental dust suppression techniques provided that the measures are successful in reducing the sustained downwind particulate concentration to below 150 ug/m^3 of the upwind level, and in preventing visible dust migration off-site.

COMBUSTIBLE GASES & OXYGEN

Ambient combustible gas and oxygen concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure combustible gases in percent lower explosive limit (LEL) and percent oxygen and calibrated daily. All combustible gas and oxygen readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

Combustible Gas:

- If the sustained ambient air concentration of combustible gas at the downwind perimeter of the site exceeds a reading of 10 to 25% LEL, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 10% LEL, work activities can resume with continued monitoring.

- If sustained combustible gas levels at the downwind perimeter of the site persist at levels in excess of 25% LEL, work activities must be halted, the source of explosion hazards identified, corrective actions taken to abate emissions and monitoring continued. Following combustible gas mitigation, work activities can resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions 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 a sustained value of 10% LEL.

Oxygen:

- If the sustained ambient oxygen concentration at the downwind perimeter of the site measures a reading between 19.5% - 21% oxygen, work activities can continue with extreme caution, however attempts to determine the potential source of oxygen displacement must be conducted.

- If the sustained oxygen level readily decreases below 19.5% LEL, work activities should be discontinued and all personnel must leave the area immediately.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels between 21-25%, work activities can resume with caution.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels exceeding 25% (fire hazard potential), work activities should be discontinued and all personnel must leave the area immediately.

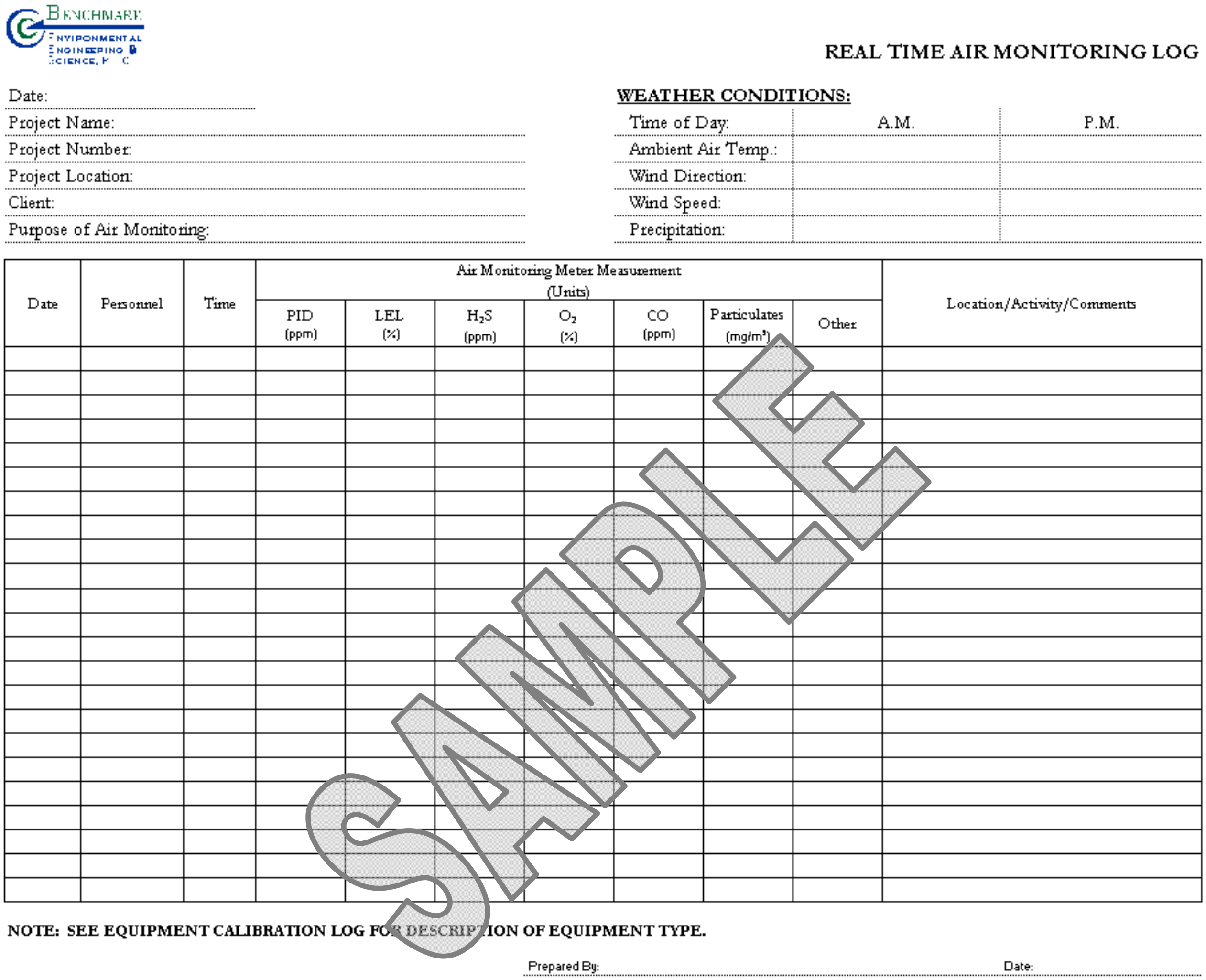
ATTACHMENTS

Real-Time Air Monitoring Log (sample)

REFERENCES

TurnKey FOPs:

006	*Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010	*Calibration and Maintenance of Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
084	*Calibration and Maintenance of Portable Particulate Meter*



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 (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

FOP 074.0

UNDERGROUND STORAGE TANK
EXCAVATION AND REMOVAL PROCEDURES

PURPOSE

This procedure describes the methods for conducting underground storage tank (UST) removal activities. In most cases, the USTs will be mechanically excavated, using a backhoe, trackhoe, excavator or other equipment. Because the pits and other excavations created during UST exhumation can represent a substantial physical hazard, it requires a particular focus on safety procedures. The Project Health and Safety Plan and/or Project Work Plan should identify practices related to excavation permits, entry, and control that must be incorporated into UST excavation activities.

PRE-EXCAVATION PROCEDURES

1. Conduct a Phase I Site Assessment in accordance with ASTM E 1527 "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process" or at a minimum conduct an EDR search of the subject property to obtain some information about the number and location of potential USTs.

2. Review project objectives outlined in the Project Work Plan and the Project Health and Safety Plan (HASP).

3. Check locations with owner/operator to ensure excavation operations will not interfere with site operations, and select appropriate access routes.

4. Stake locations in the field and measure distance from locations to nearest landmarks. Survey location, if required.

5. Obtain clearances from appropriate utilities and, if buried waste/metallic objects are suspected, screen location with appropriate geophysical methods, as necessary. Utility clearances are required 72 hours prior to commencing intrusive activities. Typically, the UST contractor will obtain the required utility clearances and permits.

6. Conduct a pre-construction meeting, as necessary. Include the client, state and/or federal regulatory agencies (as necessary) and the UST contractor.

7. Become familiar with the site by conducting a site reconnaissance. Note and identify the following: the prevailing wind direction; adjacent property zones (i.e., residential, commercial or industrial); any potential for unauthorized site access by onlookers; overhead utilities; temporary staging areas for impacted soils and USTs; and any other site features that may inhibit the progress of work.

8. During the site recon, locate the surface fill ports, if applicable, and determine the approximate size, liquid type and liquid quantity of the UST. Determine tank size (diameter and capacity) and liquid quantity by sticking the tank through the fill port with a long measuring stick. Determine the type of liquid contained within the UST; keeping in mind this may involve sample collection and profile characterization by a laboratory.

EXCAVATION PROCEDURES

1. Perform excavation equipment safety checks with the operator. Specific concerns should include, but not limited to, no leaking hydraulic lines, fire extinguisher on board of the excavation equipment, operator experience etc.

2. Conduct tailgate health and safety meeting with project team and excavation operator(s) by completing the Tailgate Safety Meeting Form (sample attached).

3. Discuss with excavation contractor personnel the scope of work and what will be expected of them.

4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

5. Conduct air monitoring as required by the HASP and/or Project Work Plan in accordance with Benchmark's FOP: Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).

6. Decontaminate excavation equipment in accordance with Benchmark's Drilling and Excavation Equipment Decontamination procedures as necessary.

7. Mobilize the excavation equipment to the site and position over the required UST location.

8. If liquid was encountered in the UST during the initial site reconnaissance, purge, contain and dispose of the UST contents in accordance with state and federal regulations as well as Benchmark's FOP: Management of Investigation-Derived Waste (IDW).

9. Excavate the UST(s) in compliance with applicable safety regulations and NYSDEC Division of Environmental Remediation, Spill Response Unit or Bulk Storage Unit guidelines and/or this FOP. In uncontrolled areas, UST excavations being conducted over several days and/or time allowed for laboratory analytical results to be returned will be covered and/or barricaded and flagged with caution/hazard tape. These open pits should be backfilled with clean fill as soon as possible.

10. Each UST contractor has their own means and methods of exhuming USTs and impacted soil and Benchmark personnel should <u>not</u> direct the contractor's activities, however, the methods performed by the contractor should be monitored closely to ensure safety is a priority. Typically, the UST fill ports will be unearthed and the top of the tank will be exposed to determine the exact size of the tank. Once the size is determined, the UST contractor will excavate along one side to the bottom of the tank and roll the tank on its side.

11. Once the UST is "loosened", the contractor should remove the tank with webbing or chains, while keeping the tank in its original horizontal position, and place the exhumed tank on a polyethylene tarp.

12. The UST contractor will then clean and dispose of the tank in accordance with state and federal regulations.

13. The Benchmark field geologist or experienced professional will determine the horizontal and vertical limits of excavation based upon soil scans with a calibrated photoionization detector (PID) in accordance with Benchmark's FOP: Screening of Soil Samples for Organic Vapors During UST Removal Activities.

    The depth is generally limited by the safe reach of the selected equipment, but may also be limited by the stability of the excavated materials (i.e. wall stability). Excavation depths exceeding the practical limits of the machine may be required as long as the groundwater table has not been encountered. Terminate all excavations at the first water bearing zone and consult the Project Manager. Typically, groundwater remediation will be required (i.e., pump and treat).

14. At no time should an excavation deeper than 4 feet be entered without first stabilizing the sidewalls by using forms, or by terracing or sloping (2:1 slope maximum) the sidewalls.

15. During impacted soil removal activities, record all required transportation information on an Impacted Soil Transportation Log (sample attached).

16. Collect a representative soil sample from each of the four sidewalls and one from the bottom and scan with a PID (i.e., initial surface scan and headspace determination) until excavated soils PID results fall below the project-required limit, typically 20 ppm. Sidewall samples shall be collected from a depth equal to the bottom and no higher than the middle of the pre-exhumation UST position.

17. Upon determining the limits of impact, collect one confirmation/verification soil sample from each of the four sidewalls and bottom of the excavation in accordance with Benchmark's Surface and Subsurface Soil Sampling Procedures. Sidewall samples shall be collected from a depth equal to the bottom and no higher than the middle of the pre-exhumation UST position.

    If the test pit is greater than 4 feet in depth, it will <u>not</u> be entered for sampling. In this event, collect samples using the excavation equipment filling laboratory-provided sample containers from the center of the bucket using the stainless steel sampling equipment (i.e., spoon, spade, trowel etc.) or drive a Shelby tube or EnCore™ sampler for VOCs.

18. If excessive water enters the excavation, via perched groundwater or precipitation, it shall be purged and contained as IDW until proper disposal can be determined (i.e., pumped through granular activated carbon vessels and discharged to the sanitary sewer). The Project Manager and NYSDEC representative should be consulted upon detection of excess water to determine proper disposal methods. On the other hand, minor amounts of water within the excavation that can be sufficiently mixed with excavated soil material is an acceptable disposal method.

19. Record UST excavation observations in the Project Field Book and/or an Impacted Soil Excavation Log (sample attached). Information recorded should include:

    - Physical dimension of the pit;

    - A scaled sketch of one side of the excavation showing the position of the UST and any lithologic contacts, zones of groundwater seepage, other special features (jointing, boulders, cobbles, zones of contamination, color abnormalities, etc.);

    - General information such as project number, excavation designation number, depth, date, name of responsible professional (i.e., geologist), type of excavating equipment utilized, time of excavation and backfilling, method of collecting samples and amount of sample collected (if applicable);

- General information about the UST such as diameter, length, quantity of liquid removed, construction material etc.;
- Rate of groundwater inflow, depth to groundwater and time of measurement, as necessary; and
- Unified Soil Classification System (USCS) designation of each distinctive unit in accordance with Benchmark's FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).

20. Photograph the progress of UST exhumation, impacted soil excavation and clean fill backfilling, highlighting unique or important features. Use a ruler or other suitable item for scale. Include a label with the excavation designation so the developed picture will be labeled, as necessary.

21. Backfill the excavation to match the existing grade compacting in 2 to 3 foot lifts with clean fill and as directed in the Project Work Plan. Excavated soils designated as "clean" via PID scan can be placed back into the hole. The Benchmark Field Team Leader will provide direction on whether excavated soils may be used as fill, or these materials are to be containerized as investigation derived waste.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Real Time Air Monitoring Log (sample)
Impacted Soil Excavation Log (sample)
Impacted Soil Transportation Log (sample)

REFERENCES

Benchmark 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*
018	*Drilling and Excavation Equipment Decontamination*
032	*Management of Investigation-Derived Waste (IDW)*
048	*Screening of Soil Samples for Organic Vapors During UST Removal Activities*
054	*Soil Description Procedures Using the Unified Soil Classification System (USCS)*
063	*Surface and Subsurface Soil Sampling Procedures*
073	*Real-Time Air Monitoring During Intrusive Activities*

Benchmark
Environmental
Engineering &
Science, PLLC

TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D
Activity:	*PPE Level:*	A	B	C	D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

Benchmark Environmental Engineering & Science, PLLC

REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

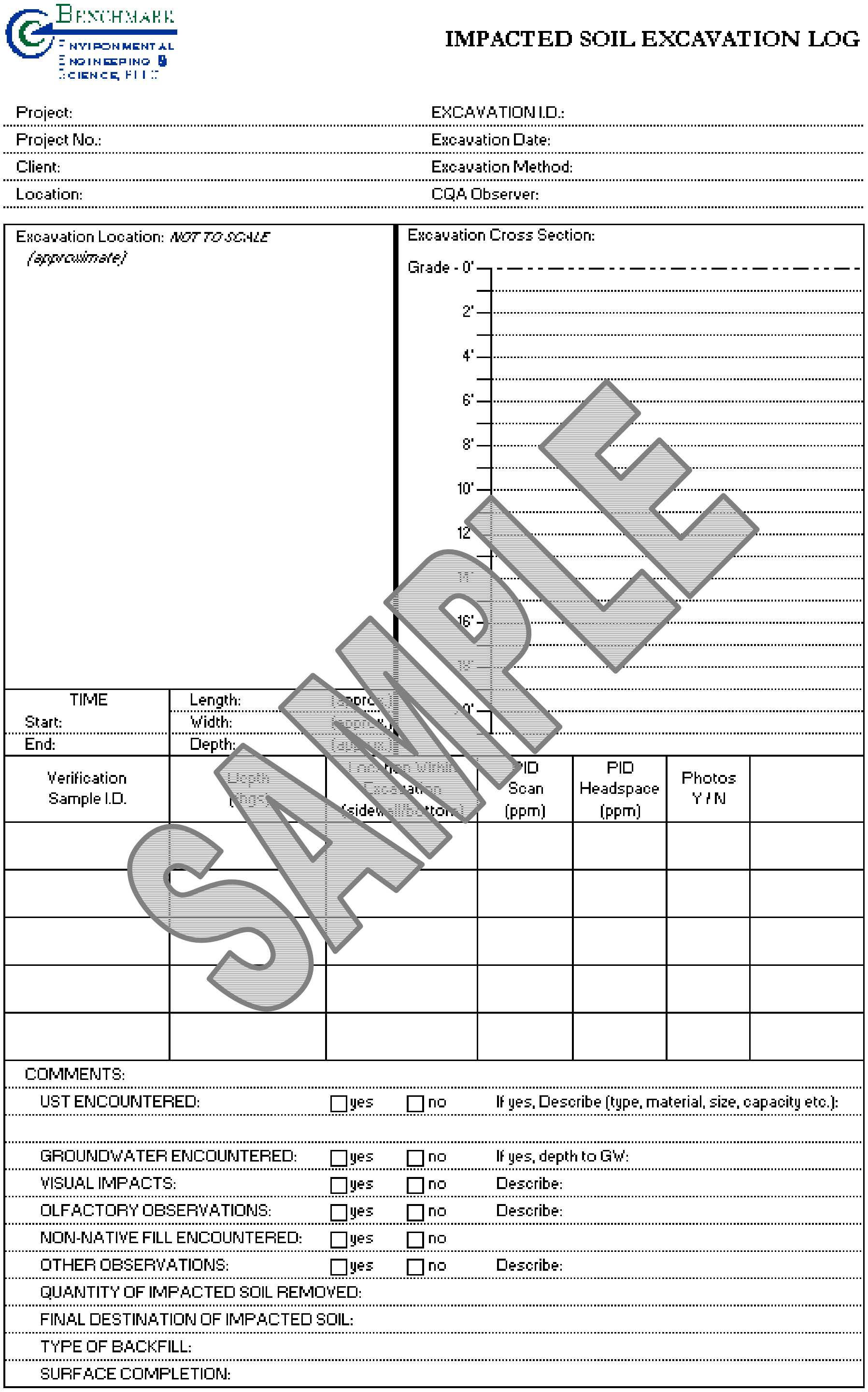
WEATHER CONDITIONS:

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 (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:



IMPACTED SOIL EXCAVATION LOG

Project:	EXCAVATION I.D.:
Project No.:	Excavation Date:
Client:	Excavation Method:
Location:	CQA Observer:

Excavation Location: *NOT TO SCALE (approximate)*

Excavation Cross Section:

TIME		
Start:	Length:	(approx.)
End:	Width:	(approx.)
	Depth:	(approx.)

Verification Sample I.D.	Depth (fbgs)	Location Within Excavation (sidewall/bottom)	PID Scan (ppm)	PID Headspace (ppm)	Photos Y / N	

COMMENTS:

UST ENCOUNTERED: ☐ yes ☐ no If yes, Describe (type, material, size, capacity etc.):

GROUNDWATER ENCOUNTERED: ☐ yes ☐ no If yes, depth to GW:

VISUAL IMPACTS: ☐ yes ☐ no Describe:

OLFACTORY OBSERVATIONS: ☐ yes ☐ no Describe:

NON-NATIVE FILL ENCOUNTERED: ☐ yes ☐ no

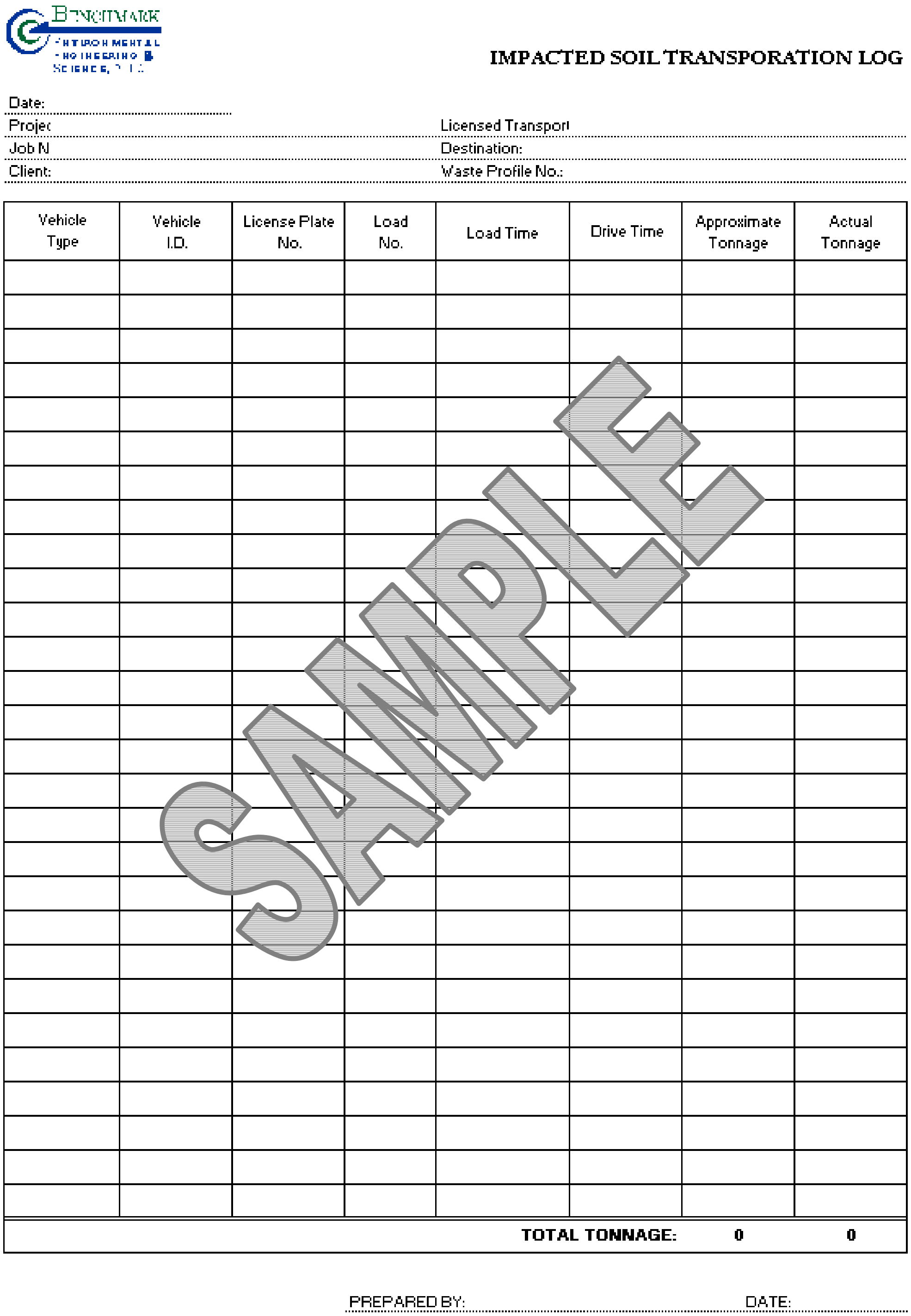
OTHER OBSERVATIONS: ☐ yes ☐ no Describe:

QUANTITY OF IMPACTED SOIL REMOVED:

FINAL DESTINATION OF IMPACTED SOIL:

TYPE OF BACKFILL:

SURFACE COMPLETION:



IMPACTED SOIL TRANSPORATION LOG

Date:
Projec
Job N
Client:
Licensed Transpor
Destination:
Waste Profile No.:

Vehicle Type	Vehicle I.D.	License Plate No.	Load No.	Load Time	Drive Time	Approximate Tonnage	Actual Tonnage
					TOTAL TONNAGE:	**0**	**0**

PREPARED BY:
DATE:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

"Before Going Into The Field" Procedure

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

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FIELD OPERATING PROCEDURES

Geoprobe Drilling Procedures

FOP 078.0

GEOPROBE DRILLING PROCEDURES

PURPOSE

This guideline presents a method for direct-push drilling a borehole through unconsolidated materials, including soils or overburden.

