Remedial Investigation/Interim Remedial Measures Work Plan

1585 Hertel Avenue Site
Buffalo, New York

April 2018 0437-017-001-003

Prepared For:

1585 Hertel LLC

Prepared By:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

2558 Hamburg Turnpike, Suite 300, Buffalo, New York 14218 | phone: (716) 856-0599 | fax: (716) 856-0583

WORK PLAN
FOR
REMEDIAL INVESTIGATION/INTERIM REMEDIAL MEASURES

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

April 2018 0437-017-001-004

Prepared for:

1585 Hertel LLC

Prepared by:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

Certification

I, Thomas H. Forbes, certify that I am currently a NYS registered professional engineer and that this April 2018 Remedial Investigation/Interim Remedial Measures (RI/IRM) Work Plan for the 1585 Hertel Avenue 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).

5-8-18

Date

THOMAS H. FORBES

No. 70953-1

RI/IRM WORK PLAN

1585 Hertel Avenue Site
Buffalo, New York
Table of Contents

Table of Contents

RI/IRM WORK PLAN

1585 Hertel Avenue Site
Buffalo, New York

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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 1585 Hertel Avenue Site (Site), located at 1585 Hertel Avenue, Buffalo, New York (see Figures 1 and 2).

The Applicant, 1585 Hertel LLC, acting as a Volunteer has elected to pursue cleanup and redevelopment of the Site under the New York State Brownfield Cleanup Program (BCP) and has submitted a BCP Application to the New York State Department of Environmental Conservation (NYSDEC) in conjunction with this work plan. The planned redevelopment is to develop the Site into a 5-story residential apartment building with retail on the first floor. The RI/IRM will be completed by Benchmark Environmental Engineering & Science, PLLC (Benchmark) in association with TurnKey Environmental Restoration, LLC (TurnKey) (collectively, Benchmark-TurnKey), on behalf of the Applicant. The work will be completed in accordance with NYSDEC DER-10 guidelines (Ref. 1).

1.1 Site Background

The Site consists of one (1) parcel (SBL No. 78.74-3-1) totaling ±0.18 acres, at the southwest corner of Hertel and Parkside Avenues, in the City of Buffalo, Erie County, New York.

The Site is currently improved with one (1), 1 story commercial building formerly used as an automobile repair shop, which will be demolished prior to site development. The remaining portion of the Site consists of asphalt and concrete surface cover as the Site was also used for retail gasoline sales. The gasoline underground storage tanks (USTs) and pump islands (minus the actual pumps) still remain at the Site.

The Site has a long history of being utilized for retail gasoline sales and automobile repair use since the late 1930s. Prior to construction of the existing gasoline service station in 1963, the Site included a previous gasoline service station in current asphalt paved and pump island areas in the northern portion of the Site.

Previous environmental investigations completed at the Site have identified elevated levels of volatile organic compounds (VOCs) and metals at concentrations exceeding NYSDEC Part 375 Industrial, Commercial and Residential Soil Cleanup Objectives (SCOs). Details of the previous investigations are presented in Section 2.8 below.

1.2 Project Objectives

For sites entering the BCP at the point of investigation, NYSDEC requires completion of a RI. However, due to the timing of the project schedule, an IRM component has been included in this work plan to address the known contamination and additional contamination that may be encountered during the RI. The primary objectives of this RI/IRM 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 potential to migrate off-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 significant risks.

As part of the RI/IRM, sampling data will be used to evaluate whether remedial alternatives can meet the cleanup objectives. The intended uses of these data dictate the confidence levels. Two data confidence levels will be employed in the RI: screening level data and definitive level data. In general, screening level confidence will apply to field measurements, including PID measurements, groundwater elevation measurements, and field analyses (i.e., pH, temperature, dissolved oxygen, 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) in Section 5.0. Sampling and analytical acceptance and performance criteria such as precision, accuracy, representativeness, comparability, completeness, and sensitivity, are defined in the QAPP.

An IRM will be completed to immediately 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: excavation of impacted soil/fill; removal of above or underground storage tanks, hydraulic lifts, along with any associated impacted soil/fill; and, off-Site disposal of impacted soil/fill. This Work Plan presents the scope of anticipated IRM activities based on current information and may be modified, subject to NYSDEC approval, immediately after the RI fieldwork is completed.

The Volunteer's intent is for the planned IRM to substantially constitute the final remedy for those areas of the Site, with the goal to achieve 6NYCRR Part 375 Unrestricted Use Soil Cleanup Objectives (USCOs). The final remedial objectives for the Site will be presented in the Alternatives Analysis Report (AAR) based on the findings of the RI and IRM(s).

Details of anticipated IRM activities are included in Section 4.0.

1.3 Project Organization and Responsibilities

The Applicant, 1585 Hertel LLC, has applied to the New York State BCP as a non-responsible party (volunteer) per ECL§27-1405. Benchmark, in association with TurnKey, herein referred to jointly as Benchmark-TurnKey, will complete the remedial investigation and manage the brownfield cleanup on behalf of the Applicant. Benchmark-TurnKey will also be responsible to verify and certify that the brownfield remedial action was completed in conformance with the approved IRM work plan 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 remedial investigation and remedial actions to be performed in accordance with the Brownfield Cleanup Agreement, the approved RI/IRM Work Plan, and NYSDEC DER-10 guidance (May 2010) by Benchmark-TurnKey.

Benchmark-TurnKey personnel as well as subcontractors for this project have not been determined at this time. Once pricing is secured, subcontract agreements are in place, and a field schedule determined, resumes for the selected project team will be provided to the Department, if requested. Benchmark-TurnKey's Project Manager's résumé, however, has been included in Appendix A. The table below presents the planned project team.

Company	Role	Name	Contact Information
1585 Hertel LLC	Applicant contact	John Daly	(716) 883-4400
Benchmark-TurnKey	Project Officer	Thomas H. Forbes, P.E.	(716) 856-0599
Benchmark-TurnKey	Project Manager	Christopher Boron	(716) 856-0599
TBD	Analytical Testing	TBD	TBD
TBD	Drilling Services	TBD	TBD
TBD	Excavation Services	TBD	TBD
Data Validation Services	DUSR	Judy Harry	TBD

2.0 SITE DESCRIPTION

2.1 General

The Site is located in a highly developed mixed use commercial and residential area, being bound by Hertel Avenue to the north, Parkside Avenue to the west, and a customer parking lot for a M&T Bank (located across Hertel Avenue north of the Site) to the south and east of the Site. The Site is currently improved with one (1) 1-story commercial buildings formerly used as an automobile repair shop and for retail gasoline sales at the corner of Hertel and Parkside Avenues which will be demolished for site redevelopment (see Figures 1, 2, 3).

2.2 Site Topography and Drainage

The Site is generally flat lying with topographic relief sloping towards Hertel and Parkside Avenues. The surface of the Site is covered with the existing building, asphalt/concrete, with some soil/gravel green surface cover on the east and south sides of the building. Precipitation (i.e., rain or melting snow) moves to the storm drains in the northwestern and northeastern corners of the Site or migrates to the roadways via overland flow. Shallow groundwater flow is likely affected by various cycles of development and filling, as well as utilities and foundations.

2.3 Geology and Hydrogeology

2.3.1 Overburden

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. According to the United States Department of Agriculture (USDA) Web soil survey (Ref. 2), Site soils are generally characterized as Urban Land-Churchville complex (Uh) Collamer complex. This complex consists of nearly level areas of urban land and deep somewhat poorly drained Churchville soils, formed in clayey deposits underlain by glacial till. This complex is located in urban areas in the City of Buffalo, ranging from 5 to 600 acres, and are irregular in shape.

The Phase II investigation (further discussed in Section 2.8) identified the subsurface conditions as fill material, ranging in thickness from 1 foot to 7 feet below ground surface (fbgs) overlying clay with varying and lesser amounts of silt, sand and gravel. The geology of the Site 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 is situated over 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. Structurally, the bedrock formations strike in an east-west direction and exhibit a regional dip that approximates 40 feet per mile (0.4 degrees) toward the south and southwest. Depth to and type of bedrock below the Site is assumed to be 30 to 35 feet and Onondaga limestone.

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. Groundwater flow in the area of the Site is likely westerly, towards the Niagara River, and along the flow path of Scajaquada Creek, which are located west and southwest, respectively from the Site. Scajaquada Creek flows towards and discharges into the Niagara River. Local groundwater flows, are likely influenced by subsurface features, such as utilities, and localized subgrade development conditions. Localized on-Site groundwater flow will be investigated during the RI, if encountered in overburden soil.

2.4 Climate

The City of Buffalo has a cold continental climate, with moisture from Lake Erie causing increased precipitation. Average annual precipitation is reportedly 40.5 inches and snowfall is 94 inches. 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 261,310 (2010 US Census Bureau). The Site is located in Census Tract 63.02, in the area of the city zoned for commercial/residential use.

The current zoning for the Site is N-3C: Neighborhood center (mixed use commercial areas at a neighborhood scale).

The surrounding land-use is mixed use, including commercial, and residential. Properties adjacent to the Site include primarily commercial.