PROCEDURE

The following procedure will be used to drill a borehole for sampling and/or well installation, using direct-push methods and equipment.

1. Follow Benchmark's Field Operating Procedure (FOP) for Drill Site Selection Procedure prior to implementing any drilling activity.
2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).
3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form (sample attached).
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's FOPs or manufacturers recommendations.
5. Ensure all drilling equipment (i.e., rods, 4-foot sampler, dedicated PVC sleeves) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with Benchmark's Drilling and Excavation Equipment Decontamination Procedures FOP.
6. Mobilize the Geoprobe™ rig to the site and position over the borehole.
7. Level and stabilize the rig and recheck the rig location against the planned drilling location.

8. Fully advance the sampler into the subsurface using an ATV-mounted direct-push Geoprobe™ drill rig and 1.5-inch diameter sampler, typically 4-feet in length and fitted with a dedicated PVC sleeve, for each four-foot core of soil.

9. Retrieve the 4-foot sample core from the driller, place on a piece of polyethylene tarp, and cut open using a sharp utility knife.

10. Visually characterize each 4-foot soil core using the Unified Soil Classification System (USCS) in accordance with Benchmark's Soil Description Procedures Using the USCS FOP.

11. Scan each 4-foot core for total volatile organic vapors with a calibrated Photovac 2020 PID equipped with a 10.6 eV lamp, and report any visual and/or olfactory observations. Record PID scan measurements in the Project Field Book and appropriate field forms.

12. If required, collect a representative soil sample for headspace determinations. In general, soil samples representative of each 4-foot core interval are collected, placed in a sealable plastic bag, and kept at or near room temperature (approximately 65-70° F) for a minimum of 15 minutes prior to measurement. Record PID headspace determination measurements in the Project Field Book and appropriate field forms.

13. Check sampler and rods periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.

14. Continue drilling until reaching the assigned total depth, or until sampler refusal occurs. Sampler refusal is when the drilling penetration drops below 0.1 feet per 2 minutes, with the full weight of the rig on the sampler.

15. Plug and abandon boreholes not used for temporary well installation in accordance with Benchmark's Field Operating Procedure for Abandonment of Borehole. Boreholes to be used as temporary wells should be completed in accordance with Benchmark's Temporary Well (Piezometer) Construction Procedures FOP.

16. Decontaminate all non-dedicated drilling tools between boring locations using potable tap water and a phosphate-free detergent (i.e., Alconox™) in accordance with Benchmark's Drilling and Excavation Equipment Decontamination Procedures FOP.

OTHER PROCEDURAL ISSUES

- Borings will not be over drilled (rat holed) without the express permission of the Benchmark field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.

- Potable water may be placed in the sampler stem if critically necessary for borehole control or to accomplish sampling objectives. This will be performed only with the express permission of the Benchmark field supervisor.

ATTACHMENTS

Drilling Safety Checklist (sample)
Tailgate Safety Meeting Form (sample)

REFERENCES

<u>Benchmark FOPs:</u>

001	*Abandonment of Borehole Procedures*
017	*Drill Site Selection Procedure*
018	*Drilling and Excavation Equipment Decontamination Procedures*
054	*Soil Description Procedures Using the USCS*
077	*Temporary Well (Piezometer) Construction Procedures*

DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs** Date:
Project No.: **0041-009-500** Drilling Company:
Client: **RealCo., Inc.** Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, either swaged Coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or load side? Clamps should not be alternated and should be of the correct size and number for the cable size to which it is installed. Clamps are complete with no missing parts?		
Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation?		
Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load?		
Drive shafts, belts, chain drives and universal joints shall be guarded to prevent accidental insertion of hands and fingers or tools.		
Outriggers shall be extended prior to and whenever the boom is raised off its cradle. Hydraulic outriggers must maintain pressure to continuously support and stabilize the drill rig even while unattended.		
Outriggers shall be properly supported on the ground surface to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement? Controls should not be blocked or locked in an action position.		
Safeties on any device shall not be bypassed or neutralized.		
Controls shall be operated smoothly and cables and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		

ITEMS TO CHECK	OK	ACTION NEEDED

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DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**

Date:

Project No.: **0041-009-500**

Drilling Company:

Client: **RealCo., Inc.**

Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
The work area around the borehole shall be kept clear of trip hazards and walking surfaces should be free of slippery material.		
Workers shall not proceed higher than the drilling deck without a fall restraining device and must attach the device in a manner to restrict fall to less than 6 feet.		
A fire extinguisher of appropriate size shall be immediately available to the drill crew. The drill crew shall have received annual training on proper use of the fire extinguisher.		
29 CFR 1910.333 © (3) Except where electrical distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to, under, by, or near power lines only in accordance with the following: .333 © (3) (ii) 50 kV or less -minimum clearance is 10 ft. For 50 kV or over - 10ft. Plus ½ in. For each additional kV **Benchmark Policy: Maintain 20 feet clearance**		
29 CFR 1910.333 © (3) (iii) While the rig is in transit with the boom in the down position, clearance from energized power lines will be maintained as follows: Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 720 kV - 16 feet		

Name: (printed)

Signed:

Date:

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

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FIELD OPERATING PROCEDURES

Stockpile Sampling Procedures for Chemical Analysis

FOP 079.0

STOCKPILE SAMPLING PROCEDURES
FOR CHEMICAL ANALYSIS

PURPOSE

This guideline presents a method for collecting representative soil samples from stockpiled borrow source material for chemical analysis.

GENERAL

In general, off-site soil that is brought to a Site for use as supplemental fill is subject to Quality Assurance sampling and analysis. If QA is required, all off-site soil proposed for use as Site backfill shall be documented by the subcontractor in writing to have originated from locations having no evidence of disposal or release of hazardous, toxic or radioactive substances, wastes or petroleum products. If the subcontractor designates a source as "virgin" soil, it shall be further documented in writing to be native soil material having not supported any known past industrial or commercial development or agricultural use. Borrow soils can be used as backfill once concentrations are confirmed to meet project designated criteria for the Constituents of Primary Concern (COPCs) and NYSDEC TAGM HWR-94-4046 recommended soil cleanup objectives (SCOs) or NYSDEC 6NYCRR Part 375 SCOs.

Sample collection equipment will include stainless steel mixing bowls, stainless steel mixing spoons, and a stainless steel hand auger with extension rods or a stainless steel spade or equivalent. It may be necessary to use a backhoe or drilling rig to facilitate sample collection.

SAMPLING PLAN

1. Virgin Sources – Virgin borrow sources will be confirmed acceptable for use as site backfill through collection of a single composite soil sample representative of the borrow pit or stockpile.

2. Non-Virgin Sources – Prior to sampling, determine the amount of soil that will be sampled. The soil will be tested via collection of one composite sample per 250 cubic yards of material from each source area. If more than 1,000 cubic yards of soils are excavated from a given off-site source area and all samples of the first 1,000 cubic yards meet project designated criteria, the sample collection frequency may be reduced to one composite for each additional 1,000 cubic yards of soils from the same source area, up to 5,000 cubic yards. For borrow sources greater than 5,000 cubic yards, sampling frequency may be reduced to one sample per 5,000 cubic yards, providing all earlier samples meet project designated criteria. Sampling procedure for non-virgin sources is described in the next section.

SAMPLE COLLECTION AND HANDLING

The following procedure will be used to collect representative soil samples from a non-virgin soil stockpile.

1. Using a stainless steel spade (or hand auger), a backhoe, or drilling rig, penetrate the pile to a depth of approximately 2 to 3 feet and collect four (4) representative grab samples of approximate equal volume from the top, middle, and bottom.

2. Transfer each grab into a small stainless steel mixing bowl.

3. **VOC Analysis:** Using a clean stainless steel spoon, transfer equal amounts from each small mixing bowl into a laboratory-supplied, 4 oz. VOC sample jar. This should be performed by randomly transferring several small aliquots from each bowl, taking care to minimize disturbance of the soil.

4. **Other COPCs:** Transfer equal aliquots from each small bowl into a large mixing bowl and homogenize the sample. Fill the remaining laboratory-supplied jars with the homogenized soil for all other project required COPCs (i.e., SVOCs, PCBs, Pesticides, Herbicides, inorganics, etc.).

5. Label each set of jars with the following information:
   - Project and site name
   - Sample Code
   - Project Number
   - Date/Time
   - Sample type (soil composite or grab)
   - Sampler's initials
   - Sample Preservation
   - Required analysis

   The sample code will consist of a unique, alphanumeric identification code keyed to the sampling location. Identify the sampling location on a field sketch.

6. Record all information associated with sample collection in the Project Field Book.

7. Label, store, and ship the samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

8. Clean the sampling and mixing equipment with Alconox and deionized water and repeat steps 1 through 7 for the remaining samples.

REFERENCES

<u>Benchmark FOPs:</u>
046 Sample Labeling, Storage and Shipment Procedures

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FIELD OPERATING PROCEDURES

Stockpile & Borrow Source Sampling Procedures for Physical Analysis

FOP 080.0

STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES FOR PHYSICAL ANALYSIS

PURPOSE

This guideline presents a method for collecting representative soil samples from stockpiled borrow source material for physical analysis.

GENERAL

Generally, one of two methods will be utilized to collect soil samples for analysis. One method is to collect the samples by digging a series of representative test pits at the borrow source area and obtaining samples from those test pits. The other method involves collecting samples from representative stockpiles (normally after the material has been mechanically screened). Both procedures are discussed within this method.

Sample collection equipment will include stainless steel mixing bowls, stainless steel mixing spoons, and a stainless steel hand auger with extension rods or a stainless steel spade or equivalent. It may be necessary to use a backhoe or drilling rig to facilitate sample collection.

STOCKPILED SOIL SAMPLING METHOD

As shown in the attached Figure 1, twelve (12) samples of approximate equal volume should be collected from the top, middle and bottom of each 1000 CY stockpile by CQA personnel and composited in the field to give one representative aliquot per 1000 CY.

Stockpile Sampling Procedure

1. Using a shovel or backhoe, penetrate the pile to a depth of about two to three feet.
2. Collect a sample using the shovel.

3. Transfer the sample to a specially prepared mixing area.
4. Repeat Steps 1 through 3 at each 1,000 CY stockpile.
5. Mix subsamples using shovel into one homogenous mass and place in a properly labeled 5-gallon bucket. Fill each bucket completely and cover.
6. Attach a label to each container and record location referencing the stockpile identification number. The label may be made with permanent marker on the side (not top) of the container or using adhesive-back paper labels affixed to the side of the container. At a minimum, the labels should be identified with the following information:
    - Project Name
    - Sample number.
    - Initials of CQA inspector or sample collection personnel.
    - Date of collection.
    - Location of collection (i.e. stockpile I.D.)
7. Return remaining contents of composite sample to stockpile.
8. Deliver the samples to the laboratory for analysis as soon as possible.
9. All information pertinent to each sampling event should be recorded by sampling personnel in the field at the time of sample collection. Each report should correspond to each stockpile and will contain the following information:
    - Project Name
    - Sample number or numbers collected
    - Field observations.
    - Climatologic conditions.
    - Date and time of collection.
    - Approximate location of test pit.
    - Name of person who collected sample.

BORROW AREA TEST PIT SAMPLING METHOD

Prior to obtaining representative soil samples, test holes should be excavated at the borrow area to determine the actual depth and lateral extent of the borrow source soil material. A base line should then be established and a grid system staked in the field. Five samples should be collected at equidistant locations for each 5000 cubic yards (CY) of soil designated for use in the borrow areas (at approximately mid-depth).

Borrow Area Sampling Procedure

1. Using a shovel, collect a representative sample at approximately mid-depth at each of the sampling locations representing 1000 CY of the proposed excavation area.
2. Transfer each sample into a labeled separate 5-gallon bucket. Fill each bucket completely and cover.
3. Attach a label to each container and record location referencing the established grid system in the borrow area. The label may be made with permanent marker on the side (not top) of the container or using adhesive-back paper labels affixed to the side of the container. At a minimum, the labels should be identified with the following information:
    - Project Name
    - Sample number.
    - Initials of CQA inspector or sample collection personnel.
    - Date of collection.
    - Location of collection (i.e. location of borrow area grid system location)
4. Deliver the samples to the laboratory for analysis as soon as possible.
5. All information pertinent to each sampling event should be recorded by sampling personnel in the field at the time of sample collection. Each report should correspond to each test pit and will contain the following information:
    - Project Name
    - Sample number or numbers collected
    - Field observations.
    - Climatologic conditions.
    - Date and time of collection.
    - Approximate location of test pit.
    - Name of person who collected sample.

ATTACHMENTS

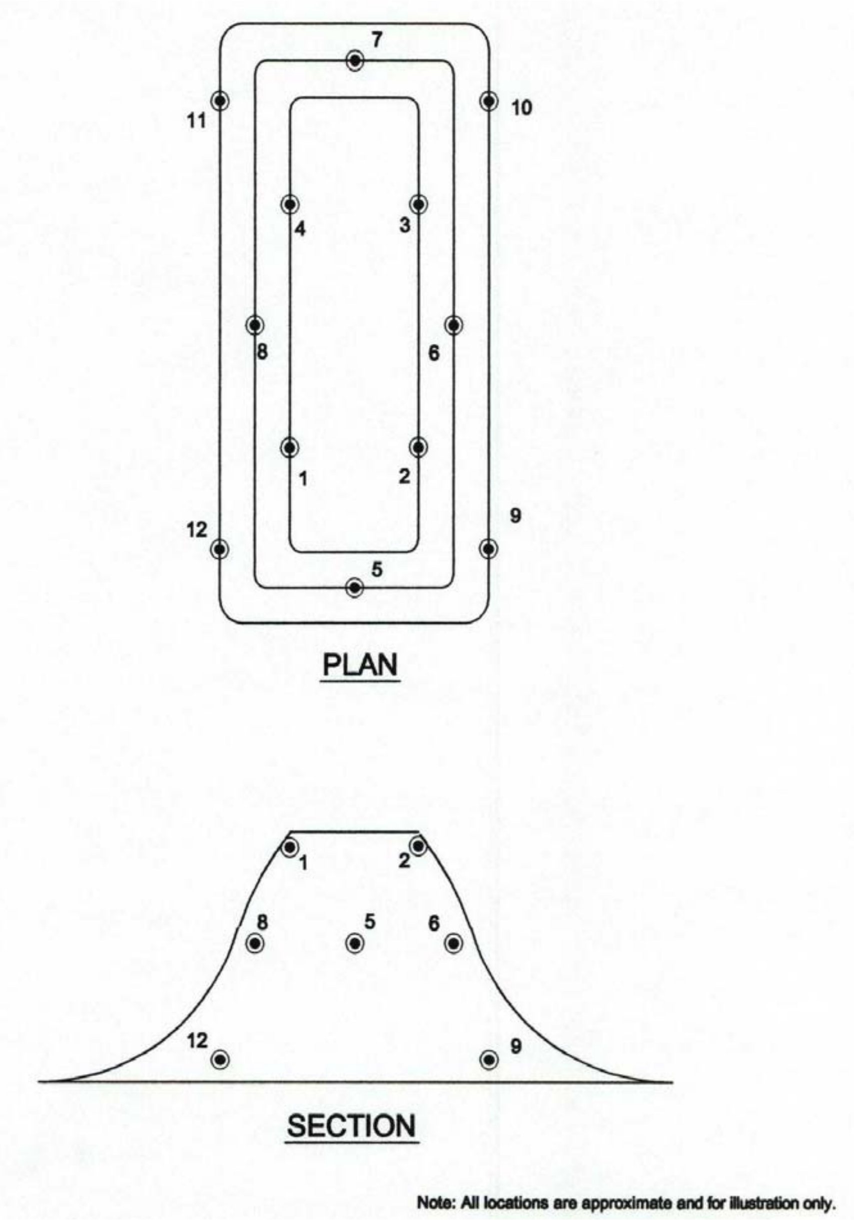
Figure 1; Stockpile Sampling Methodology

REFERENCES

None

FIGURE 4

1,000 CY STOCKPILE SAMPLING METHODOLOGY



Note: All locations are approximate and for illustration only.

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FIELD OPERATING PROCEDURES

Waste Sampling Procedures

FOP 082.0

WASTE SAMPLING PROCEDURES

PURPOSE

This guideline describes the equipment and procedures that can safely be used to collect waste samples from open and closed units.

INTRODUCTION

Hazardous wastes are regulated by the USEPA under 40 CFR Parts 260-265. Therefore, many of the methods that are used to manage, store, treat, and dispose hazardous wastes and potential hazardous wastes are of concern to both the regulators and the regulated community. Samples are often required of regulated or potentially regulated materials. While it is understood that each facility and waste stream may present its own unique sampling and analytical challenges, this procedure will list equipment and enumerate procedures that have been used by the USEPA to safely and successfully sample specific waste units.

SAFETY

Sampling of waste units should be assessed for potential hazards by both the Project Manager (PM) and the site safety officer (SSO). It is the SSOs responsibility to enforce the site Health and Safety Plan (HASP), and to ensure that procedures used during waste sampling are in accordance with current company protocol. Sampling equipment contaminated during waste sampling investigations should be cleaned with laboratory detergent and rinsed with tap water prior to returning the equipment from the field. Contaminated sampling equipment that is to be discarded must be disposed of properly in accordance with the site-specific Work Plan.

It should be noted that although Benchmark does not readily perform field activities with highly hazardous materials, we do occasionally oversee contractors who do. Therefore, it is prudent on our part to recognize those situations and be prepared to ensure the activities of our subcontractors comply with the site-specific HASP as well as those procedures discussed herein. Any reference within this procedure to personal protective equipment (PPE) upgrades above a modified level C (i.e., Tyvek, nitrile gloves, and full-face respirator) relates solely to our subcontractors.

QUALITY CONTROL PROCEDURES

In some instances, special decontamination procedures will be necessary and should be developed on a case-by-case basis according to the specific material encountered. Any cleaning procedures and equipment repairs conducted in the field deviating from those specified in the associated FOPs or the site-specific Work Plan, should be discussed with the Project Manager, and thoroughly documented in the Project Field Book.

All air monitoring and field analytical/screening equipment (i.e., photoionization detectors) should be checked and calibrated per manufacturer's specifications before being used to collect any waste stream unit sample (open or closed). The Field Team Leader should record all calibration results on appropriate field forms.

WASTE UNIT TYPES

Waste management units can be generally categorized into two types: open and closed. In general, open units are larger than closed units and include waste piles and surface impoundments whereas closed units include containers and tanks as well as ancillary tank equipment. Besides containers and tanks, sumps may also be considered closed units because they are designed to collect the spillage of liquid wastes and are sometimes configured as a confined space.

Although both may pose hazards, units that are open to the environment are generally less hazardous than closed units. Sampling of closed units is considered a higher hazard risk because of the potential of exposure to toxic gases and flammable/explosive atmospheres. Because closed units prevent the dilution of the wastes by environmental influences, they are more likely to contain materials that have concentrated levels of hazardous constituents. While opening closed units for sampling purposes, investigators/contractor's shall use Level B PPE, air monitoring instruments to ensure that the working environment does not contain hazardous levels of flammable/explosive gasses or toxic vapors, and follow the appropriate safety requirements stipulated in the site-specific HASP.

Buried waste materials should be located and excavated with extreme caution. Once the buried waste is uncovered, the appropriate safety and sampling procedures utilized will depend on the type of waste unit.

Open Units

While open units may contain many types of wastes and come in a variety of shapes and sizes, they can be generally regarded as either waste piles or surface impoundments.

Definitions of these two types of open units from 40 CFR Part 260.10 are:

- Waste pile -- any non-containerized accumulation of solid, non-flowing hazardous waste that is used for treatment or storage and that is not a containment building.
- Surface impoundment -- "...a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold the accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons."