2.6 Utilities and Groundwater Use

The subject property has access to all 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).

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, 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 off-site.

2.7 Wetlands and Floodplains

There are no State or Federal wetlands or floodplains located on Site or adjacent to the Site.

2.8 Previous Investigations

A summary of the investigations that have occurred at the Site are presented below and included in Appendix B.

2.8.1 October 2017 – Phase I Environmental Site Assessment

Benchmark completed a Phase I Environmental Site Assessment (ESA) on the Site in October 2017. Benchmark's ESA revealed the following recognized environmental conditions (RECs) in connection with the Site:

- The historic use of the Site as a petroleum retail operation and automotive repair facility from 1938 until operations ceased in 2016 are considered RECs as subsurface conditions are unknown. Note that prior to construction of the existing gasoline service station in 1963, the Site included a previous gasoline service station in current asphalt paved and pump island areas;
- The Site has an extensive tank history with existing inactive underground storage tanks (USTs), previous generations of USTs, and current/former pump island areas. Evidence indicative of former USTs (i.e., cut suspect vent pipes) was observed during the site reconnaissance. Existing and former USTs and pump islands are considered RECs due to the potential for subsurface impacts;
- The in-ground lift systems were observed within the building and are considered RECs due to the potential for impacts;
- The staining noted at the Site is considered a REC as visible impacts were noted to earthen ground surfaces proximate to an aboveground storage tank (AST) and 55-gallon drum on the eastern exterior portion of the Site. Further, additional black staining was noted within the building, including a black liquid/sludge within the floor drain system. The exact discharge point and integrity of the floor drain system is unknown thus considered a REC; and,
- The remaining materials noted at the Site, especially the exterior 55-gallon drum with an unknown liquid, are considered RECs as such will require proper handling and off-site disposal. Similarly, electronic wastes such as light ballasts potentially containing PCBs will require proper handling and off-site disposal.

Locations of the RECs described above are illustrated in Figure 3. Due to the RECs identified for the Site, Benchmark recommended completion of a Phase II Environmental Site Investigation (Phase II) to assess the RECs identified.

2.8.2 November 2017 – Phase II Environmental Investigation Report

Benchmark completed a Phase II on the Site in November 2017. The Site is located at the southeast corner of Hertel Avenue and Parkside Avenue in a mixed-use area of the North Park area in the City of Buffalo. The Site is a vacant former gas station and automotive repair facility. The gasoline and waste oil USTs and gasoline pump islands are still present at the Site. Findings of the Phase II are detailed below:

- Based on the field observations during the Phase II, it was evident that petroleum impacts where present at the Site, and, as required by law, the NYSDEC was notified and Spill No. 1706962 was assigned to the Site.
- Petroleum volatile organic compounds (pVOCs) were detected at concentrations exceeding CP-51 Soil Cleanup Levels (SCLs), 6NYCRR Part 375 Restricted Residential Soil Cleanup Objectives (RRSCOs) and/or Commercial Soil Cleanup Objectives (CSCOs) in soil samples SB-6 (2-4 fbgs), SB-7 (1.5-3.5 fbgs), which were completed in the vicinity of the pump island and existing USTs, respectively (see Figure 7). Stained soil, petroleum odors, and the highest photoionization detector (PID) measurements were also noted at these two (2) locations.
- Metals were detected in the four (4) samples analyzed soil samples. Cadmium was detected at SB-2 (0.5-2 fbgs) at concentrations above its respective CSCO. Arsenic, cadmium, and lead were detected at surface soil sample, SS-1, at concentrations above their respective CSCOs. Based on the high concentrations of arsenic (164 milligrams per kilogram (mg/kg)) and lead (1,030 mg/kg) detected in the surface soil, additional analysis may be warranted to determine if the soil present in this area is a characteristic hazardous waste.

A brief description of the field observations during the boring investigation is presented below:

Investigation Location ID	**Environmental Concern Assessed**	**Highest PID reading (parts per million, ppm) and depth (fbgs)**	**Other Observations**
SB-1	Pump Island - north	429 ppm, 7.5 fbgs.	Petroleum odors 4 to 8 fbgs
SB-2	Pump Island – east	62 ppm, 1.5 fbgs.	Petroleum odors 1 to 3.5 fbgs
SB-3	Waste Oil Tank	38 ppm, 2 fbgs.	Petroleum odors at 2 fbgs
SB-4	Pump Island - south	0.0 ppm throughout boring.	None
SB-5	USTs - south	1 ppm, 3.5 fbgs.	Petroleum odors 3 to 6 fbgs
SB-6	Pump Island - west	898 ppm, 3.5 fbgs.	Staining and strong petroleum odors 3 to 6 fbgs
SB-7	USTs - northwest	791 ppm; 3 fbgs.	Staining and petroleum odors 1 to 4 fbgs
SB-8	North of Building/Hydraulic Lifts	0.0 ppm throughout boring.	None
SS-1	AST, drum, staining on ground surface	Not measured	Surface soil is stained.

Areas of impacts described above are shown on Figure 3. It is estimated that approximately 1,000 tons of petroleum and metals impacted soil will need to be removed as part of the remedial action. This estimated volume will be further refined upon collection of RI data.

2.9 Primary Constituents of Potential Concern (COPCs)

Based on findings to date, the Constituents of Potential Concern (COPCs) are presented by media below:

- ***Soil:*** pVOCs and metals
- ***Groundwater:*** pVOCs

3.0 REMEDIAL INVESTIGATION SCOPE OF WORK

The RI scope of work is focused on defining the nature and extent of contamination on-site and potential for off-site migration, identifying the source of contamination, defining chemical constituent migration pathways, qualitatively assessing human health and ecological risks (if necessary), and obtaining data of sufficient quantity and quality to perform the alternatives analysis report. As the goal of this BCP project is to achieve USCOs, investigation activities will be completed to assess fill material present at the Site, in addition to the extent of petroleum- and metals-impacts, including beneath the building.

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 outdoor RI 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 identified on Table 1.

3.1 Preparation Activities

3.1.1 Utility Clearance

Prior to any intrusive activities, Dig Safely New York (Call 811) will be contacted by the site contractor a minimum of three 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.

3.2 RI Soil/Fill Investigation

A soil/fill investigation will be at the Site to further assess whether additional impact exists beyond the limits of, and to assess the extent of, known historical contamination. The subsurface soil/fill investigation will include the completion of soil probes to allow for characterization of subsurface 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 1.

3.2.1 Surface Soil/Fill Investigation

Surface soil/fill sampling will be completed along the eastern and southern side of the building, as part of the RI, as the remainder of the Site is covered with asphalt/concrete hardscape and the building footprint. Two (2) surface soil samples are proposed to be completed (see Figure 4). Based on the historic investigations, the stained surface soil/fill present along the eastern side of the building is impacted with arsenic, barium and lead and will be removed during the IRM to achieve the planned cleanup objectives (Unrestricted Track 1 cleanup).

3.2.2 Subsurface Soil/Fill Investigation

Ten (10) subsurface soil/fill exploratory locations will be completed as part of the RI. These investigation locations, identified as MW-1 through MW-4 and SB-9 through SB-14, will be completed to approximately 20 feet below ground surface (fbgs) or bedrock refusal, whichever comes first, to further delineate the extent of the known petroleum contamination and determine if other impacts requiring remediation are present at the Site. The proposed locations are shown on Figure 4.

Soil/fill samples retrieved from the soil borings will be field screened for the presence of volatile organics using a calibrated 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 samples for laboratory analysis. Upon reaching the completion depth of each location, field visual/olfactory and PID results will be reviewed. If significant field evidence of impact is encountered, soil borings will be expanded or supplemental step-back borings will be advanced in an attempt to delineate the extent of the impacts.

Observations for the presence of groundwater will also be made during the soil boring investigation to assess for the present of groundwater. If groundwater is determined to be present in the overburden soil, four (4) soil borings will be completed to install four (4) groundwater monitoring wells, identified as MW-1 through MW-4, as discussed in Section 3.4.

3.2.3 Soil/Fill Sample Collection and Analysis

Table 1 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 and determine if other impacts requiring remediation are present at the Site. As an IRM is proposed to be completed as part of this work plan, waste characterization samples will also be collected for analysis.

In the event that either the impacts are ubiquitous from grade to final depth or no impacts are identified, the soil/fill sample interval(s) will be collected to delineate previously identified impacts, assess fill materials present, and uniformly characterize the Site as detailed on Table 1. If differentiable impacts are noted during the investigation, additional sample location(s) will be collected. The Department will be made aware of the differing impacts if/when they are encountered.

En-core samplers will be used to collect RI VOC soil samples as described in Method 5035. 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 presented on Table 1. Tentatively Identified Compounds (TICs) analysis will be included with 20% of the RI samples collected for VOC and SVOC analysis.

3.3 Groundwater Investigation

Four (4) groundwater monitoring wells, identified as MW-1 through MW-4, will be advanced at the Site to assess groundwater quality data and flow direction. The groundwater wells will be installed into the upper most water bearing zone. Proposed groundwater monitoring well locations are identified on Figure 4 Monitoring well installation, well development, and groundwater sample collection details are discussed in the following sections.