One of the distinguishing features between waste piles and surface impoundments is the state of the waste. Waste piles typically contain solid or non-flowing materials whereas liquid wastes are usually contained in surface impoundments. The nature of the waste will also determine the mode of delivering the waste to the unit. Wastes are commonly pumped or gravity fed into impoundments while heavy equipment or trucks may be used to dump wastes in piles. Once the waste has been placed in an open unit, the state of the waste may be altered by environmental factors (e.g., temperature, precipitation, etc.).

Surface impoundments may contain several phases such as floating solids, liquid phase(s), and sludges. Waste piles are usually restricted to solids and semi-solids. All of the potential phases contained in a waste unit should be considered in developing the sample design to meet the study's objective.

Closed Units

There are a variety of designs, shapes, sizes, and functions of closed units. In addition to the challenges of the various designs and the safety requirements for sampling them, closed units are difficult to sample because they may contain liquid, solid, semi-solid/sludge, or any combination of phases. Based on the study's design, it may be necessary to obtain a cross sectional profile of the closed unit in an attempt to characterize the unit. The following are definitions of types of closed waste units described in 40 CFR Part 260.10:

- Container -- any portable device in which a material is stored, transported, treated, disposed, or otherwise handled. Examples of containers are drums, overpacks, pails, totes, and roll-offs.

- Tank -- a stationary device, designed to contain an accumulation of hazardous waste constructed primarily of non-earthen materials, which provide structural support.

Portable tanks, tank trucks, and tank cars vary in size and may range from simple to extremely complex designs. Depending on the unit's design, it may be convenient to consider some of these storage units as tanks for sampling purposes even though they meet the definition of a container.

- Ancillary equipment (tank) -- any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps that is used to distribute, meter, or control the flow of hazardous waste from its point of generation to a storage or treatment tank(s), between hazardous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site.

- Sump -- any pit or reservoir that meets the definition of a tank and those troughs/trenches connected to it that serve to collect hazardous wastes.

Note: some outdoor sumps may be considered open units/surface impoundments.

Although any of the closed units may not be completely sealed and may be partially open to the environment, the unit needs to be treated as a closed unit for sampling purposes until a determination can be made. Once a closed unit is opened, a review of the proposed sampling procedures and level of protection can be performed to determined if the (PPE) is suitable for the site conditions.

Samples collected from different waste units should not be composited into one sample container without additional analytical and/or field screening data to determine if the materials are compatible and will not cause an inadvertent chemical reaction.

EQUIPMENT

Selecting appropriate equipment to sample wastes is a challenging task due to the uncertainty of the physical characteristics and nature of the wastes. It may be difficult to separate, homogenize and/or containerize a waste due to its physical characteristics (viscosity, particle size, etc.). In addition, the physical characteristics of a waste may change with temperature, humidity, or pressure. Waste streams may vary depending on how and when a waste was generated, how and where it was stored/disposed, and the conditions under which it was stored/disposed. Also, the physical location of the wastes or the unit configuration may prevent the use of conventional sampling equipment.

Given the uncertainties that a waste may present, it is desirable to select sampling equipment that will facilitate the collection of samples that will meet the study's objective, and that will not unintentionally bias the sample by excluding some of the sample population that is under consideration. However, due to the nature of some waste matrices or the physical constraints of some waste units, it may be necessary to collect samples knowing that a portion of the desired population was omitted due to limitations of the equipment. Any deviations from the study plan or difficulties encountered in the field concerning sample collection that may have an effect on the study's objective should be documented in a log book, reviewed with the analytical data, and presented in the report.

WASTE SAMPLING EQUIPMENT

Waste sampling equipment should be made of non-reactive materials that will neither add to nor alter the chemical or physical properties of the material that is being sampled. The attached Table 1 lists some conventional equipment for sampling waste units/phases and some potential limitations of the equipment. Another reference for selecting sampling equipment is the ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data Collection Activities, D6232-98.

WASTE SAMPLING PROCEDURES

Waste Piles

Waste piles vary in size, shape, composition, and compactness, and may vary in distribution of hazardous constituents and characteristics (strata). These variables will affect safety and access considerations. The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from waste piles are listed in Table 1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

Surface Impoundments

Surface impoundments vary in size, shape, and waste content, and may vary in distribution of hazardous constituents and characteristics (strata). The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from surface impoundments are listed in Table 1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

Because of the potential danger of sampling waste units suspected of containing elevated levels of hazardous constituents, personnel should never attempt to sample surface impoundments used to manage potentially hazardous wastes from a boat. All sampling should be conducted from the banks or piers of surface impoundments. Any exception must be approved by the appropriate site safety officer and/or the Occupational Health and Safety Designee (OHSD).

Drums

Drums are the most frequent type of containers sampled by field investigators for chemical analyses and/or physical testing. Caution should be exercised by the field investigators when sampling drums because of the potential presence of explosive/flammable gases and/or toxic vapors. Therefore, the following procedures should be used when collecting samples from drums of unknown material:

1. Visually inspect all drums that are being considered for sampling for the following:
    - pressurization (bulging/dimples);
    - crystals formed around the drum opening;
    - leaks, holes, stains;

- labels, markings;
- composition and type (steel/poly and open/bung);
- condition, age, rust
- sampling accessibility

Drums showing evidence of pressurization and crystals should be furthered assessed to determine if remote drum opening is needed. If drums cannot be accessed for sampling, heavy equipment is usually necessary to stage drums for the sampling activities. Adequate time should be allowed for the drum contents to stabilize after a drum is handled.

2. Identify each drum that will be opened (e.g., paint sticks, spray paint, cones, etc).

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal drum that is not in direct contact with the earth using grounding wires, alligator clips, and a grounding rod or metal structure. If a metal drum is in an overpack drum, the metal drum should be grounded.

4. Touch the drum opening equipment to the bung or lid and allow an electrical conductive path to form. Slowly remove the bung or drum ring and/or lid with spark resistant tools (brass/beryllium).

5. Screen drums for explosive gases and toxic vapor with air monitoring instruments as bung or drum lid is removed. Depending on site conditions screen for one or more of the following:
    - radioactivity
    - cyanide fumes
    - halogen vapors
    - pH
    - flash point (requires sample for testing)

    Note the state, quantity, phases, and color of the drum contents. Record all relevant results, observations, and information in a logbook.

6. Select the appropriate sampling equipment based on the state of the material and the type of container. Sampling equipment should be made of non-reactive materials that will meet the study's objective(s).

7. Place oil wipe (as necessary), sampling equipment, and sample containers near drum(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS AND EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONDUCTED DURING DRUM SAMPLING.

Liquids -- Slowly lower the COLIWASA or drum thief to the bottom of the container. Close the COLIWASA with the inner rod or create a vacuum with the sampler's gloved thumb on the end of the thief and slowly remove the sampling device from the drum. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids -- Use a push tube, bucket auger, or screw auger or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully use a clean stainless steel spoon to place the sample into container(s) for analyses.

8. Close the drums when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the drum screening procedure (Step #5). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field.

Tanks

Sampling tanks is considered hazardous due to the potential for them to contain large volumes of hazardous materials and therefore, appropriate safety protocols must be followed. Unlike drums, tanks may be compartmentalized or have complex designs.

Preliminary information about the tank's contents and configuration should be reviewed prior to the sampling operation to ensure the safety of sampling personnel and that the study's objectives can be achieved.

In addition to having discharge valves near the bottom of tanks and bulk storage units, most tanks have hatches at the top. It is desirable to collect samples from the top hatch because of the potential for the tank's contents to be stratified. Additionally, when sampling from the discharge valve, there is a possibility of a stuck or broken valve which could cause an uncontrolled release. Investigators should not utilize valves on tanks or bulk storage devices unless they are operated by the owner or operator of the facility, or a containment plan is in place should the valve stick or break. If the investigator must sample from a tank discharge valve, the valving arrangement of the particular tank must be clearly understood to insure that the compartment(s) of interest is sampled.

Because of the many different types of designs and materials that may be encountered, only general sampling procedures that outline sampling a tank from the top hatch are listed below:

1. All relevant information concerning the tank such as the type of tank, the tank capacity, markings, condition, and suspected contents should be documented in a logbook.

2. The samplers should inspect the ladder, stairs, and catwalk that will be used to access the top hatch to ensure that they will support the samplers and their equipment.

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal tank using grounding wires, alligator clips, and a grounding rod or metal structure.

4. Any vents or pressure release valves should be slowly opened to allow the unit to vent to atmospheric pressure. Air monitoring for explosive/flammable gases and toxic vapors should be conducted during the venting with the results recorded in a log book. If dangerous concentrations of gases evolve from the vent or the pressure is too great, leave the area immediately.

5. Touch tank opening equipment to the bolts in the hatch lid and allow electrical conductive path to form. Slowly remove bolts and/or hatch with spark resistant tools (brass/beryllium). If a pressure build up is encountered or detected, cease opening activities and leave the area.

6. Screen tanks for explosive/flammable gases and toxic vapors with air monitoring instruments. Depending on the study objectives and site conditions, conduct characteristic screening (e.g., pH, halogen, etc.) as desired. Collect a small volume of sample for flash point testing, if warranted. Note the state, quantity, number of phases, and color of the tank contents. Record all relevant results, observations, and information in a logbook. Compare the screening results with any pre-existing data to determine if the tank should be sampled.

7. Select the appropriate sampling equipment based on the state of the material and the type of tank. Sampling equipment should be constructed of non-reactive materials that will meet the study's objective(s).

8. Place oil wipe (as necessary), sampling equipment, and sample containers near tanks(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONTINUOUS DURING TANK SAMPLING.

Liquids -- Slowly lower the bailer, bacon bomb, DipstickTM, COLIWASA, or Teflon® tubing to the desired sampling depth. (NOTE: In work areas where explosive/flammable atmospheres could occur, peristaltic pumps powered by 12 V. batteries should not be used.) Close the sampling device or create a vacuum and slowly remove the sampling device from the tank. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids - Use a push tube, bucket auger, screw auger, MucksuckerTM, or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully extrude the sample from the sampling device or use a clean stainless steel spoon to place the sample into containers for analyses.

9. Close the tank when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the screening procedure (Step #6). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field. IDW should be managed according to Section 5.15, and Region 4's Contaminated Media Policy.

Miscellaneous Contaminated Materials

Sampling may be required of materials or equipment (e.g., documents, building materials, equipment, etc.) to determine whether or not various surfaces are contaminated by hazardous constituents, or to evaluate the effectiveness of decontamination procedures.

Wipe or swab samples may be taken on non-absorbent, smooth surfaces such as metal, glass, plastic, etc. The wipe materials must be compatible with the solvent used and the analyses to be performed, and should not come apart during use. The wipes are saturated with a solvent; methylene chloride, hexane, isopropanol or analyte free water depending on the parameters to be analyzed. The laboratory performing the analyses can provide the appropriate solvent. Wipe samples should not be collected for volatile organic compounds analysis. Sampling personnel should be aware of hazards associated with the selected solvent and should take appropriate precautions to prevent any skin contact or inhalation of these solvents. All surfaces and areas selected for sampling should be based on the study's objectives. Typically, 10 cm by 10 cm templates are prepared from aluminum foil which are secured to the surface of interest. The prepared (saturated with solvent) wipe(s) is removed from its container with tongs or gloves, and used to wipe the entire area with firm strokes using only one side of the wipe. The goal is to systematically wipe the whole area. The wipe is then folded with the sample side inward and placed into the sample container. This procedure is repeated until the area is free of visible contamination or no more wipes remain. Care should be taken to keep the sample container tightly sealed to prevent evaporation of the solvent. Samplers must also take care to not touch the used side of the wipe.

For items with porous surfaces such as documents (usually business records), insulation, wood, etc., actual samples of the materials are required. It is therefore important, that during the collection and/or analyses of the sample that evidentiary material is not destroyed.

All secondary containing pails will be secured in the vehicles while transporting the samples from the field to the laboratory for analyses. In addition, each pail should indicate when protective equipment is recommended to handle the actual waste/sample material

REFERENCES

United States Environmental Protection Agency. November 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

Benchmark FOPs:

011 *Calibration and Maintenance of Portable Photoionization Detector*

046 *Sample Labeling, Storage and Shipment Procedures*

TABLE 1

SAMPLING EQUIPMENT for VARIOUS WASTE UNITS

Equipment	Waste Units/Phases	Limitations
scoop with bracket/conduit	impoundments, piles, containers, tanks/liquids, solids, sludges	Can be difficult to collect deeper phases in multiphase wastes. Depth constraints.
spoon	impoundments, piles, containers/solids, sludges	Similar limitations as the scoop. Generally not effective in sampling liquids.
push tube	piles, containers/cohesive solids, sludges	Should not be used to sample solids with dimensions >'/2 the diameter of the tube. Depth constraints
auger	impoundments, piles, containers / solids	Can be difficult to use in an impoundment or a container, or for solidified wastes.
sediment sampler	impoundments, piles/solids, sludges	Should not be used to sample solids with dimensions >'/2 the diameter of the tube.
ponar dredge	impoundments/solids, sludges	Must have means to position equipment to desired sampling location. Difficult to decon.
COLIWASA or drum	impoundments, containers,	Not good with viscous wastes. Devices >_ 7'
thief	tanks/liquids	Require 2 samplers to use effectively.
DipstickTM /	impoundments, containers,	Not recommended for tanks >11 feet deep.
MucksuckerTM	tanks/liquids, sludges	Devices _> 7' require 2 samplers to use effectively
bacon bomb	impoundments, tanks/ liquids	Not good with viscous wastes.
bailer	impoundments, tanks/ liquids	Only if waste is homogeneous. Not good with viscous wastes
peristaltic pump with vacuum jug assembly	impoundments, tanks/liquids	Cannot be used in flammable atmospheres. Not good with viscous wastes
back-hoe bucket	piles/solids, sludges	May be difficult to access desired sampling location. Difficult to decon. Can lose volatiles.
split-spoon	piles/solids	Requires drill rig or direct push equipment.
roto-hammer	piles, containers/solids	Physically breaks up sample. May release volatiles. Not for flammable atmospheres.

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FIELD OPERATING PROCEDURES

Calibration & Maintenance of Portable Particulate Meter

FOP 084.0

CALIBRATION AND MAINTENANCE OF PORTABLE PARTICULATE METER

PURPOSE

This guideline describes a method for calibration of a portable particulate meter, specifically the Thermo Electron Corporation MIE DataRAM 4 (Model DR-4000). The DataRAM 4 measures the concentration of airborne particulate matter (liquid or solid), as well as mean particle size, air temperature, and humidity, providing direct and continuous readout as well as electronic recording of the information. This parameter is of interest both as a general indicator of air quality, and because of its pertinence to community air monitoring typically required at most construction/remediation/investigation sites. The DataRAM covers a wide measurement range from 0.0001 mg/m^3 to 400 mg/m^3. With its large capacity internal data logging capabilities with data retrieval on screen or downloaded, the DataRAM can store up to 50,000 data points, including individual point averages, particle size, temperature, and humidity with time stamp as well as overall average and maximum concentration.

Because the DataRAM meter must be factory calibrated once a year, this guideline presents a method for start-up, operation, and maintenance, which is performed to verify instrument function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each year. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter. The user should reference the manufacturer's instruction manual prior to operating this unit.

ACCURACY & PRECISION

The calibrated accuracy of the DataRAM 4 particulate meter is within ± 2% of reading ± precision over the temperature range of -4° to 158° F (-10° to 50° C) and 10 to 95% relative humidity (non-condensing). The precision is ± 1% of reading or ± 0.001 mg/m^3, whichever is greater (1-second averaging) and ± 0.3% of reading or ± 0.0003 mg/m^3, whichever is greater (10-second averaging).

INSTRUMENT PANEL VIEW

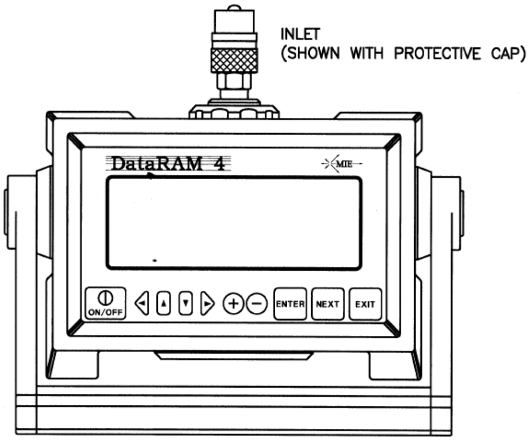


FIGURE 1. FRONT–PANEL VIEW OF DataRAM

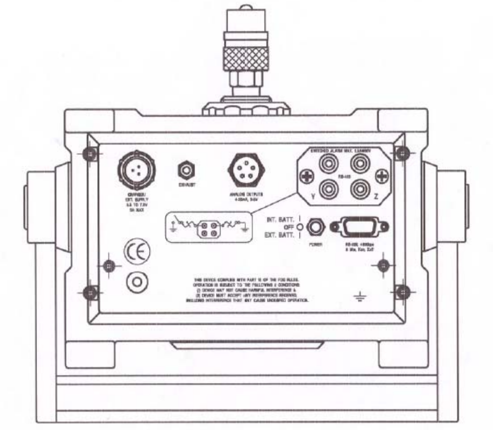


FIGURE 2. BACK–PANEL VIEW OF DataRAM

MAINTENANCE

General Guidelines

The DataRAM 4 is designed to be repaired at the factory. No user serviceable components are inside the metal enclosure of the DataRAM 4 with exception of the filter cartridge or the analytic filter holder. Access to the internal components of the unit by others than authorized MIE personnel voids warranty.

Unless a MALFUNCTION message is displayed, or other operational problems occur, the DataRAM 4 should be returned to the factory once every two years for routine check out, test, cleaning and calibration check.

Battery Charging and Cycling

If the DataRAM 4 is to be operated without its charger/power supply, i.e., deriving power from its internal battery, this battery should be fully charged before initiating a run. The

DataRAM 4 charger/power supply can be connected continuously to the instrument whether the DataRAM 4 is on or off. If the charger/power supply is not connected, the internal battery will discharge very slowly depending on storage temperature. Low storage temperature reduces battery capacity. High storage temperatures, however, reduce battery life which is of the order of 8 years at 20°C (68°F), and only 2 years at 40°C (104°F).

In general, the user should maintain the battery charge as high as possible in order to extend its charge/discharge cycling capacity (this characteristic differs from that of nickel-cadmium batteries).

Instrument Storage

If the DataRAM 4 is to be stored for an extended period of time (i.e., 3 months or more), place the 3-position switch on the back panel in its OFF position (mid-position), in order to minimize gradual battery discharge. This will have no effect on data retention or internal clock function. It is recommended, however, that the battery be recharged every 3 months in order to prolong battery life.

During storage always snap on quick-connect cap over the instrument inlet to protect the sensing optics from gradual dust contamination. Store DataRAM 4 in a dry environment.

Filter Replacement

To replace either of two types of filters used with DataRAM 4, place the instrument on its back rubber feet (front panel facing upward). On the bottom surface of the DataRAM, locate the large threaded plastic filter cover and holding the cross bar, rotate this cover counterclockwise. Remove cover and the filter holder within the open cavity.

HEPA Filter Cartridge Replacement

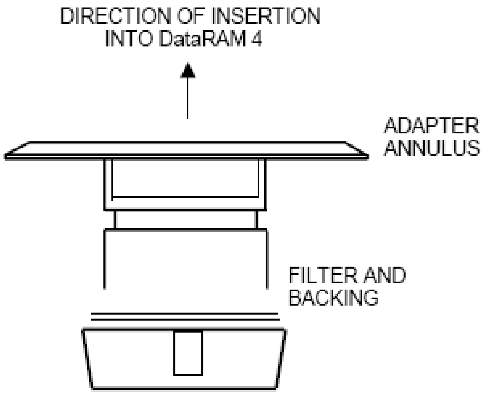
The DataRAM 4 is shipped from the factory with the HEPA filter cartridge installed. This cartridge can be identified by its metallic cover. Remove this cartridge. Clean the internal black rubber gasket against which the cartridge is normally compressed. Install new HEPA-type cartridge (MIE part no. MSA-95302) by inserting its wider ridged end first. Reposition threaded plastic cover engaging threads carefully; rotate cover clockwise, hand tightening firmly. Properly dispose of used cartridge to prevent inadvertent re-use.

Analytic Filter Installation/Replacement

In order to install or replace the analytical filter holder, proceed as follows. Remove the HEPA cartridge normally in place. Remove (separate) the inlet cover (with the blue plug) of the Millipore plastic filter holder from the rest of that holder assembly containing the white membrane filter. Insert firmly the gray plastic adapter annulus into the open face of the filter holder assembly. Remove the red plastic plug from the exhaust nipple of the filter holder assembly. Ensure that all three components of the holder assembly are fully compressed to preclude any leafage. Insert the assembly into the filter cavity of the DataRAM 4 with the gray plastic adapter annulus bearing against the internal black gasket (adapter annulus inserted first). Reposition threaded plastic cover and hand-tighten carefully and firmly. Set aside HEPA cartridge for future use.

In order to remove and/or to replace the membrane filter within its holder, remove the gray plastic adapter annulus and separate (pry apart) the two transparent plastic rings that compress the membrane filter. Make sure to remove and replace only the membrane filter (using tweezers), leaving the white backing disc in the holder. A new membrane filter should then be placed over that backing and the sealing ring should then be inserted to trap and compress the filter and backing discs. For storage, the inlet cap with the blue plug should be inserted as well as the red plug on the back of the filter holder.

Analytical filter holder with adapter annulus inserted



Cleaning of Optical Sensing Chamber

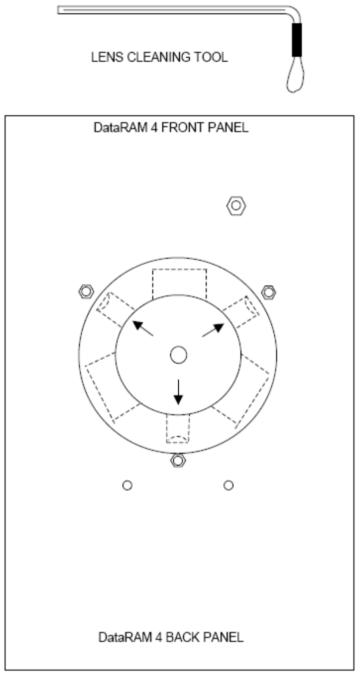
Although the DataRAM 4 incorporates filtered air shielding of the critical optical sensing surfaces, continued sampling of airborne particles at high concentrations may result in gradual build-up of contamination on those interior surfaces of the sensing chamber components. This may cause an excessively high optical background level. If this background level does becomes excessive, the DataRAM 4 will alert the user at the completion of the zeroing sequence by the display of a BACKGROUND HIGH message. If this message is presented, the DataRAM 4 can continue to be operated providing accurate measurements. However, it is then advisable to clean the front surfaces of the optical lenses within the sensing chamber at the first convenient opportunity, as described below. The tools required for this cleaning are: an intense concentrated light source (e.g., flash light) to view the inside of the sensing chamber, denatured alcohol, a soft lint-free cloth, and the special cleaning tool provided with the DataRAM 4 consisting of a cut-off cotton swab inserted in a plastic sleeve and held by a right-angle Allen wrench.

Proceed as follows to clean the lens surfaces within the sensing chamber:

- **Make sure to shut off power completely before proceeding with cleaning**
- Install the stainless steel cover on the inlet of the DataRAM 4 to protect this fitting.
- Place the DataRAM 4 upside down on a table, resting the instrument on the inlet cover and the rear protective bumper.
- Unscrew the gray plastic cover of the filter cavity on the bottom surface of the DataRAM 4.
- Remove the filter cartridge from its cavity.
- Carefully clean the black soft filter-sealing gasket within the filter cavity by wiping it with the lint-free soft cloth. Use alcohol if necessary.
- Shine the concentrated light source into the sensing chamber located about 3 cm (1¼ in.) beyond the soft-sealing gasket in the filter cavity.
- Locate the three smaller side cavities inside the sensing chamber, identified by the arrows on that figure (see page 6). These three cavities contain the lenses of the two sources and the common detector of the DataRAM 4. The frontal surfaces of these lenses are likely to require cleaning if the instrument indicates BACKGROUND HIGH.
- Wet the cotton swab of the lens-cleaning tool with alcohol (e.g., methanol, ethanol, or rubbing alcohol).

- Holding the cleaning tool by its long handle, insert this tool into the sensing chamber without touching the walls of this chamber.
- Direct the cotton swab tip towards the opening of one of the three smaller cavities as indicated by the arrows of the figure below, and insert the cotton tip into this cavity as far as it will go. Gently wipe that internal surface touched by the swab tip by a rotating motion. Carefully withdraw the swab tip from the cavity.
- Repeat previous cleaning step for the other two small cavities.
- Carefully remove the cleaning tool from the sensing chamber. Allow the alcohol to dry leaving the filter cavity open for about 15 minutes.
- Re-insert the filter cartridge into its cavity and close it with its gray plastic cover, hand-tightening it firmly. Remove the inlet cap and store on its pod on the back panel.
- Place the DataRAM 4 right side up and key ON. Proceed to check its optical background by running the ZERO/INITIALIZE check as. The message READY! should appear at the end of this check indicating that the lens contamination has been eliminated. Should the message BACKGROUND HIGH persist after completion of the above-described lens cleaning procedure, please contact the factory.

Lens cleaning tool and bottom view of open filter cavity showing location of sensor chamber lens cavities (arrows).



FACTORY CALIBRATION

For mass concentration measurements, each DataRAM 4 is factory calibrated against a set of reference monitors that, in turn, are periodically calibrated against a gravimetric standard traceable to the National Institute of Standards and Testing (NIST).

The primary factory reference method consists of generating a dust aerosol by means of a fluidized bed generator, and injecting continuously the dust into a mixing chamber from which samples are extracted concurrently by two reference filter collectors and by two master real-time monitors that are used for the routine calibration of every DataRAM 4.

The primary dust concentration reference value is obtained from the weight increase of the two filters due to the dust collected over a measured period of time, at a constant and known flow rate. The two master real-time monitors are then adjusted to agree with the reference mass concentration value (obtained from averaging the measurements of the two gravimetric filters) to within ±1%.

Three primary, NIST traceable, measurements are involved in the determination of the reference mass concentration: the weight increment from the dust collected on the filter, the sampling flow rate, and the sampling time. Additional conditions that must be met are: a) suspended dust concentration uniformity at all sampling inlets of the mixing chamber; b) identical sample transport configurations leading to reference and instrument under calibration; and c) essentially 100% collection efficiency of filters used for gravimetric reference for the particle size range of the test dust.

The test dust used for the MIE factory calibration of the DataRAM 4 is SAE Fine (ISO Fine) supplied by Powder Technology, Inc. It has the following physical characteristics (as dispersed into the mixing chamber):

- Mass median aerodynamic particle diameter: 2 to 3 µm
- Geometric standard deviation of lognormal size distribution: 2.5
- Bulk density: 2.60 to 2.65 g/cm3
- Refractive index: 1.54

In addition to the mass calibration described above, the DataRAM 4 is factory calibrated using a gas with known scattering coefficient in order to adjust the relative scattering irradiance at the two source wavelengths.

ATTACHMENTS

None

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FIELD OPERATING PROCEDURES

Field Quality Control Procedures

FOP 085.0

FIELD QUALITY CONTROL PROCEDURES

PURPOSE

In addition to traditional environmental samples (e.g., soil, groundwater, wipe, vapor etc.) described in each project work plan, site-specific field quality assurance/quality control (QA/QC) samples are typically collected and analyzed to support the required third-party data usability assessment effort of a project. Site-specific QA/QC samples generally include matrix spikes, matrix spike duplicates, blind duplicates (where appropriate), and trip blanks which accompany aqueous volatile organic compound (VOC) samples only.

The number of QA/QC field samples (blind duplicate, matrix spike/matrix spike duplicate, trip blank, field blank, or equipment blank) will be designated prior to field mobilization, but final QC sample locations will be contingent upon field conditions. This procedure outlines and discusses each QA/QC sample that may be required during a project.

PROCEDURE

A brief summary of each QA/QC sample identified above is presented below. Where appropriate, the procedure to be used to collect these samples is also presented.

- **Trip Blanks** – A sufficient number of trip blanks for VOC analysis must be prepared by the laboratory and delivered to the sampling team prior to a sampling event, typically two or three 40-ml VOA vials with organic free reagent water. One sealed blank will be carried into the field per day along with the sample containers for each day that water matrix volatile organic samples are collected. Trip blanks will be transported and handled in the same manner as the actual samples. The results of the trip blank analysis will be reviewed to evaluate if the potential for sample contamination during transportation and handling exists. The trip blanks will be analyzed for the same VOCs (and method) as the project groundwater samples.

- **Blind Duplicate** – One blind duplicate must be collected and analyzed per 20 samples collected per matrix (i.e., soil, groundwater, soil vapor, etc.). The location of the sample collection point will not be disclosed to the analytical laboratory, therefore the field sample containers will be returned to the laboratory identified only as the "blind duplicate." The well or sample location will be recorded in the Project Field Book or handheld RuggedReader® Pocket PC and on the field data sheets, and the results will be compared to review analytical precision. Sample analysis will be identical to the original sample per the project work plan. The Blind Duplicate sample must be collected simultaneously from the same source under identical conditions as the original sample.

- **Matrix Spike/Matrix Spike Duplicate (MS/MSD)** – A sufficient volume of sample will be collected at one sampling location per sampling event for MS/MSD analysis per matrix (i.e., soil and groundwater only). The laboratory will report the results of the MS/MSD analysis, which will be reviewed for sampling and analysis precision and accuracy. Sample analysis will be identical to the original sample per the project work plan. The MS/MSD sample must be collected simultaneously from the same source under identical conditions as the original sample.

- **Equipment (Rinsate) Blank** – In general, dedicated sampling equipment is used to minimize field decontamination time and avoid the need for equipment blanks; however there may be instances where the use of non-dedicated equipment cannot be avoided. An equipment blank will be collected for each day of sampling activity when non-dedicated sampling equipment is used. These equipment blank samples will be used as a QC check of the decontamination procedures for sampling equipment. Sample analysis for the equipment blank will consist of the most comprehensive parameter list used for risk assessment in which the non-dedicated equipment was used for environmental sample collection. During most projects, every effort to use dedicated sampling equipment should be made in order to minimize field decontamination time and avoid the need for equipment blanks. Equipment Blank sampling procedure is as follows:
    - Non-dedicated equipment are to be decontaminated in accordance with Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures prior to use in the field. If organic-free

deionized water (generally provided by the laboratory) is not available for decontamination, equipment will be allowed to thoroughly air dry.

  - Once properly rinsed or allowed to air dry, analyte-free water (provided by the laboratory) is poured appropriately over or through the decontaminated sample collection device, collected in a sample container, and returned to the laboratory as a sample.

- **Field Blank** – A field blank is a sample of the unused final decontamination rinse water that is collected at the sampling site and returned to the laboratory as a sample. Sample analysis for the field blank will consist of the most comprehensive parameter list used during the investigation.

- **Split Sample** – A split sample is a sample that has been portioned into two or more containers from a single sample container or sample mixing container. Samples for VOC analysis should never be mixed prior to splitting.

- **Blank Wipe Samples** – There are two types of blank wipe samples, an equipment blank and a field blank that may be required per the project work plan, both are described below:
  - Equipment Blank – Required only if reusable templates are used for wipe sample collection. The decontaminated template is wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.
  - Field Blank – Clean disposable gloves are wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.

REFERENCES

Benchmark FOPs:

040 Non-disposable and Non-dedicated Sampling Equipment Decontamination

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FIELD OPERATING PROCEDURES

Underground Piping Decommissioning Procedures

FOP 088.0

UNDERGROUND PIPING DECOMMISSIONING PROCEDURES

PURPOSE

This procedure describes the method for the excavation and removal of underground piping requiring decommissioning that may contain hazardous or flammable material. Prior to each day or as necessary, the project Health and Safety Plan (HASP) will be reviewed with field personnel (e.g., tailgate safety meeting). It is the responsibility of field personnel to ensure all field equipment is in proper working order and calibrated according to manufacturer's recommendations.

PROCEDURE

1. Review project objectives and the Project HASP with the Contractor.
2. Perform excavation equipment safety checks with the operator. Specific concerns should include, but not limited to, no leaking hydraulic lines, fire extinguisher on board of the excavation equipment, operator experience etc.
3. Conduct tailgate health and safety meeting with project team and excavation operator(s) by completing the Tailgate Safety Meeting Form (sample attached). Discuss with excavation contractor personnel the scope of work and what will be expected of them.
4. Calibrate air-monitoring equipment in accordance with the appropriate TurnKey's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Conduct community air monitoring as required by the HASP and/or Project Work Plan. Record all results on the Real Time Air Monitoring Log (sample attached), as necessary.
6. Mobilize the excavation equipment to the site and position over the required location.

7. Pre-stake locations in the field and measure distance from locations to nearest landmarks or survey the location using a handheld GPS unit, as required.

8. Wear appropriate protective gear (i.e., latex gloves, safety glasses), as required in the project HASP.

9. Excavate and expose underground piping requiring decommissioning in accordance with TurnKey's Test Pit Excavation & Logging Procedures FOP. Great care should be taken to avoid damaging the pipe and allowing the contents, if any, to be released to the environment.

10. Once exposed, over excavate the area around the section of pipe to be cut and place a container below the pipe. Tap two test holes in the top of the pipe using an intrinsically safe drill with non-sparking drill bit approximately 15 feet from the open end of the pipe (above the container).

11. Continue monitoring the ambient air space within the excavation for worker safety until work is complete. Refer to the project HASP for action levels.

12. Remove any solids and/or liquids within the first 15 to 20 feet of exposed pipe to the extent practicable.

13. Insert an appropriately sized double pipe seal apparatus into the open end of the pipe.

14. Using a single pipe seal apparatus attached to a steel rod, push the double pipe seal into the pipe beyond the tap holes (approximately 16 feet or so). Be sure to capture any residuals flowing out of the two tap holes with the previously mentioned container.

15. Retract the single pipe seal and push rod leaving an approximate 1 to 2 foot void space between the single and double pipe seal.

16. Through one of the tap holes, test the ambient air quality of the newly created void space between seals with an oxygen meter and explosimeter. If the air quality within the pipe indicates 0% oxygen on the oxygen meter and less than

10% Lower Explosive Limit (LEL) on the explosimeter, proceed with cutting the pipe into workable sections.

17. If the void space air quality exceeds either of those levels, inject nitrogen (or approved other inert gas) through the tap holes into the void air-space until safe levels are achieved. Nitrogen is 3% less dense than ambient air.

18. Cut the pipe into manageable sections (typically 15 feet) while periodically monitoring the ambient air within the pipe and injecting additional nitrogen (or approved other inert gas), as necessary.

19. Once section of pipe is removed, proceed with final cleaning activities in accordance with the project Work Plan and any local, state, and/or federal regulations.

20. Record all observations in the Project Field Book, including but not limited to length of recovered pipe, air monitoring observations, depths, diameters, etc.

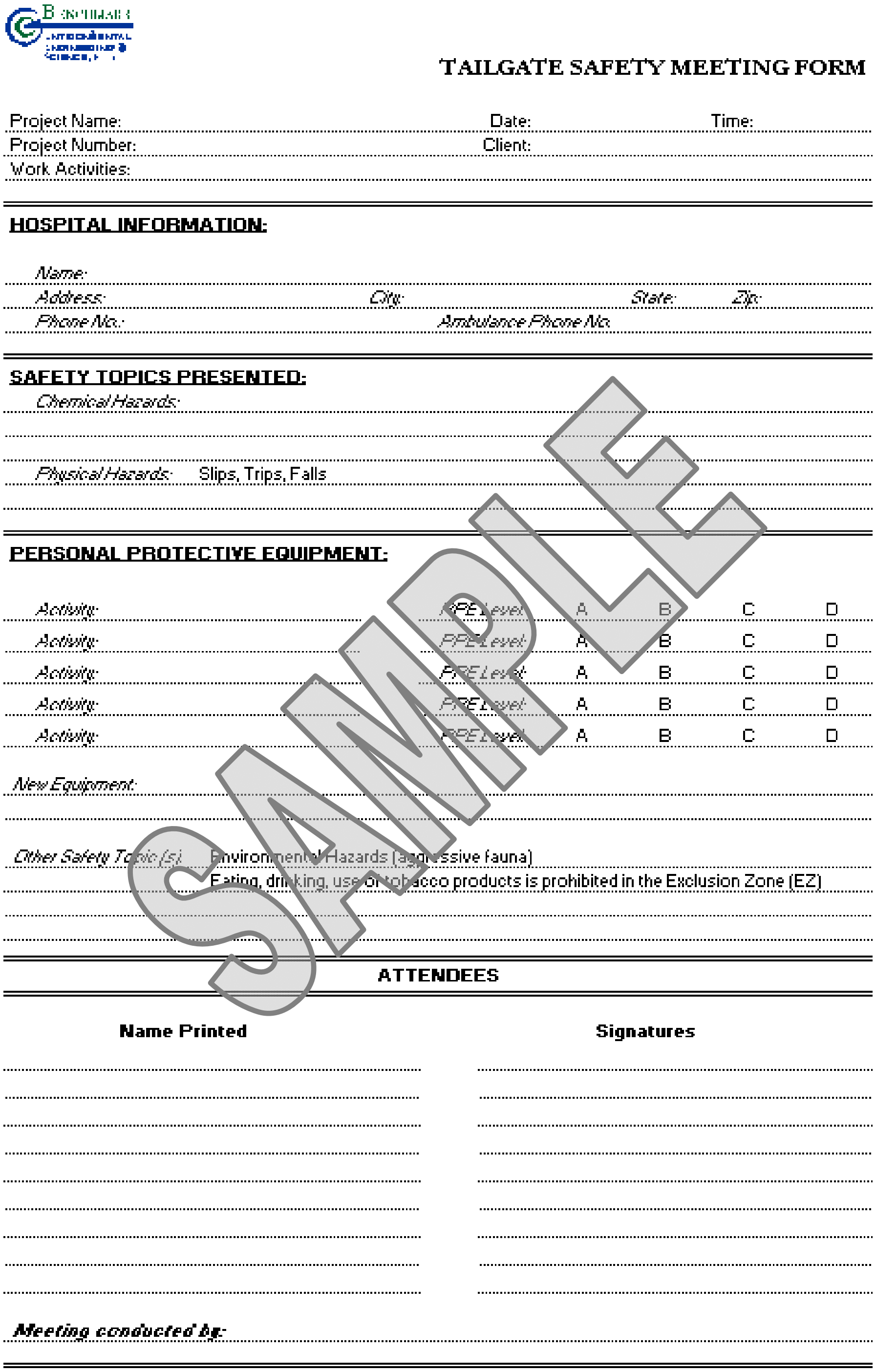
ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Real Time Air Monitoring Log (sample)

REFERENCES

<u>TurnKey FOPs:</u>

006	*Calibration and Maintenance of Combustible Gas/Oxygen Meter*
065	*Test Pit Excavation & Logging Procedures*



TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D

New Equipment:

Other Safety Topic (s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	**Signatures**

Meeting conducted by:

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 (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m³)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Outdoor Ambient Air VOC Sample Collection Procedure

FOP 090.0

OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE

PURPOSE

This procedure describes the methods for collecting outdoor ambient air samples for volatile organic compound (VOC) analysis via USEPA Method TO-15 using Summa® canisters (or approved other). Typically, outdoor air samples are collected to characterize and document site-specific VOCs that may be present in outdoor ambient air. For sample collection associated with intrusive activities that may potentially release VOCs to the ambient air, sample location(s) typically are collected downwind of the intrusive activity at the perimeter of the work area and/or exclusion zone for the Site. Upwind sample location(s) may be utilized if regional facilities (e.g. gasoline service station, factories) are located proximate to the Site to assess off-site ambient VOC contributions (background).

SAMPLE COLLECTION PROCEDURES

The following actions should be taken to document conditions during outdoor air sampling and ultimately to aid in the interpretation of the analytical results:

- A site map should be prepared to indicate the outdoor ambient air sample locations including all site improvements (e.g., buildings, access roads, etc.), public roads/streets (if applicable), the location of potential VOC contributors (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), and scale.

- Weather conditions (e.g., precipitation, wind speed, outdoor temperature, and barometric pressure) should be reported on the Air Canister Field Record (sample attached); and

- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

The following describes the outdoor air sampling procedure:

1. Typically, a 6-liter, passivated (inert), stainless steel, evacuated sampling sphere (e.g., Summa canister) (or approved other) will be supplied by the laboratory that will be conducting the analysis. The canister should be received from the laboratory, certified clean, evacuated, and prepared for sampling.

2. Sampling will take place in accordance with the project work plan. Selected sample locations will be sufficiently spaced to allow location(s) to be field modified, if necessary.

3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.

4. Prior to placement, complete an Air Canister Field Record (sample attached) of each canister, which includes: project information, field staff, weather conditions, canister serial number, flow controller number, sample date(s)/time(s), shipping date(s), canister lab vacuum, field vacuum check, initial field vacuum, final field vacuum, and duration of sample collection.

5. The pressure in the canisters must be monitored with the laboratory provided pressure gauge at the beginning and the end of the sampling period as well as before and after shipment of the canisters at the laboratory. The **target final field vacuum must be approximately 5 inches of mercury. Samples with a final field vacuum of greater than 10 inches of mercury, or equal to zero, will be flagged** and usability of the data will depend on the sample volume and reporting limits that can be achieved.

6. Canisters may be placed on the ground provided there is a clear plastic sheet beneath it to prevent cross contamination. The intake tubing, however, must be positioned at a height of approximately 3 to 5-feet above grade to collect air at an elevation representative of ambient air within the breathing zone. Typically, the canister is chained and locked to a secure step ladder with the intake tubing tethered to the ladder.

7. Ship the canisters to the laboratory under chain-of-custody command within three days of sample collection so that no sample will exceed the 30-day holding time (since receipt from the lab) per USEPA TO-15.

8. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-15, or as specified. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).

9. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.

QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Extreme care should be taken during all aspects of sample collection to ensure that sampling error is minimized and high quality data are obtained. The sampling team members should avoid actions (e.g., fueling vehicles, using permanent marking pens, and wearing freshly dry-cleaned clothing or personal fragrances), which can cause sample interference in the field. Appropriate QA/QC protocols must be followed for sample collection and laboratory analysis, such as use of certified clean sample devices, meeting sample holding times and temperatures, sample accession, chain of custody, etc. Samples should be delivered to the analytical laboratory as soon as possible after collection. In addition, laboratory accession procedures must be followed including field documentation (sample collection information and locations), chain of custody, field blanks, field sample duplicates, and laboratory duplicates, as appropriate.

Some methods require collecting samples in duplicate to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

For certain regulatory programs, a Data Usability Summary Report (DUSR) may be required to determine whether or not the data, as presented, meets the site or project specific criteria for data quality and data use. This requirement may dictate the level of QC and the category of data deliverable to request from the laboratory. Guidance on preparing a DUSR is available by contacting the NYSDEC's Division of Environmental Remediation.