3.3.1 Monitoring Well Installation

The monitoring wells will be installed following the advancement of soil borings MW-1 through MW-4 with a rotary drill rig. Each well boring will be advanced into upper most water bearing zone. 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 each borehole and a silica sand filter pack (size #0) will be installed from the base of the well to a maximum of two (2)-feet above the top of the screen. A bentonite chip seal will then be installed and allowed to hydrate sufficiently to mitigate the potential for downhole grout contamination. The newly installed monitoring wells will be completed with keyed-alike locks, a lockable J-plug, and a steel flush mounted road box.

Drill cuttings will be spread on-Site unless gross contamination (i.e., visible product) is encountered, in which case they will be placed in sealed NYSDOT-approved drums and labeled for subsequent characterization and disposal, if necessary.

3.3.2 Well Development

After installation, but not within 24 hours, newly installed monitoring wells will be developed in accordance with Benchmark-TurnKey and NYSDEC protocols. Development of the monitoring wells will be accomplished with dedicated disposable polyethylene bailers via surge and purge methodology. Field parameters including pH, temperature, turbidity, dissolved oxygen, oxidation-reduction potential (ORP) and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they became 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 discharged to the ground surface in the vicinity of the monitoring well being developed. If impacts are noted during development including odors, sheen, light non-aqueous phase liquid (LNAPL), dense non-aqueous phase liquid (DNAPL), well development water will be containerized in NYSDOT-approved drums and labeled per monitoring well location. 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.

3.3.3 Groundwater Sample Collection

Prior to sample collection, static water levels will be measured and recorded from the on-Site monitoring wells to facilitate the preparation of a Site-wide isopotential map. Following water level measurement, field personnel will purge 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 field parameters 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 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. Upon stabilization of field parameters, groundwater samples will be collected and analyzed as discussed below.

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 pump 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.

- **Polyethylene Disposable Bailer**

  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 polyethylene disposable bailer via direct grab. In general, a bottom filling dedicated polyethylene bailer is attached to a length of dedicated hollow-braid polypropylene 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 well volumes) or to dryness. Measurements for pH, temperature, specific conductance, dissolved oxygen 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, dissolved oxygen, turbidity and water level, as well as visual and olfactory field observations will be recorded. All collected 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.

3.3.4 Groundwater Sample Analyses

The four (4) groundwater wells will be sampled for Target Compound List (TCL) plus CP-51 List VOCs (including TICs), TCL SVOCs, Target Analyte List (TAL) Metals, PCBs, pesticides and herbicides. 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.

Two (2) monitoring well locations (one upgradient and one downgradient based on the RI) will be selected for emerging contaminant sampling as part of the NYSDEC's State-wide initiative to better understand the risk posed by 1,4-dioxane and per- and polyfluoroalkyl substances (PFAS).

3.4 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 5.0) 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.

3.5 Decontamination and 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-TurnKey's field operating procedures presented in Appendix E. All 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 drilling spoils, groundwater, decontamination rinse water, or other Investigative-Derived Waste (IDW) not exhibiting gross contamination (i.e., visible product, odor, sheen, etc.) will be either returned to the borehole from which it was removed (soil/fill) or discharged to the ground surface (groundwater and rinse water). IDW materials exhibiting gross contamination will be placed in sealed NYSDOT-approved drums and labeled for subsequent characterization and disposal. All generated IDW drums will be labeled alpha-numerically with regard to contents, origin, and date of generation using a paint stick marker on two sides and the top of each drum. Characterization analytical results of containerized IDW material will be used to determine if spoils can be returned to the ground surface, utilized on-Site, or require treatment and/or off-Site disposal. Drums will be securely staged on-site pending characterization 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.

3.6 Site Mapping

A Site map will be developed during the field investigation. Sample points and relevant Site features will be located on the map. Benchmark-TurnKey will employ a handheld GPS unit to identify the locations of soil borings and monitoring wells relative to State planar grid coordinates. Monitoring well elevations will be measured by Benchmark-TurnKey'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. Maps will be provided with the RI report.

3.7 Documentation

Remedial Investigation and IRM field activities will be documented in a Project Field Book and/or handheld Rugged Reader® PDA. This logbook/PDA will 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 (see Appendix C):

- Chain of Custody Form (per selected laboratory)
- Equipment Calibration Log
- Field Activity Daily Log (FADLs)
- Field Borehole/Monitoring Well Log
- Groundwater Field Form
- Investigative-Derived Waste Container Log (if necessary)
- Photographic Log
- Real-Time Air Monitoring Log

- Tailgate Safety Meeting Form
- Test Pit Excavation Log
- Problem Identification Report (as necessary)
- Corrective Measures Report

4.0 INTERIM REMEDIAL MEASURES

An IRM will be completed to address known environmental concerns previously identified (pVOC and metal impacts) and other environmental concerns identified during the RI to expedite remedial activities and overall project schedule. Specifically, the planned IRM will address the petroleum- and metals-impacted soil/fill present at the Site with contaminants present above the Part 375 USCOs as well as remove the USTs (gasoline, waste oil, heating oil), ASTs, pump islands and associated piping, hydraulic lifts, and drums.

This Work Plan includes planned IRM activities based on current information and may be modified, subject to NYSDEC approval, after the RI fieldwork is completed. The planned IRM includes the following tasks:

- Building demolition;
- Removal and proper disposal of the gasoline UST, waste oil UST, heat oil UST, pump island and associated piping, hydraulic lifts and drums;
- Removal and proper disposal of sediments from interior drains;
- Removal and landfill disposal of approximately 1,000 tons of petroleum- and metals-impacted soil/fill from the Site; and
- Collection of post-excavation confirmatory samples.

The collection of post-excavation confirmatory samples will be from the extent of contamination excavation and/or BCP Site limits. The results of the IRM post-excavation samples will be used to assess if contamination present at the Site extends to off-site locations.

It has been estimated that approximately 1,000 tons of soil/fill will be removed from the Site. Based on previous investigations, the depth of petroleum-impacts ranged from approximate 3 to 6 fbgs. The extent and depth of excavation (see Figure 5) may change based on the findings of the RI, actual field conditions encountered during the IRM and results of the confirmation samples. We note the full extent of contamination (i.e., impacts present beneath the building, USTs, hydraulic lifts and exterior stained soil with metals) is unknown.

The planned IRM is intended to constitute the NYSDEC-approved final remedy for the Site. We do not anticipate the need for an environmental easement or post-remedial requirements as the objective is to achieve a Track 1 Unrestricted cleanup. The final remedy for the Site will be determined in the Alternatives Analysis Report (AAR) for the project.

4.1 Building Demolition

Prior to implementation of the IRM, the Site building will be demolished to allow access to remove the interior hydraulic lifts, address the lead-impacted soil/fill along the eastern portion of the Site, and address any additional impacts identified during the RI. A pre-demolition asbestos contained material (ACM) survey will be completed prior to the demolition. If ACM is identified, it will be abated in accordance with 12 NYCRR Part 56 and properly disposed. A demolition permit will be obtained from the City of Buffalo prior to beginning the demolition work. The building and pump island will be demolished and removed. Demolition debris will either disposed of off-site or transported to a permitted recycling facility.

4.2 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 RI-IRM-AA Report.

4.3 Waste Characterization

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

4.4 Removal of Impacted Soil/Fill

The petroleum- and metals-impacted soil/fill present at the Site will be excavated and removed for proper landfill disposal, in addition to other concerns identified during the RI.

Remedial excavation work will be directed by an experienced Benchmark-TurnKey professional to remove impacted soil/fill material. A PID and visual/olfactory observations will be used to screen soil/fill materials and assist in verifying removal of impacted soil/fill. Vertical excavation will continue, as described above, until the impacted soil/fill is removed and the Part 375 USCOs are achieved. The lateral extents of the remedial excavation will be similar, unless the impacts exceed the boundary of the Site. These criteria will be satisfied unless excavation has reached the property line or NYSDEC agrees that no further excavation is required.

4.5 Excavation Confirmation Sampling

Post excavation confirmatory samples will be collected from the excavated areas, with bias toward material exhibiting evidence of visual and olfactory contamination, if remaining. Post-excavation confirmatory sample locations from the excavated areas will include samples from 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 the excavation is completed to bedrock, no bottom samples will be collected.

Samples from the excavations will be analyzed for TCL plus CP-51 list VOCs, Part 375 List SVOCs (in the petroleum-impacted areas, with NYSDEC approval based on favorable RI data) and will also include TAL metals in the metals-impacted area, in accordance with USEPA Methodology with an equivalent Category B deliverables package to facilitate data evaluation by a third-party validation expert. Tentatively Identified Compounds (TICs) analysis will be included with 20% of the post-excavation samples analyzed for VOCs and SVOCs. Expedited turnaround times may be requested for the analytical results to minimize the time that the excavation(s) remains open. Additional analytical parameters may be analyzed from post-excavation confirmatory samples, based on the results of the RI and consultation with the Department.

4.6 Soil Vapor Intrusion Evaluation

If at the completion of the IRM activities, VOC contamination is present in the overburden soil at concentration above the USCOs or present in the groundwater at concentrations above the NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Groundwater Quality and Standards (GWQS) as soil vapor intrusion (SVI) assessment will be completed.

4.7 Groundwater Management

If encountered, water removed from excavations and surface water run-in to excavations during the impacted soil removal will be handled on-site prior to discharge to the municipal sewer. 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 treatment using granular activated carbon (GAC). Following completion of excavation work, settled solids remaining in the tank and spent filter bags will be disposed of off-site.

If the accumulated waters require treatment, the spent GAC will be characterized and regenerated off-site, or disposed at a permitted disposal facility in accordance with applicable federal and state regulations. The storage tank will be decontaminated via pressure washing. Benchmark-TurnKey or the Site owner will coordinate with the City of Buffalo to obtain any necessary temporary sewer discharge permits.

4.8 Excavation Backfill

As the goal of the remedial activities is to achieve the USCOs and allow redevelopment activities begin, backfill at the Site will not likely occur until subsurface redevelopment activities are complete. Materials brought to the Site for use during redevelopment will be sampled and/or imported in accordance with DER-10 requirements.

The imported materials will be placed in accordance with redevelopment requirements to achieve design grades necessary to facility redevelopment activities (e.g., geotechnical requirements). Table 2 includes the chemical criteria for import of backfill material to the Site. Backfill will comply with DER-10 guidance.

5.0 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been prepared in support of the RI/IRM 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 as 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 USEPA's Requirements for Quality Assurance Project Plans for Environmental Data Operations (Ref. 3); the EPA Region II CERCLA Quality Assurance Manual (Ref. 4), and NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (May 2010).

5.1 Scope of the QAPP

This QAPP was prepared to provide quality assurance (QA) guidelines to be implemented during the RI/IRM 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 quality assurance and quality control 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 investigation activities, once completed, will yield data whose integrity can be defended.

QA refers to the conduct of all planned and systematic actions necessary to perform satisfactorily all 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). QA is an overview monitoring of the performance of QC activities through audits rather than first time inspections.

5.2 QAPP Organization and Responsibility

The principal organizations involved in verifying achievement of data collection goals for the 1585 Hertel Avenue Site include: the NYSDEC, NYSDOH, 1585 Hertel LLC (Volunteer), Benchmark Environmental Engineering and Science, PLLC and TurnKey Environmental Restoration, LLC (Volunteer's Consultants), the drilling subcontractor(s), the independent environmental laboratory, and the 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 the RI/IRM Work Plan 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 all QA documentation collected during brownfield cleanup construction and to confirm that the QA Plan was followed.

5.2.2 Volunteer

1585 Hertel 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 environmental consultant and/or legal counsel. The Applicants 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 Environmental Engineering & Science, PLLC (Benchmark) in association with TurnKey Environmental Restoration, LLC (TurnKey), are the prime engineering and scientific consultants, respectively, on this project and are 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 or TurnKey'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.

- *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):* *Christopher Boron*

  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:* *Christopher Boron*

  The Field Team Leader (FTL) has the responsibility for implementation of specific project tasks identified at the Site, 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-TurnKey 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:* *Lori E. Riker*

  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 all sample results from the analytical laboratory.

5.4 Field Responsibilities

Benchmark-TurnKey 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. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

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 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 4).

The general level of QC effort will be 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 site-specific MS/MSD or MS/Duplicate for every 20 or fewer investigative samples of a given matrix. One 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

Methods and protocol to be used to collect environmental samples (i.e., soil and groundwater) for this investigation are described in the Benchmark-TurnKey Field Operating Procedures (FOPs), summarized on Table 4 and presented electronically in Appendix E.

The number and types of environmental samples to be collected is summarized on Table 1. Sample parameter lists, holding times and sample container requirements are summarized on Table 3. The sampling program and related site activities are discussed below. 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, the 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 section and FOPs for Sampling, Labeling, Storage, and Shipment, located in Appendix E, describe procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory.

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 all 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 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, 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, 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

All 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

The Department may split any soil or groundwater samples at the Department's expense, during this RI/IRM. Benchmark-TurnKey personnel will cooperate with the Department 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.

FOPs located in Appendix E 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 FOPs located in Appendix E. A summary of the FOPs is presented on Table 4.

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 identified in Appendix E. The performance of all field activities, calibration checks on all field instruments at the beginning of each day of use, manual checks of field calculations, checking for transcription errors and review of field log books 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 from the USEPA's Contract Laboratory Program (CLP) *National Functional Guidelines for Organic Data Review* (Ref. 5), and Contract Laboratory Program, *National Functional Guidelines for Inorganic Data Review* (Ref. 6). 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. All 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 all data to determine whether deliverables specified in this QAPP are present. The reviewer will determine whether all required items are present and request copies of missing deliverables.

6.0 INVESTIGATION SUPPORT DOCUMENTS

6.1 Health and Safety Protocols

Benchmark-TurnKey has prepared a Site-Specific Health and Safety Plan (HASP) for use by our employees in accordance with 40 CFR 300.150 of the NCP and 29 CFR 1910.120. The HASP, provided in Appendix D, 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 and IRM. A member of the field team will be designated to serve as the on-site Health and Safety Officer throughout the field program. This person will report directly to the Project Manager and the Corporate Health and Safety Coordinator. 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 the RI and IRM activities at the Site. A CAMP is included within Benchmark-TurnKey's HASP (see HASP Appendix D). Particulate and VOC monitoring will be performed along the downwind perimeter of the work area during subgrade excavation, grading and soil/fill 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 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).

6.2 Citizen Participation Activities

NYSDEC will coordinate and lead community relations throughout the course of the project. Benchmark-TurnKey will support NYSDEC's community relations activities, as necessary. A Citizen Participation Plan will be prepared by TurnKey and submitted to NYSDEC under separate cover. 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.

7.0 REPORTING AND SCHEDULE

Upon completion of the RI and IRM fieldwork, a comprehensive RI/IRM/AAR will be completed summarizing the RI and IRM tasks completed as described below.

7.1 Remedial Investigation Reporting

The RI section of the RI/IRM/AA report will include the following information and documentation, consistent with the NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (May 2010).

- Introduction and background;
- A description of the site and the investigation areas;
- A description of the field procedures and methods used during the RI;
- The collection of geospatial data and presentation of investigation drawings detailing the investigation locations, IRM activities, potential areas of concern, presence of buildings, and subgrade utilities.
- 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 investigations, considered by Benchmark-TurnKey to be of useable quality, including geochemical data, field measurements, validated analytical results, etc.;
- Comparative criteria that may be used to calculate cleanup levels during the AA process, such as NYSDEC Soil Cleanup Objectives 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 on-site and off-site qualitative human health and environmental exposure assessment, completed in accordance with DER-10; and
- Supporting materials for RI data. These will include boring logs, monitoring well construction diagrams, laboratory analytical reports, and similar information.

In addition, Benchmark-TurnKey will require third-party analytical data review by a qualified, independent data validation expert for the RI and historic investigation data.

Specifically, a Data Usability Summary Report (DUSR) will be prepared, with appropriate data qualifiers added to the results. The DUSR will follow NYSDEC format per the NYSDEC's September 1997 DUSR guidelines and May 2010 DER-10 guidance. The DUSR and any necessary qualifications to the data will be appended to the RI report.

7.2 IRM Reporting

A qualified environmental professional (QEP) will be on-Site to document 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;
- 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 all 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.

7.3 Alternatives Analysis Report

An AAR is typically developed to provide a forum for evaluating and selecting a recommended remedial approach, in accordance with DER-10. However, the planned IRM will effectively remove contaminants from the Site. If additional contamination is discovered during RI site characterization activities, the AAR may need to evaluate additional remedial measures beyond the IRM activities (e.g., additional soil removal and/or cover placement). If the IRM effectively removes site contaminants, the AAR will evaluate the IRM as the final remedy.

A list of remedial action objectives will be developed based on findings of the RI and IRM and 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 remedial action objectives 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 response actions will form the foundation for the development and screening of applicable remedial alternatives against the following criteria as described in 6NYCRR 375-1.8(f) and DER-10-4.2:

- Overall Protection of Human Health and the Environment
- Compliance with Standards, Criteria, & Guidance (SCGs)
- Long-term Effectiveness & Permanence
- Reduction of Toxicity, Mobility, or Volume
- Short-term 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 action. 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.

8.0 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.

9.0 REFERENCES

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

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

3. U.S. Environmental Protection Agency. *Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5).* October 1998.

4. U.S. Environmental Protection Agency, Region II. *CERCLA Quality Assurance Manual, Revision I.* October 1989.

5. U.S. Environmental Protection Agency. National Functional Guidelines for Organic Data Review (EPA-540/R-94-012), 1994a.

6. U.S. Environmental Protection Agency. National Functional Guidelines for Inorganic Data Review (EPA-540/R-94-013), 1994b.