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene); then the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with detection limits similar to background (e.g., tetrachloroethene via EPA Method TO-15).

ATTACHMENTS

Air Canister Field Record (sample)

REFERENCES

United States Environmental Protection Agency. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. Second Addition (EPA/625/R-96/010b). January 1999.

BENCHMARK
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AIR CANISTER FIELD RECORD

PROJECT INFORMATION:

Project:
Job No:
Location:
Field Staff:
Client:

SAMPLE I.D.:

Size of Canister:
Canister Serial No.:
Flow Controller No.:
Sample Date(s):
Shipping Date:
Sample Type: ☐ Indoor Air ☐ Outdoor Air
☐ Subslab, complete section below ☐ Soil Gas
Soil Gas Probe Depth:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:
Ambient Air Temp. - P.M.:
Wind Direction:
Wind Speed:
Precipitation:

FIELD SAMPLING INFORMATION:

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check [1]				
Initial Field Vacuum [2]				
Final Field Vacuum [3]				
Duration of Sample Collection				

LABORATORY CANISTER PRESSURIZATION:

Initial Vacuum (inches Hg and psia)		
Final Pressure (psia)		
Pressurization Gas		

SUBSLAB SHROUD:

Shroud Helium Concentration:
Calculated tubing volume: x 3 =
Purged Tubing Volume Concentration:
Is the purged volume concentration less than or equal to 10% in shroud?
☐ YES, continue sampling
☐ NO, improve surface seal and retest

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

NOTES:

1 Vacuum measured using portable vacuum gauge (provided by Lab)
2 Vacuum measured by canister gauge upon opening valve
3 Vacuum measured by canister gauge prior to closing valve

Signed:

APPENDIX E

SITE-SPECIFIC HEALTH & SAFETY PLAN

SITE HEALTH AND SAFETY PLAN
for
BROWNFIELD CLEANUP PROGRAM
BCP ACTIVITIES

1 HOWELL STREET SITE
BUFFALO, NEW YORK

May 2022 0258-022-002

Prepared for:

Howell Street Venture LLC

Prepared By:

Benchmark Civil/Environmental Engineering & Geology, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716)856-0599

In Association With:

TurnKey Environmental Restoration, LLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716)856-0635

1 HOWELL STREET SITE
HEALTH AND SAFETY PLAN FOR BCP ACTIVITIES

ACKNOWLEDGEMENT

Plan Reviewed by (initial):

Corporate Health and Safety Director: Thomas H. Forbes, P.E.

Project Manager: Nathan Munley

Designated Site Safety and Health Officer: Nathan Munley

Acknowledgement:
I acknowledge that I have reviewed the information contained in this site-specific Health and Safety Plan, and understand the hazards associated with performance of the field activities described herein. I agree to comply with the requirements of this plan.

NAME (PRINT)	SIGNATURE	DATE

1 HOWELL STREET SITE
HEALTH AND SAFETY PLAN FOR BCP ACTIVITIES

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1 HOWELL STREET SITE
HEALTH AND SAFETY PLAN FOR BCP ACTIVITIES

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1 HOWELL STREET SITE
HEALTH AND SAFETY PLAN FOR BCP ACTIVITIES

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1.0 INTRODUCTION

1.1 General

In accordance with OSHA requirements contained in 29 CFR 1910.120, this Health and Safety Plan (HASP) describes the specific health and safety practices and procedures to be employed by and Benchmark Civil/Environmental Engineering & Geology, PLLC and TurnKey Environmental Restoration, LLC employees (referred to jointly hereafter as "Benchmark-TurnKey") during Remedial Investigation (RI) activities at the 1 Howell Street Site located at 1 Howell Street, City of Buffalo, Erie County, New York. This HASP presents procedures for Benchmark-TurnKey employees who will be involved with RI/IRM field activities; it does not cover the activities of other contractors, subcontractors or other individuals on the Site. These firms will be required to develop and enforce their own HASPs as discussed in Section 2.0. Benchmark-TurnKey accepts no responsibility for the health and safety of contractor, subcontractor or other personnel.

This HASP presents information on known Site health and safety hazards using available historical information, and identifies the equipment, materials and procedures that will be used to eliminate or control these hazards. Environmental monitoring will be performed during the course of field activities to provide real-time data for on-going assessment of potential hazards.

1.2 Background

The Site addressed at 1 Howell Street consists of a single ±0.73-acre parcel, located at the southernmost end of Howell Street adjacent to Scajaquada Creek in a highly developed mixed use commercial and residential area in the City of Buffalo, Erie County, New York (SBL: 88.36-2-6).

The Site is currently vacant and includes one (1) existing building which is currently unused, associated asphalt and gravel covered parking areas, and grass covered areas. Portions of the building are structurally compromised. The Site is zoned as N-2R residential use according to the City of Buffalo Unified Development Ordinance (Buffalo Green Code 2017). Based on historic records and previous investigations, the Site has been used for robe manufacturing with dye house operations and has a history of petroleum storage and distribution from at least the early 1930s through the 1970s. Multiple commercial operations including window and door repair and manufacturing, roofing contracting, and construction operations have occupied the Site.

Multiple underground storage tanks (USTs) and aboveground storage tanks (ASTs) were present/are potentially still present on Site, including subgrade distribution piping. A portion of the Site, and surrounding off-Site areas, were previously remediated under NYS Spill No. 9507939. NYSDEC Spill documents indicate that gross petroleum contaminated soils remain around the existing building, and in select areas along the property boundary of the Site. Additionally, remedial measures were completed related to elevated polychlorinated biphenyls (PCBs) in sludges that were improperly handled from on-Site aboveground storage tank (AST) removal in accordance with the Resource Conservation and Recovery Act (RCRA) listing 915173. A February 2022 Limited Phase II Site Investigation, verified that grossly contaminated petroleum soil-fill was still present on-Site, as indicated in the NYSDEC Spill records, and Spill No. 2109702 was opened for the Site. Elevated benzene, toluene, ethylbenzene, and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), and metals were identified exceeding the regulatory Part 375 Restricted Residential Use Soil Cleanup Objectives (SCOs). Elevated chlorinated volatile organic compounds (VOCs) were also identified in on-Site soils.

The properties adjoining the Site, and in the neighborhood surrounding the Site, primarily include mixed use commercial and residential properties. The Site is bordered by Howell Street to the west, the Scajaquada Creek Greenway Trail and a commercial retail property (grocery store) to the east, a municipal park and Scajaquada Creek to the south, and commercial and residential properties to the north.

1.3 Known and Suspected Environmental Conditions

Previous investigations have identified environmental contamination related to the former uses of the Site. Elevated photoionization detector readings greater than 400 ppm, strong organic odors, and visual gross contamination and staining were detected. Contaminant migration in assumed backfill was also noted. Laboratory analytical results indicate elevated VOCs, PAHs, and metals were identified exceeding Part 375 Restricted Residential SCOs. Details of the previous investigation are presented in Section 2 below. Subsurface conditions will be further assessed as part of the RI.

1.4 Parameters of Interest

Based on the previous investigations, constituents of potential concern (COPCs) in soil/fill, groundwater, and indoor air at the Site include:

- **Volatile Organic Compounds (VOCs)** – VOCs present at elevated concentrations may include petroleum VOCs including benzene, xylene, toluene, and ethylbenzene. Non-petroleum related VOC contamination was also identified, specifically chlorinated VOCs including cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, and vinyl chloride.

- **Semi-volatile Organic Compounds (SVOCs)** – SVOCs present at elevated concentrations in soil/fill may include polycyclic aromatic hydrocarbons (PAHs), which are byproducts of incomplete combustion. Specific analytes detected include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

- **Inorganic Compounds** – The inorganic COPCs present at elevated concentrations include arsenic and lead.

1.5 Overview of Activities

Benchmark-TurnKey personnel will be on-Site to observe and perform RI and IRM activities. The field activities to be completed are described below.

<u>Remedial Investigation Activities</u>

1. **Subsurface Soil Sampling:** Benchmark-TurnKey will advance test pits and collect subsurface soil samples for the purpose of determining the nature and extent of potential COPC impacts in the subsurface soil/fill.

2. **Monitoring Well Installation/Development and Sampling:** Benchmark-TurnKey will observe the installation of four (4) groundwater monitoring wells, develop the wells, and collect groundwater samples for the purpose of determining the nature and extent of potential COPC impacts.

3. **Soil Vapor Investigation:** Benchmark-TurnKey will observe the installation of three (3) soil vapor sampling probes, purge the probes and associated tubing, and collect soil vapor samples for the purpose of determining the nature and extent of potential COPC impacts.

Potential IRM Activities

1. **Pre-construction Activity:** The remediation contractor would clear the site of vegetation and install interior Site haul roads prior to IRM and redevelopment activities.
2. **Pre-construction Activity:** A Stormwater Pollution Prevention Plan (SWPPP) would be prepared, and erosion control measures implemented.
3. **Soil Excavation:** The remediation contractor would perform soil excavation activities.
4. **Building Demolition:** The remediation contractor will complete demolition of the currently vacant on-Site building floor slabs and foundations.
5. **Verification Sampling:** The remediation contractor, in association with Benchmark-TurnKey, will collect soil samples from the sidewalls and bottom of the excavations using a backhoe to verify that cleanup objectives have been met.
6. **Backfilling:** The remediation contractor would coordinate and perform backfilling activities, as necessary.
7. **Groundwater and Surface Management:** The remediation contractor will direct groundwater/surface water collection during soil excavation activities and coordinate disposal/treatment of the collected water, in association with Benchmark-TurnKey.

2.0 ORGANIZATIONAL STRUCTURE

This section of the HASP describes the lines of authority, responsibility and communication as they pertain to health and safety functions at the Site. The purpose of this chapter is to identify the personnel who impact the development and implementation of the HASP and to describe their roles and responsibilities. This chapter also identifies other contractors and subcontractors involved in work operations and establish the lines of communications among them for health and safety matters. The organizational structure described in this chapter is consistent with the requirements of 29 CFR 1910.120(b)(2). This section will be reviewed by the Project Manager and updated as necessary to reflect the current organizational structure at this Site.

2.1 Roles and Responsibilities

All Benchmark-TurnKey personnel on the Site must comply with the minimum requirements of this HASP. The specific responsibilities and authority of management, safety and health, and other personnel on this Site are detailed in the following paragraphs.

2.1.1 Corporate Health and Safety Director

The Benchmark-TurnKey Corporate Health and Safety Director is ***Mr. Thomas H. Forbes, P.E.*** The Corporate Health and Safety Director responsible for developing and implementing the Health and Safety program and policies for Benchmark Environmental Engineering & Science, PLLC and TurnKey Environmental Restoration, LLC, and consulting with corporate management to ensure adequate resources are available to properly implement these programs and policies. The Corporate Health and Safety Director coordinates Benchmark-TurnKey's Health and Safety training and medical monitoring programs and assists project management and field staff in developing site-specific health and safety plans.

2.1.2 Project Manager

The Project Manager for this Site is ***Mr. Nathan T. Munley.*** The Project Manager has the responsibility and authority to direct all Benchmark-TurnKey work operations at the Site. The Project Manager coordinates safety and health functions with the Site Safety and Health Officer and bears ultimate responsibility for proper implementation of this HASP.

He may delegate authority to expedite and facilitate any application of the program, including modifications to the overall project approach as necessary to circumvent unsafe work conditions. Specific duties of the Project Manager include:

- Preparing and coordinating the Site work plan.
- Providing Benchmark-TurnKey workers with work assignments and overseeing their performance.
- Coordinating health and safety efforts with the Site Safety and Health Officer (SSHO).
- Reviewing the emergency response coordination plan to assure its effectiveness.
- Serving as the primary liaison with Site contractors and the property owner.

2.1.3 Site Safety and Health Officer

The SSHO for this Site is ***Mr. Nathan T. Munley***. The qualified alternate SSHO is ***Mr. Chris Z. Boron, P.G.*** The SSHO reports to the Project Manager. The SSHO 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 SSHO are:

- Managing the safety and health functions for Benchmark-TurnKey personnel on the Site.
- Serving as the point of contact for safety and health matters.
- Ensuring that Benchmark-TurnKey field personnel working on the Site have received proper training (per 29 CFR Part 1910.120(e)), that they have obtained medical clearance to wear respiratory protection (per 29 CFR Part 1910.134), and that they are properly trained in the selection, use and maintenance of personal protective equipment, including qualitative respirator fit testing.
- Performing or overseeing Site monitoring as required by the HASP.
- Assisting in the preparation and review of the HASP.
- Maintaining site-specific safety and health records as described in this HASP.

- Coordinating with the Project Manager, Site Workers, and Contractor's SSHO as necessary for safety and health efforts.

2.1.4 Site Workers

Site workers are responsible for: complying with this HASP or a more stringent HASP, if appropriate (i.e., Contractor and Subcontractor's HASP); using proper PPE; reporting unsafe acts and conditions to the SSHO; and following the safety and health instructions of the Project Manager and SSHO.

2.1.5 Other Site Personnel

Other Site personnel who will have health and safety responsibilities will include the drilling contractor, excavation contractor and demolition contractor, who will be responsible for developing, implementing and enforcing a Health and Safety Plan equally stringent or more stringent than Benchmark-TurnKey's HASP. Benchmark-TurnKey assumes no responsibility for the health and safety of anyone outside its direct employ. Each Contractor's HASP shall cover all non- Benchmark/TurnKey Site personnel. Each Contractor shall assign a SSHO who will coordinate with Benchmark-TurnKey's SSHO as necessary to ensure effective lines of communication and consistency between contingency plans.

In addition to Benchmark-TurnKey and Contractor personnel, other individuals who may have responsibilities in the work zone include subcontractors and governmental agencies performing Site inspection work (i.e., the New York State Department of Environmental Conservation). The Contractor shall be responsible for ensuring that these individuals have received OSHA-required training (29 CFR 1910.120(e)), including initial, refresher and site-specific training, and shall be responsible for the safety and health of these individuals while they are on-site.

3.0 HAZARD EVALUATION

Due to the presence of certain contaminants at the Site, the possibility exists that workers will be exposed to hazardous substances during field activities. The principal points of exposure would be through direct contact with and incidental ingestion of soil, and through the inhalation of contaminated particles or vapors. Other points of exposure may include direct contact with groundwater. In addition, the use of drilling and/or medium to large-sized construction equipment (e.g., excavator) will also present conditions for potential physical injury to workers. Further, since work will be performed outdoors, the potential exists for heat/cold stress to impact workers, especially those wearing protective equipment and clothing. Adherence to the medical evaluations, worker training relative to chemical hazards, safe work practices, proper personal protection, environmental monitoring, establishment work zones and Site control, appropriate decontamination procedures and contingency planning outlined herein will reduce the potential for chemical exposures and physical injuries.

3.1 Chemical Hazards

As discussed in Section 1.3, VOCs, CVOCs, SVOCs, and metals impacts have been identified at the Site. Table 1 lists exposure limits for airborne concentrations of the COPCs identified in Section 1.4 of this HASP. Brief descriptions of the toxicology of the prevalent COPCs and related health and safety guidance and criteria are provided below.

- **Benzene (CAS #71-43-2)** poisoning occurs most commonly through inhalation of the vapor; however, benzene can also penetrate the skin and poison in that way. Locally, benzene has a comparatively strong irritating effect, producing erythema and burning and, in more severe cases, edema and blistering. Exposure to high concentrations of the vapor (i.e., 3,000 ppm or higher) may result in acute poisoning characterized by the narcotic action of benzene on the central nervous system. In acute poisoning, symptoms include confusion, dizziness, tightening of the leg muscles, and pressure over the forehead. Chronic exposure to benzene (i.e., long term exposure to concentrations of 100 ppm or less) may lead to damage of the blood-forming system. Benzene is very flammable when exposed to heat or flame and can react vigorously with oxidizing materials.
- **Xylenes (o, m, and p) (CAS #95-47-6, 108-38-3, and 106-42-3)** are colorless, flammable liquids present in paint thinners and fuels. Acute exposure may cause central nervous system depression, resulting in headache, dizziness, fatigue, muscular weakness, drowsiness, and coordination loss. Repeated exposures may also cause removal of lipids from the skin, producing dry, fissured dermatitis.

Exposure of high concentrations of vapor may cause eye irritation and damage, as well as irritation of the mucus membranes.

- **Toluene (CAS #108-88-3)** is a common component of paint thinners and automobile fuel. Acute exposure predominantly results in central nervous system depression. Symptoms include headache, dizziness, fatigue, muscular weakness, drowsiness, and coordination loss. Repeated exposures may cause removal of lipids from the skin, resulting in dry, fissured dermatitis.
- **Ethylbenzene (CAS #100-41-4)** is a component of automobile gasoline. Over-exposure may cause kidney, skin liver and/or respiratory disease. Signs of exposure may include dermatitis, irritation of the eyes and mucus membranes, headache. Narcosis and coma may result in more severe cases.
- **Cis-1,2-dichloroethene (cis-1,2-DCE) (CAS #156-59-2)** is a breakdown product of PCE. Direct exposure is mostly by inhalation resulting in heart and liver damage.
- **Trichloroethene (TCE) (CAS #79-01-6)** was formally widely used in dry cleaning operations. It is toxic by inhalation and skin absorption. It is an irritant to the skin, eyes, and mucous membranes. Symptoms of exposure may include headache, dizziness, and nausea. Exposure may cause liver and kidney damage. TCE is a suspected human carcinogen.
- **Tetrachloroethene (CAS #127-18-4)** was formally widely used in dry cleaning operations as a solvent. It is harmful by ingestion inhalation and skin absorption. Exposure can cause dermatitis, dizziness, nausea, liver and kidney damage. This compound is a suspected carcinogen.
- **Vinyl chloride (CAS #75-01-4)** is an intermediate in the production of chlorinated compounds. It is a biodegradation product of TCE and PCE. Inhalation exposure may result in damage to the liver, kidneys, lungs and other organs. In addition to liver cancer, exposure has also been linked to an increased risk of lung, brain, hematopoietic, and digestive tract cancers.
- **Polycyclic Aromatic Hydrocarbons (PAHs)** are formed as a result of the pyrolysis and incomplete combustion of organic matter such as fossil fuel. PAH aerosols formed during the combustion process disperse throughout the atmosphere, resulting in the deposition of PAH condensate in soil, water and on vegetation. In addition, several products formed from petroleum processing operations (e.g., roofing materials and asphalt) also contain elevated levels of PAHs. Hence, these compounds are widely dispersed in the environment. PAHs are characterized by a molecular structure containing three or more fused, unsaturated carbon rings. Seven of the PAHs are classified by USEPA as probable human carcinogens (USEPA Class B2). These are: benzo(a)pyrene; benzo(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; chrysene; dibenzo(a,h)anthracene; and indeno(1,2,3-cd)pyrene. The primary route of exposure to PAHs is through incidental ingestion and inhalation of contaminated particulates. PAHs are characterized by an organic odor, and exist as oily liquids

in pure form. Acute exposure symptoms may include acne-type blemishes in areas of the skin exposed to sunlight.

- **Arsenic (CAS #7440-38-2)** is a naturally occurring element and is usually found combined with one or more elements, such as oxygen or sulfur. Inhalation is a more important exposure route than ingestion. First phase exposure symptoms include nausea, vomiting, diarrhea and pain in the stomach. Prolonged contact is corrosive to the skin and mucus membranes. Arsenic is considered a Group A human carcinogen by the USEPA. Exposure via inhalation is associated with an increased risk of lung cancer. Exposure via the oral route is associated with an increased risk of skin cancer.
- **Lead (CAS #7439-92-1)** can affect almost every organ and system in our bodies. The most sensitive is the central nervous system, particularly in children. Lead also damages kidneys and the immune system. The effects are the same whether it is breathed or swallowed. Lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect memory. Lead may cause anemia.

With respect to the anticipated RI/IRM activities discussed in Section 1.5, possible routes of exposure to the above-mentioned contaminants are presented in Table 2. The use of proper respiratory equipment, as outlined in Section 7.0 of this HASP, will minimize the potential for exposure to airborne contamination, if deemed necessary. Exposure to contaminants through dermal and other routes will also be minimized through the use of safe work practices (Section 6.0), protective clothing (Section 7.0), and proper decontamination procedures (Section 12.0).

3.2 Physical Hazards

RI/IRM field activities at the 1 Howell Street Site may present the following physical hazards:

- The potential for physical injury during heavy construction equipment use, such as backhoes, excavators and drilling equipment.

- The potential for heat/cold stress to employees during the summer/winter months (see Section 10.0).

- The potential for slip and fall injuries due to rough, uneven terrain and/or open excavations.

These hazards represent only some of the possible means of injury that may be present during RI/IRM operations and sampling activities at the Site. Since it is impossible to list all potential sources of injury, it shall be the responsibility of each individual to exercise proper care and caution during all phases of the work.

4.0 TRAINING

4.1 Site Workers

All personnel performing RI/IRM activities at the Site (such as, but not limited to, equipment operators, general laborers, and drillers) and who may be exposed to hazardous substances, health hazards, or safety hazards and their supervisors/managers responsible for the Site shall receive training in accordance with 29 CFR 1910.120(e) before they are permitted to engage in operations in the exclusion zone or contaminant reduction zone. This training includes an initial 40-hour Hazardous Waste Site Worker Protection Course, an 8-hour Annual Refresher Course subsequent to the initial 40-hour training, and 3 days of actual field experience under the direct supervision of a trained, experienced supervisor. Additional site-specific training shall also be provided by the SSHO prior to the start of field activities. A description of topics to be covered by this training is provided below.