TABLES

TABLE 1

SAMPLING AND ANALYSIS PLAN

RI/IRM WORK PLAN

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

Matrix	Investigation Location		Estimated Number of Samples	Full List VOCs [1,4]	TCL SVOCs [4]	TAL Metals	PCBs	Pesticides	Herbicides
	SB-1/MW-1	Subsurface Soil/Fill	2	2	2	2	1	1	1
	SB-2/MW-2		2	2	2	2	1	1	1
	SB-3/MW-3		2	2	2	2	1	1	1
	SB-4/MW-4		2	2	2	2	1	1	1
	SB-5		2	2	2	2	1	1	1
	SB-6		2	2	2	2	1	1	1
	SB-7		2	2	2	2	1	1	1
	SB-8		2	2	2	2	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 & AIR SAMPLES:				**19**	**19**	**19**	**11**	**11**	**11**

Matrix	Investigation Location		Estimated Number of Samples	Full List VOCs	TCL SVOCs	TAL Metals	PCBs	Pesticides	Herbicides
Groundwater	MW-1	Northeast	1	1	1	1	1	1	1
	MW-2	Nortwest	1	1	1	1	1	1	1
	MW-3	Southwest	1	1	1	1	1	1	1
	MW-4	Southeast	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
	Submersible Pump	Equipment Blank	1	1	1	1	1	1	1
TOTAL GROUNDWATER SAMPLES:				**8**	**8**	**8**	**8**	**8**	**8**

Notes:

1. Full List VOCs = TCL plus CP-51 List VOCs via Method 8260.
2. All locations shall be sampled and archived by the laboratory for potential analysis / reanalysis.
3. GW field parameters including: pH, specific conductance, temperature, DO, ORP, and turbidity will be collected and recorded.
4. Tentatively Identified Compounds (TICs) analysis will be included with 20% of the RI samples collected for VOC and SVOC analysis.

Acronyms:

VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds
TCL = Target Compound List
TAL = Target Analyte List
PCBs = Polychlorinated Biphenyls

TABLE 2

CRITERIA FOR USE OF OFF-SITE SOIL

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

Parameter	Allowable Concentration for Use of Off-Site Soil[1]
Volatile Organic Compounds (mg/kg)	
1,1,1-Trichloroethane	0.68
1,1-Dichloroethane	0.27
1,1-Dichloroethene	0.33
1,2-Dichlorobenzene	1.1
1,2-Dichloroethane	0.02
1,2-Dichloroethene(cis)	0.25
1,2-Dichloroethene(trans)	0.19
1,3-Dichlorobenzene	2.4
1,4-Dichlorobenzene	1.8
1,4-Dioxane	0.1
Acetone	0.05
Benzene	0.06
Butylbenzene	12
Carbon tetrachloride	0.76
Chlorobenzene	1.1
Chloroform	0.37
Ethylbenzene	1
Hexachlorobenzene	0.33
Methyl ethyl ketone	0.12
Methyl tert-butyl ether	0.93
Methylene chloride	0.05
Propylbenzene-n	3.9
Sec-Butylbenzene	11
Tert-Butylbenzene	5.9
Tetrachloroethene	1.3
Toluene	0.7
Trichloroethene	0.47

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TURNKEY
ENVIRONMENTAL
RESTORATION, LLC

TABLE 2

CRITERIA FOR USE OF OFF-SITE SOIL

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

Parameter	Allowable Concentration for Use of Off-Site Soil[1]
Volatile Organic Compounds (mg/kg)	
Trimethylbenzene-1,2,4	3.6
Trimethylbenzene-1,3,5	8.4
Vinyl chloride	0.02
Xylene (mixed)	0.26
Semi-Volatile Organic Compounds (mg/kg)	
Acenaphthene	20
Acenaphthylene	100
Anthracene	100
Benzo(a)anthracene	1
Benzo(a)pyrene	1
Benzo(b)fluoranthene	1
Benzo(g,h,i)perylene	100
Benzo(k)fluoranthene	0.8
Chrysene	1
Dibenz(a,h)anthracene	0.33
Fluoranthene	100
Fluorene	30
Indeno(1,2,3-cd)pyrene	0.5
m-Cresol(s)	0.33
Naphthalene	12
o-Cresol(s)	0.33
p-Cresol(s)	0.33
Pentachlorophenol	0.8
Phenanthrene	100
Phenol	0.33
Pyrene	100

Benchmark Environmental Engineering & Science, PLLC

TurnKey Environmental Restoration, LLC

TABLE 2

CRITERIA FOR USE OF OFF-SITE SOIL

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

Parameter	Allowable Concentration for Use of Off-Site Soil[1]
Metals (mg/kg)	
Arsenic	13
Barium	350
Beryllium	7.2
Cadmium	2.5
Chromium, Hexavalent[2]	1
Chromium, Trivalent[2]	30
Copper	50
Cyanide	27
Lead	63
Manganese	1600
Mercury (total)	0.18
Nickel	30
Selenium	3.9
Silver	2
Zinc	109
PCBs/Pesticides (mg/kg)	
2,4,5-TP Acid (Silvex)	3.8
4,4'-DDE	0.0033
4,4'-DDT	0.0033
4,4'-DDD	0.0033
Aldrin	0.005
Alpha-BHC	0.02
Beta-BHC	0.036
Chlordane (alpha)	0.094
Delta-BHC	0.04
Dibenzofuran	7
Dieldrin	0.005
Endosulfan I	2.4
Endosulfan II	2.4

TABLE 2

CRITERIA FOR USE OF OFF-SITE SOIL

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

Parameter	Allowable Concentration for Use of Off-Site Soil[1]
PCBs/Pesticides (mg/kg)	
Endosulfan sulfate	2.4
Endrin	0.014
Heptachlor	0.042
Lindane	0.1
Polychlorinated biphenyls	0.1

Notes:

1. Values per 6NYCRR Part 375 Table 375-6.8(a)
2. The SCO for Hexavalent or Trivalent Chromium is considered to be met if the analysis for the total species of this contaminant is below the specific SCO for Hexavalent Chromium.

TABLE 3

SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS

1585 HERTEL AVENUE 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
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

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
SVOCs = Semi-Volatile Organic Compounds
TCL = Target Compound List
TAL = Target Analyte List
WMG = Wide Mouth Glass