4.1.1 Initial and Refresher Training

Initial and refresher training is conducted by a qualified instructor as specified under OSHA 29 CFR 1910.120(e)(5) and is specifically designed to meet the requirements of OSHA 29 CFR 1910.120(e)(3) and 1910.120(e)(8). The training covers, as a minimum, the following topics:

- OSHA HAZWOPER regulations.
- Site safety and hazard recognition, including chemical and physical hazards.
- Medical monitoring requirements.
- Air monitoring, permissible exposure limits, and respiratory protection level classifications.
- Appropriate use of personal protective equipment (PPE), including chemical compatibility and respiratory equipment selection and use.
- Work practices to minimize risk.
- Work zones and Site control.

- Safe use of engineering controls and equipment.
- Decontamination procedures.
- Emergency response and escape.
- Confined space entry procedures.
- Heat and cold stress monitoring.
- Elements of a Health and Safety Plan.
- Spill containment.

Initial training also incorporates workshops for PPE and respiratory equipment use (Levels A, B and C), and respirator fit testing. Records and certification received from the course instructor documenting each employee's successful completion of the training identified above are maintained on file at Benchmark-TurnKey's Buffalo, NY office. Contractors and Subcontractors are required to provide similar documentation of training for all their personnel who will be involved in on-site work activities.

Any employee who has not been certified as having received health and safety training in conformance with 29 CFR 1910.120(e) is prohibited from working in the exclusion and contamination reduction zones, or to engage in any on-site work activities that may involve exposure to hazardous substances or wastes.

4.1.2 Site Training

Site workers are given a copy of the HASP and provided a site-specific briefing prior to the commencement of work to ensure that employees are familiar with the HASP and the information and requirements it contains. The Site briefing shall be provided by the SSHO prior to initiating field activities and shall include:

- Names of personnel and alternates responsible for Site safety and health.
- Safety, health and other hazards present on the Site.
- The site lay-out including work zones and places of refuge.

- The emergency communications system and emergency evacuation procedures.
- Use of PPE.
- Work practices by which the employee can minimize risks from hazards.
- Safe use of engineering controls and equipment on the site.
- Medical surveillance, including recognition of symptoms and signs of over-exposure as described in Chapter 5 of this HASP.
- Decontamination procedures as detailed in Chapter 12 of this HASP.
- The emergency response plan as detailed in Chapter 15 of this HASP.
- Confined space entry procedures, if required, as detailed in Chapter 13 of this HASP.
- The spill containment program as detailed in Chapter 9 of this HASP.
- Site control as detailed in Chapter 11 of this HASP.

Supplemental health and safety briefings will also be conducted by the SSHO on an as-needed basis during the course of the work. Supplemental briefings are provided as necessary to notify employees of any changes to this HASP as a result of information gathered during ongoing Site characterization and analysis. Conditions for which the SSHO may schedule additional briefings include, but are not limited to: a change in Site conditions (e.g., based on monitoring results); changes in the work schedule/plan; newly discovered hazards; and safety incidents occurring during Site work.

4.2 Supervisor Training

On-site safety and health personnel who are directly responsible for or who supervise the safety and health of workers engaged in hazardous waste operations (i.e., SSHO) shall receive, in addition to the appropriate level of worker training described in Section 4.1, above, 8 additional hours of specialized supervisory training, in compliance with 29 CFR 1910.120(e)(4).

4.3 Emergency Response Training

Emergency response training is addressed in Attachment A of this HASP, Emergency Response Plan.

4.4 Site Visitors

Each Contractor's SSHO will provide a site-specific briefing to all Site visitors and other non- Benchmark/TurnKey personnel who enter the Site beyond the Site entry point. The site-specific briefing will provide information about Site hazards, the Site layout including work zones and places of refuge, the emergency communications system and emergency evacuation procedures, and other pertinent safety and health requirements as appropriate.

Site visitors will not be permitted to enter the exclusion zone or contaminant reduction zones unless they have received the level of training required for Site workers as described in Section 4.1.

5.0 MEDICAL MONITORING

Medical monitoring examinations are provided to Benchmark-TurnKey employees as stipulated under 29 CFR Part 1910.120(f). These exams include initial employment, annual and employment termination physicals for all Benchmark-TurnKey employees involved in hazardous waste site field operations. Post-exposure examinations are also provided for employees who may have been injured, received a health impairment, or developed signs or symptoms of over-exposure to hazardous substances or were accidentally exposed to substances at concentrations above the permissible exposure limits without necessary personal protective equipment. Such exams are performed as soon as possible following development of symptoms or the known exposure event.

Medical evaluations are performed by Health Works, an occupational health care provider under contract with Benchmark-TurnKey. Health Works is located in Seneca Square Plaza, 1900 Ridge Road, West Seneca, New York 14224. The facility can be reached at (716) 823-5050 to schedule routine appointments or post-exposure examinations.

Medical evaluations are conducted according to the Benchmark-TurnKey Medical Monitoring Program and include an evaluation of the workers' ability to use respiratory protective equipment. The examinations include:

- Occupational/medical history review.
- Physical exam, including vital sign measurement.
- Spirometry testing.
- Eyesight testing.
- Audio testing (minimum baseline and exit, annual for employees routinely exposed to greater than 85db).
- EKG (for employees >40 yrs age or as medical conditions dictate).
- Chest X-ray (baseline and exit, and every 5 years).
- Blood biochemistry (including blood count, white cell differential count, serum multiplastic screening).
- Medical certification of physical requirements (i.e., sight, musculoskeletal,

cardiovascular) for safe job performance and to wear respiratory protection equipment.

The purpose of the medical evaluation is to determine an employee’s fitness for duty on hazardous waste sites; and to establish baseline medical data. In conformance with OSHA regulations, Benchmark-TurnKey will maintain and preserve medical records for a period of 30 years following termination of employment. Employees are provided a copy of the physician's post-exam report, and have access to their medical records and analyses.

6.0 SAFE WORK PRACTICES

All Benchmark-TurnKey employees shall conform to the following safe work practices during all on-site work activities conducted within the exclusion and contamination reduction zones:

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth contact is strictly prohibited.
- The hands and face must be thoroughly washed upon leaving the work area and prior to engaging in any activity indicated above.
- Respiratory protective equipment and clothing must be worn by all personnel entering the Site as required by the HASP or as modified by the Site safety officer. Excessive facial hair (i.e., beards, long mustaches or sideburns) that interferes with the satisfactory respirator-to-face seal is prohibited.
- Contact with surfaces/materials either suspected or known to be contaminated will be avoided to minimize the potential for transfer to personnel, cross contamination and need for decontamination.
- Medicine and alcohol can synergize the effects of exposure to toxic chemicals. Due to possible contraindications, use of prescribed drugs should be reviewed with the Benchmark-TurnKey occupational physician. Alcoholic beverage and illegal drug intake are strictly forbidden during the workday.
- All personnel shall be familiar with standard operating safety procedures and additional instructions contained in this Health and Safety Plan.
- On-site personnel shall use the “buddy” system. No one may work alone (i.e., out of earshot or visual contact with other workers) in the exclusion zone.
- Personnel and equipment in the contaminated area shall be minimized, consistent with effective Site operations.
- All employees have the obligation to immediately report and if possible, correct unsafe work conditions.
- Use of contact lenses on-site will not be permitted. Spectacle kits for insertion into full-face respirators will be provided for Benchmark-TurnKey employees, as requested and required.

The recommended specific safety practices for working around the contractor's equipment (e.g., backhoes, bulldozers, excavators, drill rigs etc.) are as follows:

- Although the Contractor and subcontractors are responsible for their equipment and safe operation of the Site, Benchmark-TurnKey personnel are also responsible for their own safety.

- Subsurface work will not be initiated without first clearing underground utility services.

- Heavy equipment should not be operated within 20 feet of overhead wires. This distance may be increased if windy conditions are anticipated or if lines carry high voltage. The Site should also be sufficiently clear to ensure the project staff can move around the heavy machinery safely.

- Care should be taken to avoid overhead wires when moving heavy-equipment from location to location.

- Hard hats, safety boots and safety glasses should be worn at all times in the vicinity of heavy equipment. Hearing protection is also recommended.

- The work Site should be kept neat. This will prevent personnel from tripping and will allow for fast emergency exit from the Site.

- Proper lighting must be provided when working at night.

- Construction activities should be discontinued during an electrical storm or severe weather conditions.

- The presence of combustible gases should be checked before igniting any open flame.

- Personnel shall stand upwind of any construction operation when not immediately involved in sampling/logging/observing activities.

- Personnel will not approach the edge of an unsecured trench/excavation closer than 2 feet.

7.0 PERSONAL PROTECTIVE EQUIPMENT

7.1 Equipment Selection

PPE will be donned when work activities may result in exposure to physical or chemical hazards beyond acceptable limits, and when such exposure can be mitigated through appropriate PPE. The selection of PPE will be based on an evaluation of the performance characteristics of the PPE relative to the requirements and limitations of the Site, the task-specific conditions and duration, and the hazards and potential hazards identified at the Site.

Equipment designed to protect the body against contact with known or suspect chemical hazards are grouped into four categories according to the degree of protection afforded. These categories designated A through D consistent with United States Environmental Protection Agency (USEPA) Level of Protection designation, are:

- **Level A:** Should be selected when the highest level of respiratory, skin and eye protection is needed.

- **Level B:** Should be selected when the highest level of respiratory protection is needed, but a lesser level of skin protection is required. Level B protection is the minimum level recommended on initial Site entries until the hazards have been further defined by on-site studies. Level B (or Level A) is also necessary for oxygen-deficient atmospheres.

- **Level C:** Should be selected when the types of airborne substances are known, the concentrations have been measured and the criteria for using air-purifying respirators are met. In atmospheres where no airborne contaminants are present, Level C provides dermal protection only.

- **Level D:** Should not be worn on any Site with elevated respiratory or skin hazards. This is generally a work uniform providing minimal protection.

OSHA requires the use of certain PPE under conditions where an immediate danger to life and health (IDLH) may be present. Specifically, OSHA 29 CFR 1910.120(g)(3)(iii) requires use of a positive pressure self-contained breathing apparatus, or positive pressure air-line respirator equipped with an escape air supply when chemical exposure levels present a substantial possibility of immediate serious injury, illness or death, or impair the ability to escape. Similarly, OSHA 29 CFR 1910.120(g)(3)(iv) requires donning totally-encapsulating chemical protective suits (with a protection level equivalent to Level A protection) in conditions where skin absorption of a hazardous substance may result in a substantial possibility of immediate serious illness, injury or death, or impair the ability to escape.

In situations where the types of chemicals, concentrations, and possibilities of contact are unknown, the appropriate level of protection must be selected based on professional experience and judgment until the hazards can be further characterized. The individual components of clothing and equipment must be assembled into a full protective ensemble to protect the worker from site-specific hazards, while at the same time minimizing hazards and drawbacks of the personal protective gear itself. Ensemble components are detailed below for levels A/B, C, and D protection.

7.2 Protection Ensembles

7.2.1 Level A/B Protection Ensemble

Level A/B ensembles include similar respiratory protection, however Level A provides a higher degree of dermal protection than Level B. Use of Level A over Level B is determined by: comparing the concentrations of identified substances in the air with skin toxicity data, and assessing the effect of the substance (by its measured air concentrations or splash potential) on the small area of the head and neck unprotected by Level B clothing.

The recommended PPE for level A/B is:

- Pressure-demand, full-face piece self-contained breathing apparatus (MSHA/-NIOSH approved) or pressure-demand supplied-air respirator with escape self-contained breathing apparatus (SCBA).
- Chemical-resistant clothing. For Level A, clothing consists of totally-encapsulating chemical resistant suit. Level B incorporates hooded one-or two-piece chemical splash suit.
- Inner and outer chemical resistant gloves.
- Chemical-resistant safety boots/shoes.
- Hardhat.

7.2.2 Level C Protection Ensemble

Level C protection is distinguished from Level B by the equipment used to protect the respiratory system, assuming the same type of chemical-resistant clothing is used. The main selection criterion for Level C is that conditions permit wearing an air-purifying device. The device (when required) must be an air-purifying respirator (MSHA/NIOSH approved) equipped with filter cartridges. Cartridges must be able to remove the substances encountered. Respiratory protection will be used only with proper fitting, training and the approval of a qualified individual. In addition, an air-purifying respirator can be used only if: oxygen content of the atmosphere is at least 19.5% in volume; substances are identified and concentrations measured; substances have adequate warning properties; the individual passes a qualitative fit-test for the mask; and an appropriate cartridge/canister is used, and its service limit concentration is not exceeded.

Recommended PPE for Level C conditions includes:

- Full-face piece, air-purifying respirator equipped with MSHA and NIOSH approved organic vapor/acid gas/dust/mist combination cartridges or as designated by the SSHO.
- Chemical-resistant clothing (hooded, one or two-piece chemical splash suit or disposable chemical-resistant one-piece suit).
- Inner and outer chemical-resistant gloves.
- Chemical-resistant safety boots/shoes.
- Hardhat.

An air-monitoring program is part of all response operations when atmospheric contamination is known or suspected. It is particularly important that the air be monitored thoroughly when personnel are wearing air-purifying respirators. Continual surveillance using direct-reading instruments is needed to detect any changes in air quality necessitating a higher level of respiratory protection.

7.2.3 Level D Protection Ensemble

As indicated above, Level D protection is primarily a work uniform. It can be worn in areas where only boots can be contaminated, where there are no inhalable toxic substances and where the atmospheric contains at least 19.5% oxygen.

Recommended PPE for Level D includes:

- Coveralls.
- Safety boots/shoes.
- Safety glasses or chemical splash goggles.
- Hardhat.
- Optional gloves; escape mask; face shield.

7.2.4 Recommended Level of Protection for Site Tasks

Based upon current information regarding both the contaminants suspected to be present at the Site and the various tasks that are included in the remedial activities, the minimum required levels of protection for these tasks shall be as identified in Table 3.

8.0 EXPOSURE MONITORING

8.1 General

Based on the results of historic sample analysis and the nature of the proposed work activities at the Site, the possibility exist that organic vapors and/or particulates may be released to the air during intrusive construction activities. Ambient breathing zone concentrations may at times, exceed the permissible exposure limits (PELs) established by OSHA for the individual compounds (see Table 1), in which case respiratory protection will be required. Respiratory and dermal protection may be modified (upgraded or downgraded) by the SSHO based upon real-time field monitoring data.

8.1.1 On-Site Work Zone Monitoring

Benchmark-TurnKey personnel will conduct routine, real-time air monitoring during all intrusive construction phases such as excavation, backfilling, drilling, etc. The work area will be monitored at regular intervals using a PID, combustible gas meter and a particulate meter. Observed values will be recorded and maintained as part of the permanent field record.

Additional air monitoring measurements may be made by Benchmark-TurnKey personnel to verify field conditions during subcontractor oversight activities. Monitoring instruments will be protected from surface contamination during use. Additional monitoring instruments may be added if the situations or conditions change. Monitoring instruments will be calibrated in accordance with manufacturer's instructions before use.

8.1.2 Off-Site Community Air Monitoring

In addition to on-site monitoring within the work zone(s), monitoring at the down-wind 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 Attachment C. 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.

8.2 Monitoring Action Levels

8.2.1 On-Site Work Zone Action Levels

The PID, or other appropriate instrument(s), will be used by Benchmark-TurnKey personnel to monitor organic vapor concentrations as specified in this HASP. Combustible gas will be monitored with the "combustible gas" option on the combustible gas meter or other appropriate instrument(s). In addition, fugitive dust/particulate concentrations will be monitored during major soil intrusion (viz., well/boring installation) using a real-time particulate monitor as specified in this plan. In the absence of such monitoring, appropriate respiratory protection for particulates shall be donned. Sustained readings obtained in the breathing zone may be interpreted (with regard to other Site conditions) as follows for Benchmark-TurnKey personnel:

- Total atmospheric concentrations of unidentified vapors or gases ranging from 0 to 1 ppm above background on the PID) - Continue operations under Level D (see Appendix A).

- Total atmospheric concentrations of unidentified vapors or gases yielding sustained readings from >1 ppm to 5 ppm above background on the PID (vapors not suspected of containing high levels of chemicals toxic to the skin) - Continue operations under Level C (see Appendix A).

- Total atmospheric concentrations of unidentified vapors or gases yielding sustained readings of >5 ppm to 50 ppm above background on the PID - Continue operations under Level B (see Appendix A), re-evaluate and alter (if possible) construction methods to achieve lower vapor concentrations.

- Total atmospheric concentrations of unidentified vapors or gases above 50 ppm on the PID - Discontinue operations and exit the work zone immediately.

The particulate monitor will be used to monitor respirable dust concentrations during all intrusive activities and during handling of Site soil/fill. Action levels based on the instrument readings shall be as follows:

- Less than 50 mg/m^3 - Continue field operations.
- 50-150 mg/m^3 - Don dust/particulate mask or equivalent
- Greater than 150 mg/m^3 - Don dust/particulate mask or equivalent. Initiate engineering controls to reduce respirable dust concentration (viz., wetting of excavated soils or tools at discretion of Site Health and Safety Officer).

Readings from the field equipment will be recorded and documented on the appropriate Project Field Forms. All instruments will be calibrated before use on a daily basis and the procedure will be documented on the appropriate Project Field Forms.

8.2.2 Community Air Monitoring Action Levels

In addition to the action levels prescribed in Section 8.2.1 for Benchmark-TurnKey personnel on-site, the following criteria shall also be adhered to for the protection of downwind receptors consistent with NYSDOH requirements (Attachment C):

o **<u>ORGANIC VAPOR PERIMETER MONITORING</u>:**

  - If the <u>sustained</u> ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone <u>exceeds 5 ppm</u> above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the <u>sustained</u> organic vapor decreases below 5 ppm over background, work activities can resume with continued monitoring.
  - If the <u>sustained</u> ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone are <u>greater than 5 ppm</u> over background <u>but less than 25 ppm</u> for the 15-minute average, activities can resume provided that: the organic vapor level 200 feet downwind of the working site or half the distance to the nearest off-site residential or commercial structure, whichever

is less, but in no case less than 20 feet, is below 5 ppm over background; and more frequent intervals of monitoring, as directed by the Site Health and Safety Officer, are conducted.

- If the sustained organic vapor level is above 25 ppm at the perimeter of the exclusion zone for the 15-minute average, the Site Health and Safety Officer must be notified and work activities shut down. The Site Health and Safety Officer will determine when re-entry of the exclusion zone is possible and will implement downwind air monitoring to ensure vapor emissions do not impact the nearest off-site residential or commercial structure at levels exceeding those specified in the ***Organic Vapor Contingency Monitoring Plan*** below. All readings will be recorded and will be available for New York State Department of Environmental Conservation (DEC) and Department of Health (DOH) personnel to review.

o **ORGANIC VAPOR CONTINGENCY MONITORING PLAN:**

- If the sustained organic vapor level is greater than 5 ppm over background 200 feet downwind from the work area or half the distance to the nearest off-site residential or commercial property, whichever is less, all work activities must be halted.

- If, following the cessation of the work activities or as the result of an emergency, sustained organic levels persist above 5 ppm above background 200 feet downwind or half the distance to the nearest off-site residential or commercial property from the work area, then the air quality must be monitored within 20 feet of the perimeter of the nearest off-site residential or commercial structure (20-foot zone).

- If efforts to abate the emission source are unsuccessful and if sustained organic vapor levels approach or exceed 5 ppm above background within the 20-foot zone for more than 30 minutes, or are sustained at levels greater than 10 ppm above background for longer than one minute, then the ***Major Vapor Emission Response Plan*** (see below) will automatically be placed into effect.

o **MAJOR VAPOR EMISSION RESPONSE PLAN:**

Upon activation, the following activities will be undertaken:

1. All Emergency Response Contacts as listed in this Health and Safety Plan and the Emergency Response Plan (Attachment A) will be advised.

2. The local police authorities will immediately be contacted by the Site Health and Safety Officer and advised of the situation.

3. Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two <u>sustained</u> successive readings below action levels are measured, air monitoring may be halted or modified by the Site Health and Safety Officer.

The following personnel are to be notified in the listed sequence in the event that a Major Vapor Emission Plan is activated:

Responsible Person	**Contact**	**Phone Number**
SSHO	Police	911
SSHO	State Emergency Response Hotline	(800) 457-7362

Additional emergency numbers are listed in the Emergency Response Plan included as Attachment A.

- **EXPLOSIVE VAPORS:**
    - <u>Sustained</u> atmospheric concentrations of greater than 10% LEL in the work area - Initiate combustible gas monitoring at the downwind portion of the Site perimeter.
    - <u>Sustained</u> atmospheric concentrations of greater than 10% LEL at the downwind Site perimeter – Halt work and contact local Fire Department.

- **AIRBORNE PARTICULATE COMMUNITY AIR MONITORING**

Respirable (PM-10) particulate monitoring will be performed on a continuous basis at the upwind and downwind perimeter of the exclusion zone. The monitoring will be performed using real-time monitoring equipment capable of measuring PM-10 and integrating over a period of 15-minutes for comparison to the airborne particulate action levels. The equipment will be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities. All readings will be recorded and will be available for NYSDEC and NYSDOH review. Readings will be interpreted as follows:

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (ug/m^3) greater than the background (upwind perimeter) reading 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 provided that the downwind PM-10 particulate levels do not exceed 150 ug/m^3 above the upwind level and that visible dust is not migrating from the work area.

- If, after implementation of dust suppression techniques downwind PM-10 levels are greater than 150 ug/m^3 above the upwind level, work activities must be stopped and dust suppression controls re-evaluated. Work can resume provided that supplemental dust suppression measures and/or other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m^3 of the upwind level and in preventing visible dust migration.

Pertinent emergency response information including the telephone number of the Fire Department is included in the Emergency Response Plan (Attachment A).

9.0 SPILL RELEASE/RESPONSE

This chapter of the HASP describes the potential for and procedures related to spills or releases of known or suspected petroleum and/or hazardous substances on the Site. The purpose of this Section of the HASP is to plan appropriate response, control, counter-measures and reporting, consistent with OSHA requirements in 29 CFR 1910.120(b)(4)(ii)(J) and (j)(1)(viii). The spill containment program addresses the following elements:

- Potential hazardous material spills and available controls.
- Initial notification and evaluation.
- Spill response.
- Post-spill evaluation.

9.1 Potential Spills and Available Controls

An evaluation was conducted to determine the potential for hazardous material and oil/petroleum spills at this Site. For the purpose of this evaluation, hazardous materials posing a significant spill potential are considered to be:

- CERCLA Hazardous Substances as identified in 40 CFR Part 302, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).

- Extremely Hazardous Substances as identified in 40 CFR Part 355, Appendix A, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).

- Hazardous Chemicals as defined under Section 311(e) of the Emergency Planning and Community Right-To-Know Act of 1986, where such chemicals are present or will be stored in excess of 10,000 lbs.

- Toxic Chemicals as defined in 40 CFR Part 372, where such chemicals are present or will be stored in excess of 10,000 lbs.

- Chemicals regulated under 6NYCRR Part 597 where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).

Oil/petroleum products are considered to pose a significant spill potential whenever the following situations occur:

- The potential for a "harmful quantity" of oil (including petroleum and non-petroleum-based fuels and lubricants) to reach navigable waters of the U.S. exists (40 CFR Part 112.4). Harmful quantities are considered by USEPA to be volumes that could form a visible sheen on the water or violate applicable water quality standards.

- The potential for any amount of petroleum to reach any waters of NY State, including groundwater, exists. Petroleum, as defined by NY State in 6NYCRR Part 612, is a petroleum-based heat source, energy source, or engine lubricant/maintenance fluid.

- The potential for any release, to soil or water, of petroleum from a bulk storage facility regulated under 6NYCRR Part 612. A regulated petroleum storage facility is defined by NY State as a site having stationary tank(s) and intra-facility piping, fixtures and related equipment with an aggregate storage volume of 1,100 gallons or greater.

The evaluation indicates that, based on Site history a hazardous material spill and/or a petroleum product spill is not likely to occur during RI/IRM efforts.

9.2 Initial Spill Notification and Evaluation

Any worker who discovers a hazardous substance or oil/petroleum spill will immediately notify the Project Manager and SSHO. The worker will, to the best of his/her ability, report the material involved, the location of the spill, the estimated quantity of material spilled, the direction/flow of the spill material, related fire/explosion incidents, if any, and any associated injuries. The Emergency Response Plan presented in Attachment A of this HASP will immediately be implemented if an emergency release has occurred.

Following initial report of a spill, the Project Manager will make an evaluation as to whether the release exceeds RQ levels. If an RQ level is exceeded, the Project Manager will notify the Site owner and NYSDEC at 1-800-457-7362 within 2 hours of spill discovery. The Project Manager will also determine what additional agencies (e.g., USEPA) are to be contacted regarding the release, and will follow-up with written reports as required by the applicable regulations.

9.3 Spill Response

For all spill situations, the following general response guidelines will apply:

- Only those personnel involved in overseeing or performing containment operations will be allowed within the spill area. If necessary, the area will be roped, ribboned, or otherwise blocked off to prevent unauthorized access.
- Appropriate PPE, as specified by the SSHO, will be donned before entering the spill area.
- Ignition points will be extinguished/removed if fire or explosion hazards exist.
- Surrounding reactive materials will be removed.
- Drains or drainage in the spill area will be blocked to prevent inflow of spilled materials or applied materials.

For minor spills, the Contractor will maintain a Spill Control and Containment Kit in the Field Office or other readily accessible storage location. The kit will consist of, at a minimum, a 50 lb. bag of "speedy dry" granular absorbent material, absorbent pads, shovels, empty 5-gallon pails and an empty open-top 55-gallon drum. Spilled materials will be absorbed, and shoveled into a 55-gallon drum for proper disposal (NYSDEC approval will be secured for on-site treatment of the impacted soils/absorbent materials, if applicable). Impacted soils will be hand-excavated to the point that no visible signs of contamination remains, and will be drummed with the absorbent.

In the event of a major release or a release that threatens surface water, a spill response contractor will be called to the Site. The response contractor may use heavy equipment (e.g., excavator, backhoe, etc.) to berm the soils surrounding the spill Site or create diversion trenching to mitigate overland migration or release to navigable waters. Where feasible, pumps will be used to transfer free liquid to storage containers. Spill control/cleanup contractors in the Western New York area that may be contacted for assistance include:

Include other spill contractors if necessary:

- The Environmental Service Group of NY, Inc.: (716) 695-6720
- Environmental Products and Services, Inc.: (716) 447-4700

- Op-Tech: (716) 873-7680

9.4 Post-Spill Evaluation

If a reportable quantity of hazardous material or oil/petroleum is spilled as determined by the Project Manager, a written report will be prepared as indicated in Section 9.2. The report will identify the root cause of the spill, type and amount of material released, date/time of release, response actions, agencies notified and/or involved in cleanup, and procedures to be implemented to avoid repeat incidents. In addition, all re-useable spill cleanup and containment materials will be decontaminated, and spill kit supplies/disposable items will be replenished.

10.0 HEAT/COLD STRESS MONITORING

Since some of the work activities at the Site will be scheduled for both the summer and winter months, measures will be taken to minimize heat/cold stress to Benchmark-TurnKey employees. The Site Safety and Health Officer and/or his or her designee will be responsible for monitoring Benchmark-TurnKey field personnel for symptoms of heat/cold stress.

10.1 Heat Stress Monitoring

Personal protective equipment may place an employee at risk of developing heat stress, a common and potentially serious illnesses often encountered at construction, landfill, waste disposal, industrial or other unsheltered sites. The potential for heat stress is dependent on a number of factors, including environmental conditions, clothing, workload, physical conditioning and age. Personal protective equipment may severely reduce the body's normal ability to maintain temperature equilibrium (via evaporation and convection) and require increased energy expenditure due to its bulk and weight.

Proper training and preventive measures will mitigate the potential for serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illness. To avoid heat stress, the following steps should be taken:

- Adjust work schedules.
- Modify work/rest schedules according to monitoring requirements.
- Mandate work slowdowns as needed.
- Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat (i.e., eight fluid ounces must be ingested for approximately every 1 lb of weight lost). The normal thirst

mechanism is not sensitive enough to ensure that enough water will be consumed to replace lost perspiration. When heavy sweating occurs, workers should be encouraged to drink more.

- Train workers to recognize the symptoms of heat related illness.

Heat-Related Illness - Symptoms:

- Heat rash may result from continuous exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include: muscle spasms; pain in the hands, feet and abdomen.
- Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: pale, cool, moist skin; heavy sweating; dizziness; nausea; fainting.
- Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are: red, hot, usually dry skin; lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse; coma.

The monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70 degrees Fahrenheit or above. For monitoring the body's recuperative ability to excess heat, one or more of the following techniques should be used as a screening mechanism.

- Heart rate may be measured by the radial pulse for 30 seconds as early as possible in the resting period. The rate at the beginning of the rest period should not exceed 100 beats per minute. If the rate is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest periods stay the same, If the pulse rate is 100 beats per minute at the beginning of the nest rest period, the following work cycle should be further shortened by 33%.
- Body temperature may be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period

should not exceed 99.6 degrees Fahrenheit. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period remains the same. However, if the oral temperature exceeds 99.6 degrees Fahrenheit at the beginning of the next period, the work cycle may be further shortened by 33%. Oral temperature should be measured at the end of the rest period to make sure that it has dropped below 99.6 degrees Fahrenheit. No Benchmark-TurnKey employee will be permitted to continue wearing semi-permeable or impermeable garments when his/her oral temperature exceeds 100.6 degrees Fahrenheit.

10.2 Cold Stress Monitoring

Exposure to cold conditions may result in frostbite or hypothermia, each of which progresses in stages as shown below.

- **Frostbite** occurs when body tissue (usually on the extremities) begins to freeze. The three states of frostbite are:

    1) **Frost nip** - This is the first stage of the freezing process. It is characterized by a whitened area of skin, along with a slight burning or painful sensation. Treatment consists of removing the victim from the cold conditions, removal of boots and gloves, soaking the injured part in warm water (102 to 108 degrees Fahrenheit) and drinking a warm beverage. Do not rub skin to generate friction/ heat.

    2) **Superficial Frostbite** - This is the second stage of the freezing process. It is characterized by a whitish gray area of tissue, which will be firm to the touch but will yield little pain. The treatment is identical for Frost nip.

    3) **Deep Frostbite** - In this final stage of the freezing process the affected tissue will be cold, numb and hard and will yield little to no pain. Treatment is identical to that for Frost nip.

- **Hypothermia** is a serious cold stress condition occurring when the body loses heat at a rate faster than it is produced. If untreated, hypothermia may be fatal. The stages of hypothermia may not be clearly defined or visible at first, but generally include:

    1) Shivering
    2) Apathy (i.e., a change to an indifferent or uncaring mood)

3) Unconsciousness
4) Bodily freezing

Employees exhibiting signs of hypothermia should be treated by medical professionals. Steps that can be taken while awaiting help include:

1) Remove the victim from the cold environment and remove wet or frozen clothing. (Do this carefully as frostbite may have started.)

2) Perform active re-warming with hot liquids for drinking (Note: do not give the victim any liquid containing alcohol or caffeine) and a warm water bath (102 to 108 degrees Fahrenheit).

3) Perform passive re-warming with a blanket or jacket wrapped around the victim.

In any potential cold stress situation, it is the responsibility of the Site Health and Safety Officer to encourage the following:

- Education of workers to recognize the symptoms of frostbite and hypothermia.

- Workers should dress warmly, with more layers of thin clothing as opposed to one thick layer.

- Personnel should remain active and keep moving.

- Personnel should be allowed to take shelter in a heated area, as necessary.

- Personnel should drink warm liquids (no caffeine or alcohol if hypothermia has set in).

- For monitoring the body's recuperation from excess cold, oral temperature recordings should occur:

  - At the Site Safety Technicians discretion when suspicion is based on changes in a worker's performance or mental status.

  - At a workers request.

  - As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind chill less than 20 degrees Fahrenheit or wind chill less than 30 degrees Fahrenheit with precipitation).

- As a screening measure, whenever anyone worker on-site develops hypothermia.

Any person developing moderate hypothermia (a core body temperature of 92 degrees Fahrenheit) will not be allowed to return to work for 48 hours without the recommendation of a qualified medical doctor.

11.0 WORK ZONES AND SITE CONTROL

Work zones around the areas designated for construction activities will be established on a daily basis and communicated to all employees and other Site users by the SSHO. It shall be each Contractor's Site Safety and Health Officer's responsibility to ensure that all Site workers are aware of the work zone boundaries and to enforce proper procedures in each area. The zones will include:

- Exclusion Zone ("Hot Zone") - The area where contaminated materials may be exposed, excavated or handled and all areas where contaminated equipment or personnel may travel. Flagging tape will delineate the zone. All personnel entering the Exclusion Zone must wear the prescribed level of personal protective equipment identified in Section 7.

- Contamination Reduction Zone - The zone where decontamination of personnel and equipment takes place. Any potentially contaminated clothing, equipment and samples must remain in the Contamination Reduction Zone until decontaminated.

- Support Zone - The part of the site that is considered non-contaminated or "clean." Support equipment will be located in this zone, and personnel may wear normal work clothes within this zone.

In the absence of other task-specific work zone boundaries established by the SSHO, the following boundaries will apply to all investigation and construction activities involving disruption or handling of Site soils or groundwater:

- Exclusion Zone: 50 foot radius from the outer limit of the sampling/construction activity.

- Contaminant Reduction Zone: 100 foot radius from the outer limit of the sampling/construction activity.

- Support Zone: Areas outside the Contaminant Reduction Zone.

Access of non-essential personnel to the Exclusion and Contamination Reduction Zones will be strictly controlled by the SSHO. Only personnel who are essential to the completion of the task will be allowed access to these areas and only if they are wearing the prescribed level of protection. Entrance of all personnel must be approved by the SSHO.

The SSHO will maintain a Health and Safety Logbook containing the names of Benchmark-TurnKey workers and their level of protection. The zone boundaries may be changed by the SSHO as environmental conditions warrant, and to respond to the necessary changes in work locations on-site.

12.0 DECONTAMINATION

12.1 Decontamination for Benchmark-TurnKey Employees

The degree of decontamination required is a function of a particular task and the environment within which it occurs. The following decontamination procedure will remain flexible, thereby allowing the decontamination crew to respond appropriately to the changing environmental conditions that may arise at the Site. All Benchmark-TurnKey personnel on-site shall follow the procedure below, or the Contractor's procedure (if applicable), whichever is more stringent.

Station 1 - Equipment Drop: Deposit visibly contaminated (if any) re-useable equipment used in the contamination reduction and exclusion zones (tools, containers, monitoring instruments, radios, clipboards, etc.) on plastic sheeting.

Station 2 - Boots and Gloves Wash and Rinse: Scrub outer boots and outer gloves. Deposit tape and gloves in waste disposal container.

Station 3 - Tape, Outer Boot and Glove Removal: Remove tape, outer boots and gloves. Deposit tape and gloves in waste disposal container.

Station 4 - Canister or Mask Change: If worker leaves exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot cover donned, and worker returns to duty.

Station 5 - Outer Garment/Face Piece Removal: Protective suit removed and deposited in separate container provided by Contractor. Face piece or goggles are removed if used. Avoid touching face with fingers. Face piece and/or goggles deposited on plastic sheet. Hard hat removed and placed on plastic sheet.

Station 6 - Inner Glove Removal: Inner gloves are the last personal protective equipment to be removed. Avoid touching the outside of the gloves with bare fingers. Dispose of these gloves in waste disposal container.

Following PPE removal, personnel shall wash hands, face and forearms with absorbent wipes. If field activities proceed for duration of 6 consecutive months or longer, shower facilities will be provided for worker use in accordance with OSHA 29 CFR 1910.120(n).

12.2 Decontamination for Medical Emergencies

In the event of a minor, non-life threatening injury, personnel should follow the decontamination procedures as defined, and then administer first-aid.

In the event of a major injury or other serious medical concern (e.g., heat stroke), immediate first-aid is to be administered and the victim transported to the hospital in lieu of further decontamination efforts unless exposure to a Site contaminant would be considered "Immediately Dangerous to Life or Health."

12.3 Decontamination of Field Equipment

The Contractor in accordance with his approved Health and Safety Plan in the Contamination Reduction Zone will conduct decontamination of heavy equipment. As a minimum, this will include manually removing heavy soil contamination, followed by steam cleaning on an impermeable pad.

Benchmark-TurnKey personnel will conduct decontamination of all tools used for sample collection purposes. It is expected that all tools will be constructed of nonporous, nonabsorbent materials (i.e., metal), which will aid in the decontamination effort. Any tool or part of a tool made of porous, absorbent material (i.e., wood) will be placed into suitable containers and prepared for disposal.

Decontamination of bailers, split-spoons, spatula knives, and other tools used for environmental sampling and examination shall be as follows:

- Disassemble the equipment
- Water wash to remove all visible foreign matter.
- Wash with detergent.
- Rinse all parts with distilled-deionized water.
- Allow to air dry.
- Wrap all parts in aluminum foil or polyethylene.

13.0 CONFINED SPACE ENTRY

OSHA 29 CFR 1910.146 identifies a confined space as a space that is large enough and so configured that an employee can physically enter and do assigned work, has limited or restricted means for entry and exit, and is not intended for continuous employee occupancy. Confined spaces include, but are not limited to, trenches, storage tanks, process vessels, pits, sewers, tunnels, underground utility vaults, pipelines, sumps, wells, and excavations.

Confined space entry by Benchmark-TurnKey employees is not anticipated to be necessary to complete the RI/IRM activities identified in Section 2.0. In the event that the scope of work changes or confined space entry appears necessary, the Project Manager will be consulted to determine if feasible engineering alternatives to confined space entry can be implemented. If confined space entry by Benchmark-TurnKey employees cannot be avoided through reasonable engineering measures, task-specific confined space entry procedures will be developed and a confined-space entry permit will be issued through Benchmark-TurnKey's corporate Health and Safety Director. Benchmark-TurnKey employees shall not enter a confined space without these procedures and permits in place.

14.0 FIRE PREVENTION AND PROTECTION

14.1 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.

14.2 Equipment and Requirements

Fire extinguishers will be provided by each Contractor 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. As a minimum, all extinguishers shall be checked monthly and weighed semi-annually, and recharged if necessary. Recharge or replacement shall be mandatory immediately after each use.

14.3 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 National Fire Protection Association.

14.4 Hot Work

If the scope of work necessitates welding or blowtorch operation, the hot work permit presented in Attachment B will be completed by the SSHO and reviewed/issued by the Project Manager.

15.0 EMERGENCY INFORMATION

In accordance with OSHA 29 CFR Part 1910, an Emergency Response Plan is attached to this HASP as Attachment A. The hospital route map is presented within Attachment A as Figure 1.

16.0 REFERENCES

1. New York State Department of Environmental Conservation. *DER-10; Technical Guidance for Site Investigation and Remediation.* May 2010.

TABLES

TABLE 1

TOXICITY DATA FOR CONSTITUENTS OF POTENTIAL CONCERN

SITE HEALTH AND SAFETY PLAN
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Parameter	Synonyms	CAS No.	Code	Concentration Limits [1]		
				PEL	TLV	IDLH
VOCs: ppm						
Benzene	*Benzol, Phenyl hydride*	71-43-2	*Ca*	1	10	500
Xylenes (o, m, p)	*o-, m-, p-isomers*	1330-20-7	*None*	100	100	900
Toulene	*Methyl benzene, Methyl Benzol*	108-88-3	*C-300*	200	50	500
Ethylbenzene	*Ethylbenzol, Phenylethane*	100-41-4	*None*	100	100	800
cis-1,2-dichloroethene	*1,2-DCE (cis)*	156-59-2	*None*	200	200	1000
Trichloroethene	*TCE*	79-01-6	*Ca*	100	50	1000
Tetrachloroethene	*PCE, perchloroethene, perc*	127-18-4	*Ca*	100	100	900
Vinyl chloride	*VC*	75-01-4	*Ca*	1	1	ND
PAHs						
Benzo(a)anthracene	*None*	56-55-3	*None*	--	--	--
Benzo(a)pyrene	*None*	50-32-8	*None*	--	--	--
Benzo(b)fluoranthene	*None*	205-99-2	*None*	--	--	--
Benzo(k)fluoranthene	*None*	207-08-9	*None*	--	--	--
Chrysene	*None*	218-01-9	*None*	--	--	--
Dibenzo(a,h)anthracene	*None*	53-70-3	*None*	--	--	--
Indeno(1,2,3-cd)pyrene	*None*	193-39-5	*None*	--	--	--
Metals						
Arsenic	*None*	*7440-38-2*	*Ca*	*0.01*	*0.01*	*5*
Lead	*None*	7439-92-1	*None*	0.05	0.15	100

Notes:

1. Concentration limits as reported by NIOSH Pocket Guide to Chemical Hazards, September 2007 (NIOSH Publication No. 2005-149, fourth printing with chages and updates).
2. " -- " = concentration limit not available; exposure should be minimized to the extent feasible through appropriate engineering controls & PPE.

Explanation:

C-## = Ceiling Level equals the maximum exposure concentration allowable during the work day.

IDLH = Immediately Dangerous to Life or Health.

TLV = Threshold Limit Value, established by American Conference of Industrial Hygienists (ACGIH), equals the maximum exposure concentration allowable for 8 hours/day @ 40 hr

TLVs are the amounts of chemicals in the air that almost all healthy adult workers are predicted to be able to tolerate without adverse effects. There are three types.

TLV-TWA (TLV-Time-Weighted Average) which is averaged over the normal eight-hour day/forty-hour work week. (Most TLVs.)

TLV-C or Ceiling limits are the concentration that should not be exceeded during any part of the working exposure.

Unless the initials "STEL" or "C" appear in the Code column, the TLV value should be considered to be the eight-hour TLV-TWA.