TABLE 4

SUMMARY OF FIELD OPERATING PROCEDURES

REMEDIAL INVESTIGATION / INTERIM REMEDIAL MEASURES WORK PLAN

1585 HERTEL AVENUE SITE

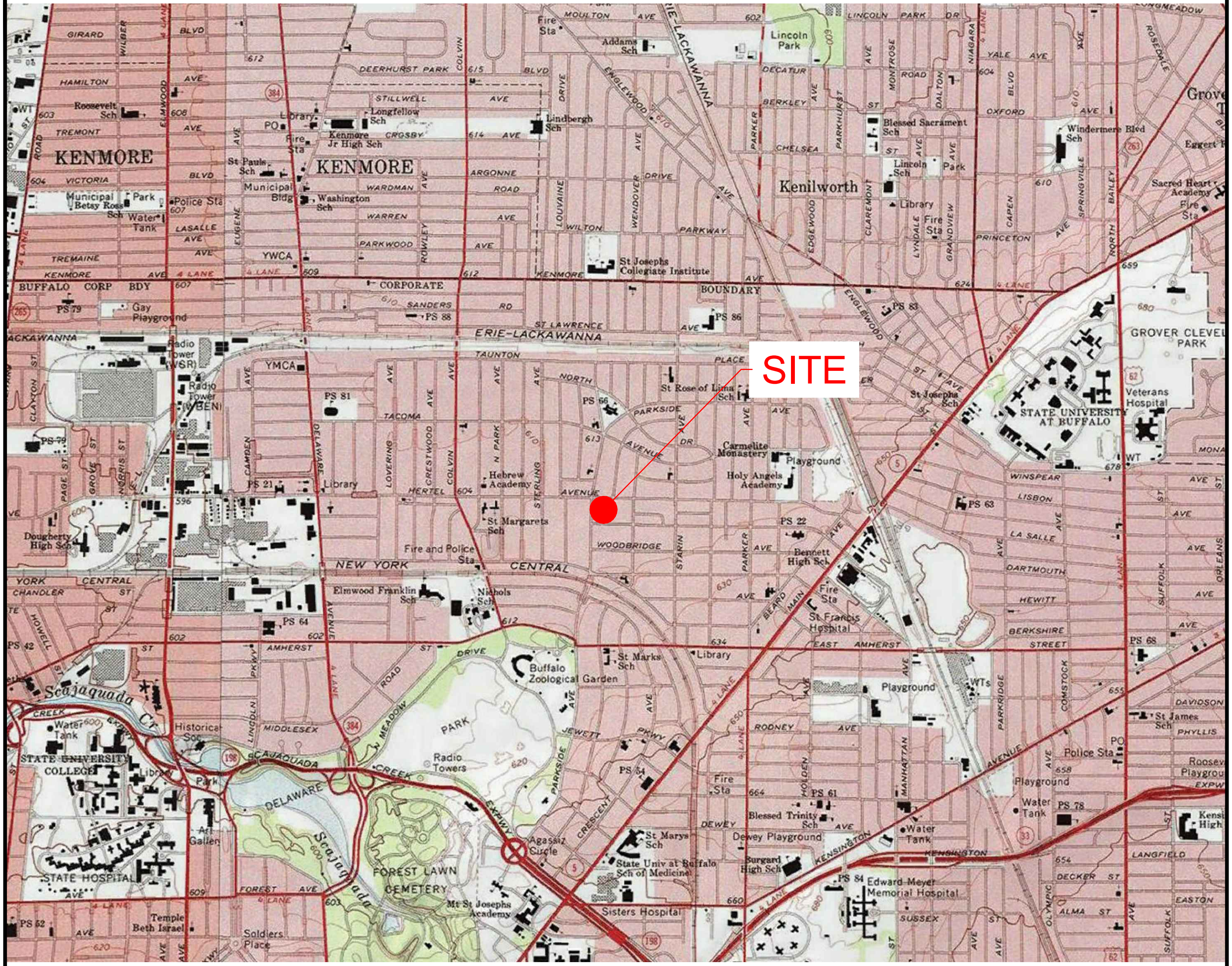
BUFFALO, NEW YORK

FOP No.	Procedure
001.1	Abandonment of Borehole Procedures
002.0	Abandonment of Monitoring Wells 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
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 Impacted Soil Removal Activities
054.2	Soil Description Procedures Using The Visual-Manual Method
058.0	Split-Spoon Sampling Procedures
063.2	Surface and Subsurface Soil Sampling Procedures
065.1	Test Pit Excavation and Logging Procedures
073.2	Real-Time Air Monitoring During Intrusive Activities
078.0	Geoprobe Drilling Procedure
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

FIGURES

F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 1 - Site Location and Vicinity Map.dwg

FIGURE 1



3,000' 0' 3,000' 6,000'

SCALE: 1 INCH = 3,000 FEET
SCALE IN FEET
(approximate)

N

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: B0437-017-001

DATE: DECEMBER 2017

DRAFTED BY: CMS-CMC

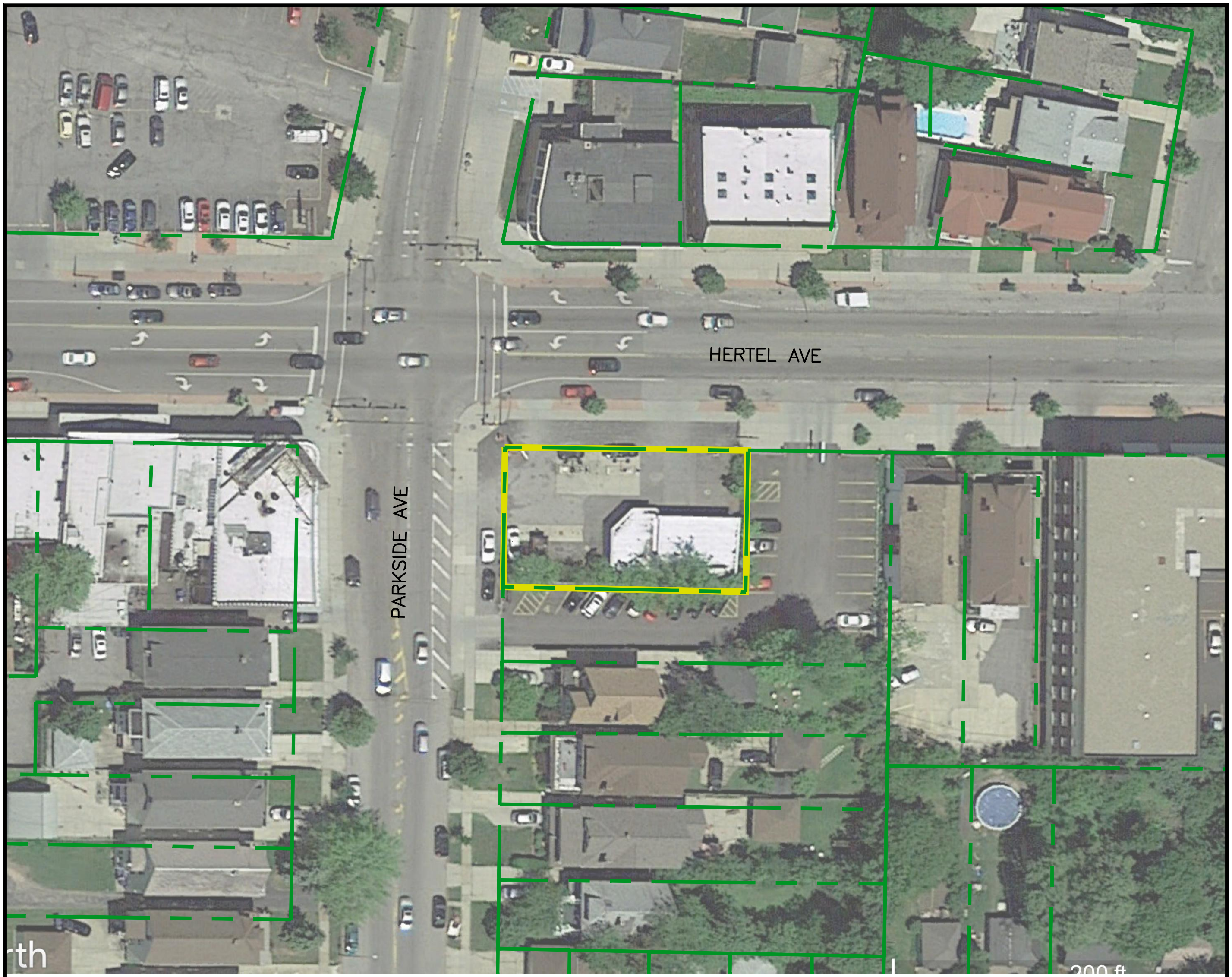
SITE LOCATION AND VICINITY MAP

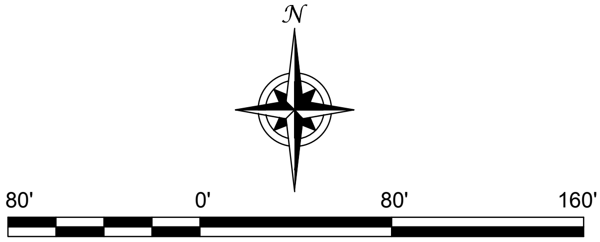
BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 2; Site Plan (Aerial).dwg

FIGURE 2





SCALE: 1 INCH = 80 FEET
SCALE IN FEET
(approximate)

LEGEND:

▬	BCP SITE BOUNDARY
— - - — - - —	PARCEL BOUNDARY

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-017-001

DATE: DECEMBER 2017

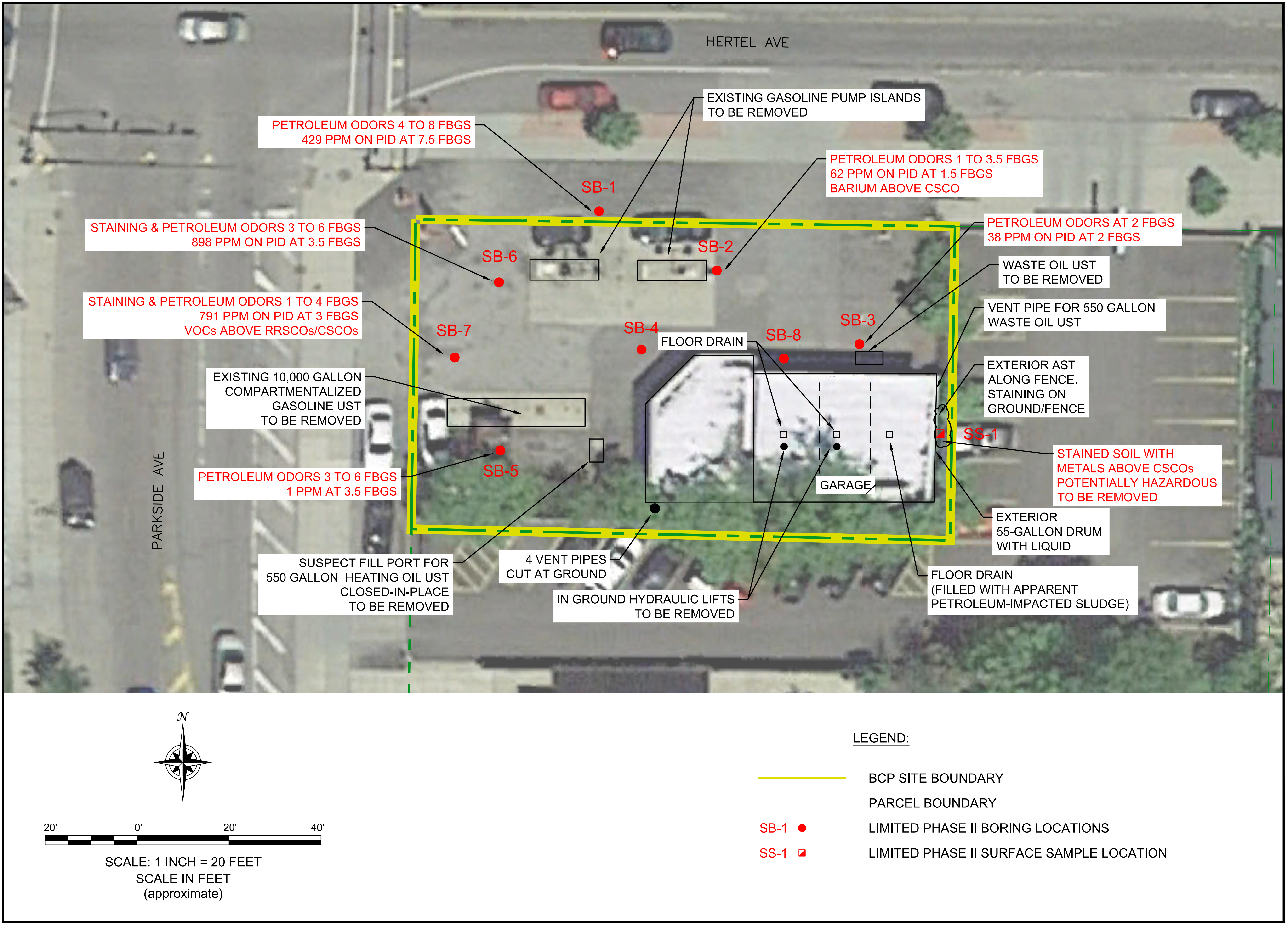
DRAFTED BY: CMC

SITE PLAN (AERIAL)

BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 3; Site Plan with Phase I ESA RECs and Limited Phase II Boring Locations.dwg



DATE: DECEMBER 2017
DRAFTED BY: CMC

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

JOB NO.: 0437-017-001

SITE PLAN WITH PHASE I ESA RECs & AREAS OF IMPACTS

BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

PREPARED FOR
1585 HERTEL LLC

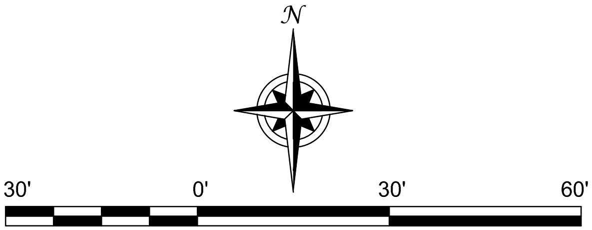
FIGURE 3

DISCLAIMER:
PROPERTY OF BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC. 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 ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC.

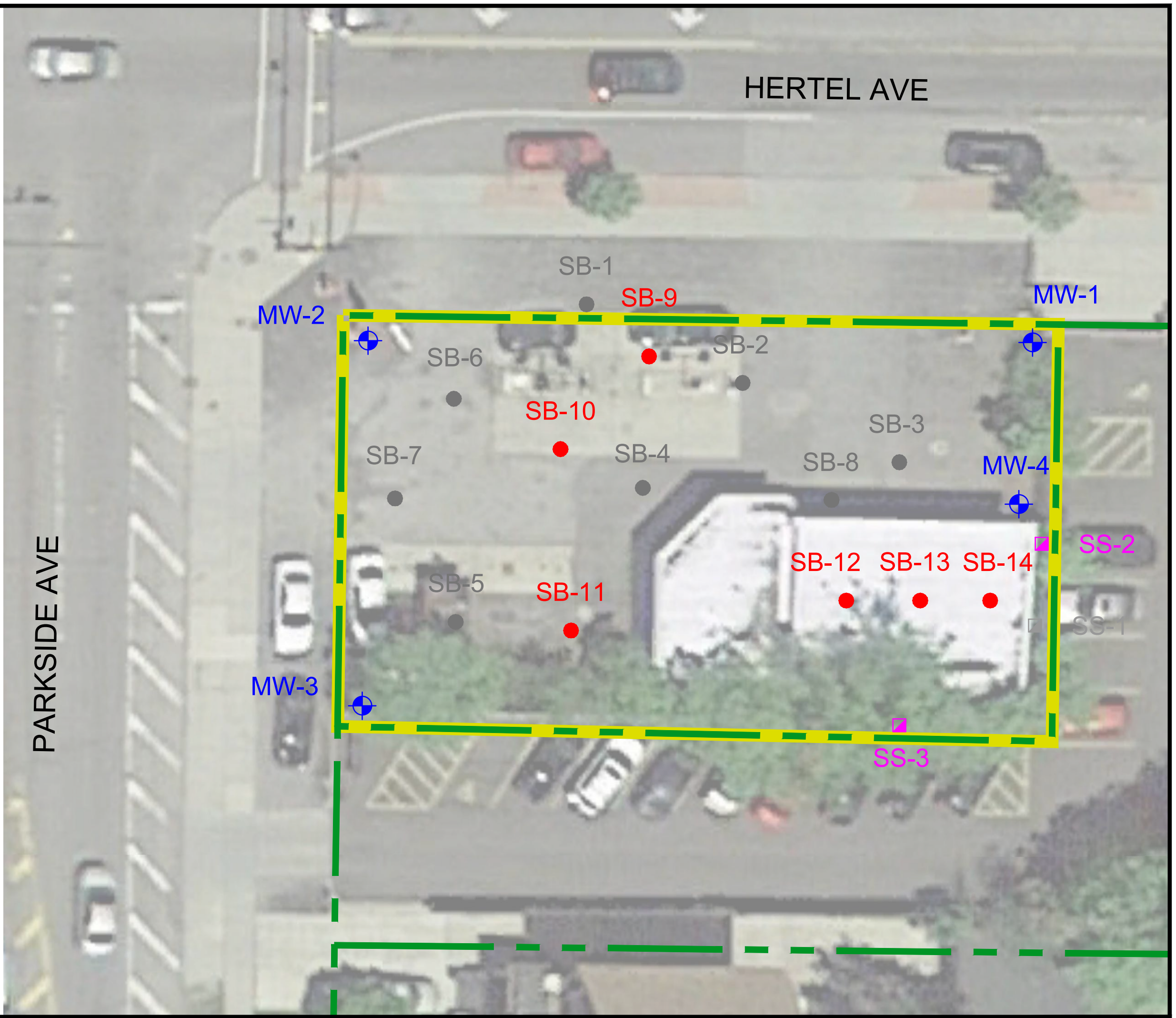
F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 4; Proposed Remedial Investigation Boring Locations.dwg

LEGEND:

🟨	PROPERTY BOUNDARY
🟩	PARCEL BOUNDARY
SB-1 ●	PHASE II SOIL BORING
SS-1 ◪	PHASE II SURFACE SOIL SAMPLE
MW-1 ⊕	RI SOIL BORING/MONITORING WELL
SB-1 ●	RI SOIL BORING
SS-3 ◪	RI SURFACE SOIL SAMPLE



SCALE: 1 INCH = 30 FEET
SCALE IN FEET
(approximate)