PEL = Permissible Exposure Limit, established by OSHA, equals the maximium exposure conconcentration allowable for 8 hours per day @ 40 hours per week

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TURNKEY
ENVIRONMENTAL
RESTORATION, LLC

TABLE 2

POTENTIAL ROUTES OF EXPOSURE TO THE CONSTITUENTS OF POTENTIAL CONCERN

SITE HEALTH & SAFETY PLAN
1 HOWELL STREET SITE
BUFFALO, NEW YORK

Activity [1]	Direct Contact with Soil/Fill	Inhalation of Vapors or Dust	Direct Contact with Groundwater or Surface waters
Remedial Investigation Tasks			
1. Subsurface Soil Sampling	X	X	
2. Monitoring Well Installation/Development Sampling	X	X	X
3. Soil Vapor Investigation	X	X	
Interim Remedial Measures Tasks			
1. Soil Excavation	X	X	
2. Building Demolition	X	X	
3. Verification Sampling	X	X	
4. Backfilling	X	X	
5. Groundwater and Surface Water Management	X		X

Notes:

1. Activity as described in Section 1.5 of the Health and Safety Plan.

TABLE 3

REQUIRED LEVELS OF PROTECTION
FOR BCP REDEVELOPMENT TASKS

SITE HEALTH & SAFETY PLAN
1 HOWELL STREET SITE
BUFFALO, NEW YORK

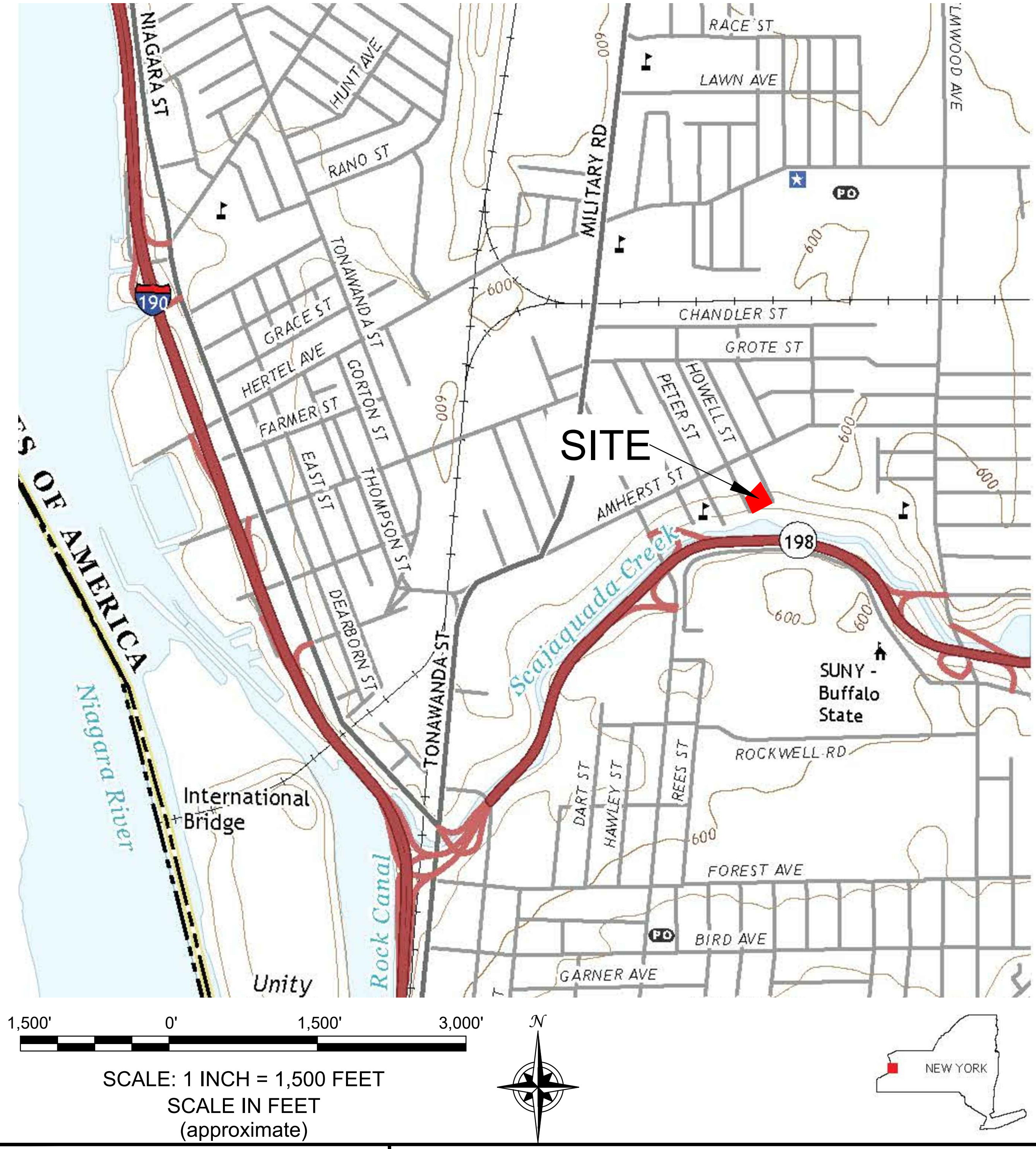
Activity	Respiratory Protection[1]	Clothing	Gloves[2]	Boots[2, 3]	Other Required PPE/Modifications[2, 4]
Remedial Investigation Tasks					
1. Subsurface Soil Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Monitroing Well Installation/Development Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
3. Soil Vapor Investigation	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
Interim Remedial Measures Tasks					
1. Soil Excavation	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Backfilling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
3. Verification Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
4. Groundwater and Surface Water Management	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS

Notes:

1. Respiratory equipment shall conform to guidelines presented in Section 7.0 of this HASP.
2. HH = hardhat; L= Latex; L/N = latex inner glove, nitrile outer glove; N = Nitrile; S = Saranex; SG = safety glasses; SGSS = safety glasses with sideshields; STSS = steel toe safety shoes.
3. Latex outer boot (or approved overboot) required whenever contact with contaminated materials may occur. SSHO may downgrade to STSS (steel-toed safety shoes) if contact will be limited to cover/replacement soils.
4. Dust masks shall be donned as directed by the SSHO (site safety and health officer) or site safety technician whenever potentially contaminated airborne particulates (i.e., dust) are present in significant amounts in the breathing zone. Goggles may be substituted with safety glasses w/side-shields whenever contact with contaminated liquids is not anticipated.

FIGURES

FIGURE 1



SCALE: 1 INCH = 1,500 FEET
SCALE IN FEET
(approximate)

BENCHMARK IN ASSOCIATION WITH **TURNKEY** ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

SITE LOCATION AND VICINITY MAP

HEALTH AND SAFETY PLAN

1 HOWELL STREET

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

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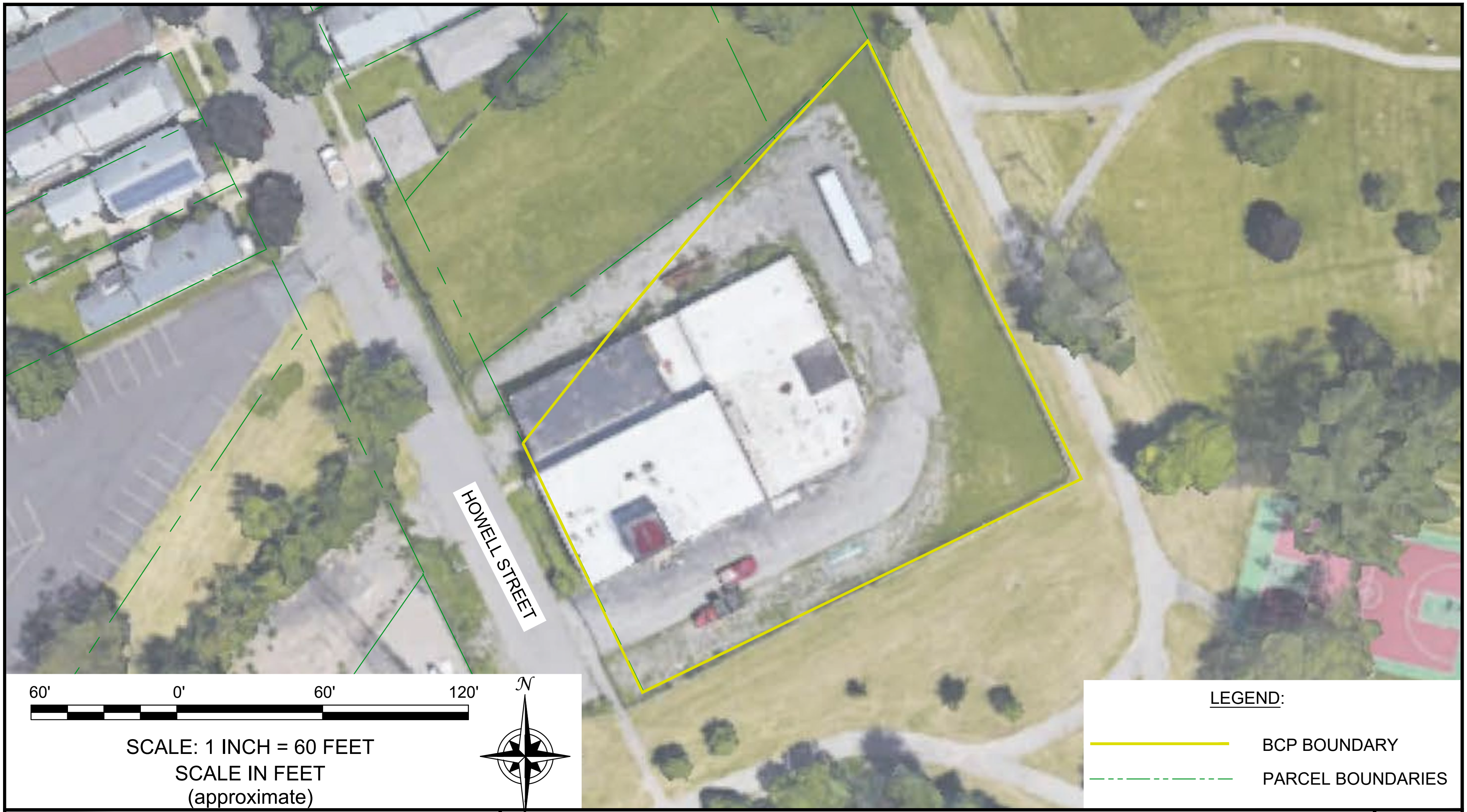

BENCHMARK IN ASSOCIATION WITH TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

SITE PLAN (AERIAL)

HEALTH AND SAFETY PLAN

1 HOWELL STREET

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 2

DISCLAIMER: ***PROPERTY OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC. & TURNKEY ENVIRONMENTAL RESTORATION, LLC*** *IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS & SUPPLIERS WITHOUT THE WRITTEN CONSENT OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC & TURNKEY ENVIRONMENTAL RESTORATION, LLC.*

ATTACHMENT A

EMERGENCY RESPONSE PLAN

EMERGENCY RESPONSE PLAN
for
BROWNFIELD CLEANUP PROGRAM ACTIVITIES

1 HOWELL STREET SITE
BUFFALO, NEW YORK

May 2022 0258-022-002

Prepared for:

Howell Street Venture LLC

Prepared By:

Benchmark Civil/Environmental Engineering & Geology, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716)856-0599

In Association With:

TurnKey Environmental Restoration, LLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716)856-0635

1 HOWELL STREET SITE
HEALTH AND SAFETY PLAN FOR BCP ACTIVITIES
APPENDIX A: EMERGENCY RESPONSE PLAN

TABLE OF CONTENTS

LIST OF FIGURES

1.0 GENERAL

This report presents the site-specific Emergency Response Plan (ERP) referenced in the Site Health and Safety Plan (HASP) prepared for Brownfield Cleanup Program related activities at the 1 Howell Street Site located at 1 Howell Street, Buffalo, NY. This appendix of the HASP describes potential emergencies that may occur at the Site; procedures for responding to those emergencies; roles and responsibilities during emergency response; and training all workers must receive in order to follow emergency procedures. This ERP also describes the provisions this Site has made to coordinate its emergency response planning with other contractors on-site and with off-site emergency response organizations.

This ERP is consistent with the requirements of 29 CFR 1910.120(l) and provides the following site-specific information:

- Pre-emergency planning.
- Personnel roles, lines of authority, and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Evacuation routes and procedures.
- Decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- Emergency personal protective equipment (PPE) and equipment.

2.0 PRE-EMERGENCY PLANNING

This Site has been evaluated for potential emergency occurrences, based on site hazards, the required work tasks, the site topography, and prevailing weather conditions. The results of that evaluation indicate the potential for the following site emergencies to occur at the locations indicated.

Type of Emergency:

1. Medical, due to physical injury

Source of Emergency:

1. Slip/trip/fall

Location of Source:

1. Non-specific

3.0 ON-SITE EMERGENCY RESPONSE EQUIPMENT

Emergency procedures may require specialized equipment to facilitate worker rescue, contamination control and reduction, or post-emergency clean up. Emergency response equipment available on the Site is listed below. The equipment inventory and storage locations are based on the potential emergencies described above. This equipment inventory is designed to meet on-site emergency response needs and any specialized equipment needs that off-site responders might require because of the hazards at this Site but not ordinarily stocked.

Any additional personal protective equipment (PPE) required and stocked for emergency response is also listed in below. During an emergency, the Emergency Response Coordinator (ERC) is responsible for specifying the level of PPE required for emergency response. At a minimum, PPE used by emergency responders will comply with Section 7.0, Personal Protective Equipment, of this HASP. Emergency response equipment is inspected at regular intervals and maintained in good working order. The equipment inventory is replenished as necessary to maintain response capabilities.

Emergency Equipment	Quantity	Location
First Aid Kit	1	Site Vehicle
Chemical Fire Extinguisher	1 (minimum)	All heavy equipment and Site Vehicle

4.0 EMERGENCY PLANNING MAPS

An area-specific map of the Site will be developed on a daily basis during performance of field activities. The map will be marked to identify critical on-site emergency planning information, including: emergency evacuation routes, a place of refuge, an assembly point, and the locations of key site emergency equipment. Site zone boundaries will be shown to alert responders to known areas of contamination. There are no major topographical features, however the direction of prevailing winds/weather conditions that could affect emergency response planning are also marked on the map. The map will be posted at site-designated place of refuge and inside the Benchmark personnel field vehicle.

5.0 EMERGENCY CONTACTS

The following identifies the emergency contacts for this ERP.

Emergency Telephone Numbers:

Project Manager: *Nathan Munley*
Work: (716) 856-0599
Mobile: (716) 289-1072

Corporate Health and Safety Director: *Thomas H. Forbes, P.E.*
Work: (716) 856-0599
Mobile: (716) 864-1730

Site Safety and Health Officer (SSHO): *Nathan Munley*
Work: (716) 856-0599
Mobile: (716) 289-1072

Alternate SSHO: *Chris Boron, P.G.*
Work: (716) 856-0635
Mobile: (716) 864-2726

SISTERS OF CHARITY HOSPITAL (ER):	(716) 826-7000
FIRE:	911
AMBULANCE:	911
POLICE:	911
STATE EMERGENCY RESPONSE HOTLINE:	(800) 457-7362
NATIONAL RESPONSE HOTLINE:	(800) 424-8802
NYSDOH:	(716) 847-4385
NYSDEC:	(716) 851-7220
NYSDEC 24-HOUR SPILL HOTLINE:	(800) 457-7252

The Site location is:

1 Howell Street
Buffalo, New York, 14207
Site Phone Number: Benchmark-TurnKey Staff Cell Phones to be used

6.0 EMERGENCY ALERTING & EVACUATION

Internal emergency communication systems are used to alert workers to danger, convey safety information, and maintain site control. Any effective system can be employed. Two-way radio headsets or field telephones are often used when work teams are far from the command post. Hand signals and air-horn blasts are also commonly used. Every system must have a backup. It shall be the responsibility of each contractor's Site Health and Safety Officer to ensure all personnel entering the site understand an adequate method of internal communication. Unless all personnel are otherwise informed, the following signals shall be used.

1) Emergency signals by portable air horn, siren, or whistle: two short blasts, personal injury; continuous blast, emergency requiring site excavation.

2) Visual signals: hand gripping throat, out of air/cannot breathe; hands on top of head, need assistance; thumbs up, affirmative/ everything is OK; thumbs down, no/negative; grip partner's wrist or waist, leave area immediately.

If evacuation notice is given, site workers leave the worksite with their respective buddies, if possible, by way of the nearest exit. Emergency decontamination procedures detailed in Section 12.0 of the HASP are followed to the extent practical without compromising the safety and health of site personnel. The evacuation 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 rehearsals and inputs from emergency response organizations. Wind direction indicators are located so that workers can determine a safe up wind or cross wind evacuation route and assembly area if not informed by the emergency response coordinator at the time the evacuation alarm sounds. Since work conditions and work zones within the site may be changing on daily basis, it shall be the responsibility of the construction Site Health and Safety Officer to review evacuation routes and procedures as necessary and to inform all Benchmark-TurnKey workers of any changes.

Personnel exiting the site will gather at a designated assembly point. To determine that everyone has successfully exited the site, personnel will be accounted for at the assembly site. If any worker cannot be accounted for, notification is given to the SSHO (***Nathan***

Munley or SSHO Alternate Chris Boron, P.G.) so that appropriate action can be initiated. Contractors and subcontractors on this site have coordinated their emergency response plans to ensure that these plans are compatible and that source(s) of potential emergencies are recognized, alarm systems are clearly understood, and evacuation routes are accessible to all personnel relying upon them.

7.0 EXTREME WEATHER CONDITIONS

In the event of adverse weather conditions, the Site Safety and Health Officer in conjunction with the Contractor's SSHO will determine if engineering operations can continue without sacrificing the health and safety of site personnel. Items to be considered prior to determining if work should continue include but are not limited to:

- Potential for heat/cold stress.
- Weather-related construction hazards (e.g., flooding or wet conditions producing undermining of structures or sheeting, high wind threats, etc).
- Limited visibility.
- Potential for electrical storms.
- Limited site access/egress (e.g., due to heavy snow)

8.0 EMERGENCY MEDICAL TREATMENT & FIRST AID

Personnel Exposure:

The following general guidelines will be employed in instances where health impacts threaten to occur acute exposure is realized:

- Skin Contact: Use copious amounts of soap and water. Wash/rinse affected area for at least 15 minutes. Decontaminate and provide medical attention. Eyewash stations will be provided on site. If necessary, transport to Buffalo General Hospital.
- Inhalation: Move to fresh air and, if necessary, transport to Hospital.
- Ingestion: Decontaminate and transport to Hospital.

Personal Injury:

Minor first-aid will be applied on-site as deemed necessary. In the event of a life threatening injury, the individual should be transported to Hospital via ambulance. The Site Health and Safety Officer will supply available chemical specific information to appropriate medical personnel as requested.

First aid kits will conform to Red Cross and other applicable good health standards, and shall consist of a weatherproof container with individually sealed packages for each type of item. First aid kits will be fully equipped before being sent out on each job and will be checked weekly by the SSHO to ensure that the expended items are replaced.

Directions to (Sisters of Charity Hospital) (see Figure 1):

The following directions describe the best route from the Site to the Emergency Room at Sisters of Charity Hospital:

- From the Site, travel north on Howell Street to Amherst Street
- Turn left on Amherst Street
- After 0.2 miles, turn left onto Grant Street
- After 0.2 miles, turn right onto NY-198 East
- After 2.2 miles, take the exit toward NY -5, Main Street
- After 800 feet, take a slight left turn onto Kensignton Avenue
- After 800 feet, turn left to arrive at Sisters of Charity Hospital (2157 Main Street, Buffalo, NY 14214)

9.0 EMERGENCY RESPONSE CRITIQUE & RECORD KEEPING

Following an emergency, the SSHO and Project Manager shall review the effectiveness of this Emergency Response Plan (ERP) in addressing notification, control and evacuation requirements. Updates and modifications to this ERP shall be made accordingly. It shall be the responsibility of each contractor to establish and assure adequate records of the following:

- Occupational injuries and illnesses.
- Accident investigations.
- Reports to insurance carrier or State compensation agencies.
- Reports required by the client.
- Records and reports required by local, state, federal and/or international agencies.
- Property or equipment damage.
- Third party injury or damage claims.
- Environmental testing logs.
- Explosive and hazardous substances inventories and records.
- Records of inspections and citations.
- Safety training.

10.0 EMERGENCY RESPONSE TRAINING

All persons who enter the worksite, including visitors, shall receive a site-specific briefing about anticipated emergency situations and the emergency procedures by the SSHO. Where this site relies on off-site organizations for emergency response, the training of personnel in those off-site organizations has been evaluated and is deemed adequate for response to this site.

FIGURES

FIGURE 1: HOSPITAL ROUTE MAP

DIRECTIONS:
- TRAVEL NORTH ON HOWELL STREET TO AMHERST STREET
- TURN LEFT ONTO AMHERST STREET
- TURN LEFT ONTO GRANT STREET
- TURN RIGHT ONTO NY-198 EAST
- TAKE EXIT TOWARD NY-5, MAIN STREET
- TAKE A SLIGHT LEFT TURN ONTO KENSINGTON AVENUE
- TURN LEFT INTO SISTERS OF CHARITY HOSPITAL

BENCHMARK IN ASSOCIATION WITH TURNKEY ENVIRONMENTAL RESTORATION, LLC

2558 HAMBURG TURNPIKE, SUITE 300, BUFFALO, NY 14218, (716) 856-0599

PROJECT NO.: T0258-022-002

DATE: MAY 2022

DRAFTED BY: CEH

HOSPITAL ROUTE MAP

EMERGENCY RESPONSE PLAN

1 HOWELL STREET

BUFFALO, NEW YORK

PREPARED FOR

HOWELL STREET VENTURE, LLC

FIGURE 1

*__DISCLAIMER:__ **PROPERTY OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC. & TURNKEY ENVIRONMENTAL RESTORATION, LLC** __IMPORTANT:__ THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME. INFORMATION CONTAINED HEREON IS NOT TO BE DISCLOSED OR REPRODUCED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY SUBCONTRACTORS & SUPPLIERS WITHOUT THE WRITTEN CONSENT OF BENCHMARK CIVIL/ENVIRONMENTAL ENGINEERING & GEOLOGY, PLLC & TURNKEY ENVIRONMENTAL RESTORATION, LLC.*

ATTACHMENT B

HOT WORK PERMIT FORM

BENCHMARK TURNKEY

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:

ATTACHMENT C

NYSDOH 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.