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-001-002

DATE: APRIL 2018

DRAFTED BY: RFL-CMC-CCB

PROPOSED REMEDIAL INVESTIGATION LOCATIONS

BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

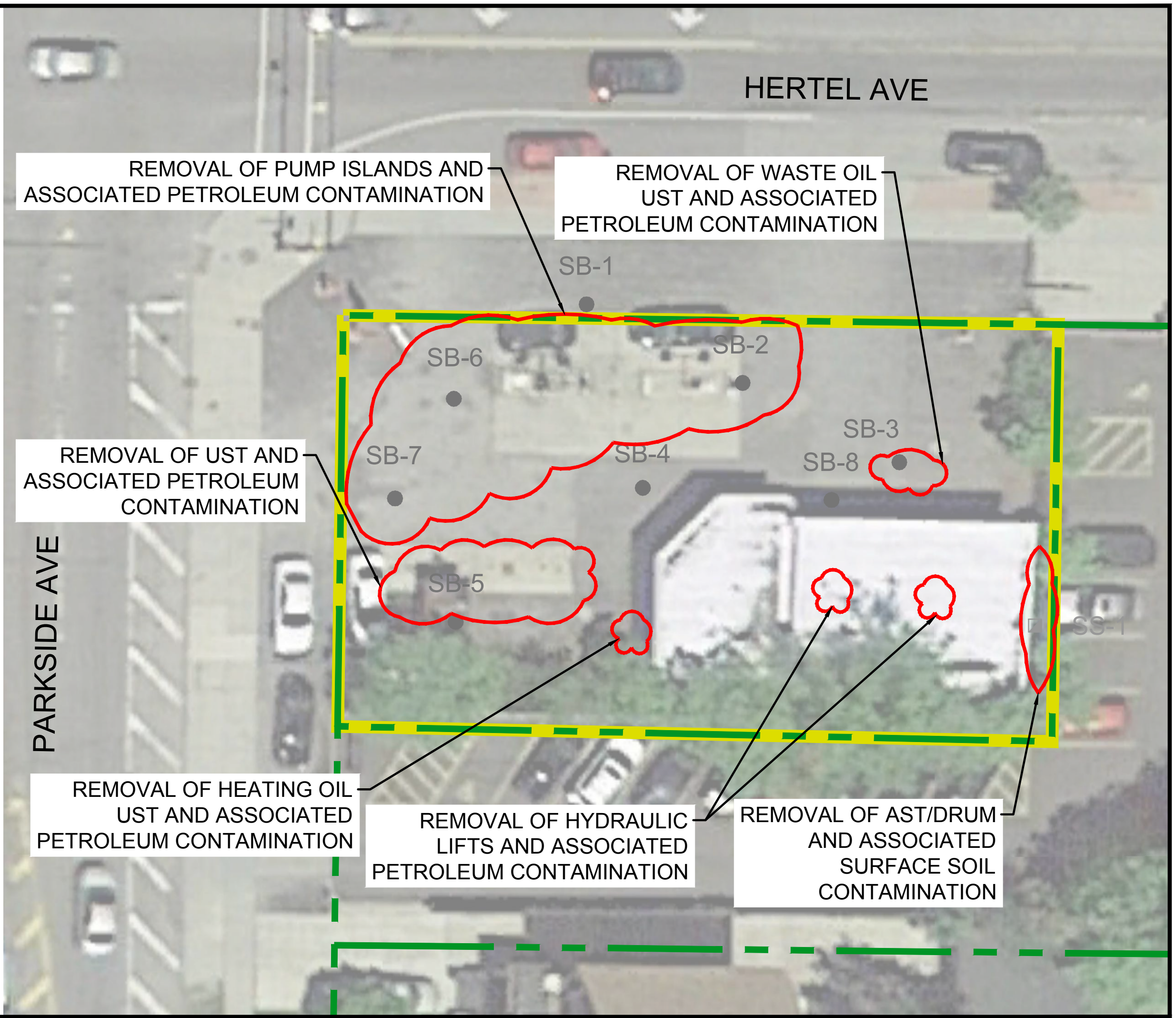
1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

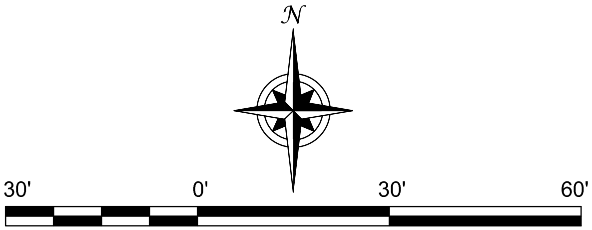
FIGURE 4

F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 5; Areas of Remedial Action.dwg

LEGEND:

━━━━	PROPERTY BOUNDARY
━ · · ━ · · ━	PARCEL BOUNDARY
SB-1 ●	SOIL BORING
SS-1 ◪	SURFACE SOIL SAMPLE





SCALE: 1 INCH = 30 FEET
SCALE IN FEET
(approximate)

BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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

PROJECT NO.: 0437-001-002

DATE: DECEMBER 2017

DRAFTED BY: RFL-CMC-CCB

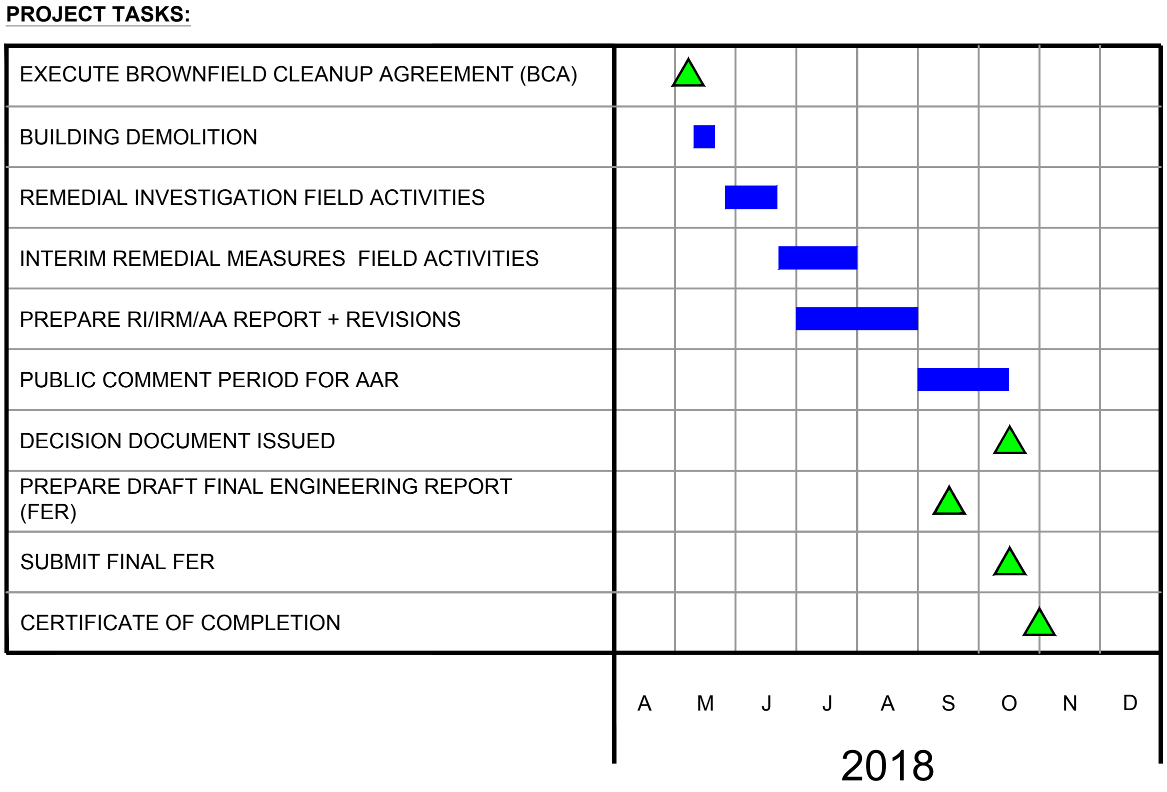
AREAS OF REMEDIAL ACTION

BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

FIGURE 5

F:\CAD\Benchmark\1585 Hertel LLC\2 - RI-IRM Work Plan\Figure 6; Preliminary Project Schedule.dwg



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-017-001

DATE: APRIL 2018

DRAFTED BY: CMC

PRELIMINARY PROJECT SCHEDULE

BROWNFIELD CLEANUP PROGRAM
RI-IRM-AA WORK PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

FIGURE 6

APPENDIX A

RESUMES OF PROJECT PERSONNEL

THOMAS H. FORBES, P.E.
PRINCIPAL ENGINEER

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.

CHRISTOPHER Z. BORON
SENIOR PROJECT MANAGER

EDUCATION

Bachelors of Science (Geology) 1995; State University of New York, College at Fredonia

REGISTRATION AND AFFILIATIONS

Certified Professional Geologist #11624, American Institute of Professional Geologists, 2013
Hazardous Waste Safety Training (OSHA) – 1999
Annual Hazardous Waste Safety Refresher Training (OSHA) - 2000-Present

SUMMARY OF EXPERIENCE

Mr. Boron has 16 years of experience in the environmental field on a variety of projects involving environmental assessment, investigation and remediation, as well as geotechnical engineering within various regulatory programs. His experience includes Phase I and II Environmental Site Assessments (ESAs) for property transaction due diligence following ASTM 1597-13 and USEPA All Appropriate Inquiry (AAI); vapor intrusion investigations of industrial, commercial and residential structures following New York State Department of Health (NYSDOH) guidance for evaluating soil vapor intrusion into buildings; all aspects of remedial investigations, feasibility studies/alternatives analysis and site remediation under NYSDEC Inactive Hazardous Waste Site (Superfund) Program, Voluntary Cleanup Program, New York State Brownfield Cleanup Program and Environmental Restoration Program; all aspects of investigation and remediation involving petroleum spill sites regulated by the New York State Department of Environmental Conservation (NYSDEC) Petroleum Spills Division; solid waste facility construction management and construction quality assurance monitoring and testing following the NYSDEC Division of Solid Waste regulations.

REPRESENTATIVE PROJECT EXPERIENCE

July 2014 to Present: **TurnKey Environmental Restoration, LLC**

- **Brownfield Cleanup Program Project, Former Millard Fillmore Gates Hospital, City of Buffalo, New York.** A local development group has taken ownership of the former Millard Fillmore Gates Hospital for redevelopment. The Site was accepted in to the NYSDEC Brownfield Cleanup Program in February 2013 and a remedial investigation work plan has been prepared and accepted by NYSDEC. Remedial investigation activities are expected to begin in August 2014. My responsibilities will include oversight of the remedial investigation, implementation of remedial actions and preparation of the NYSDEC required reporting documents.

September 1998 to July 2014: **GZA GeoEnvironmental of New York**

- **Brownfield Cleanup Program Project, Central Park Plaza, City of Buffalo, New York**. A local developer obtained access to complete a Phase I and II ESA at the dilapidated Central Park Plaza, a vacant 27 acre commercial facility on the east side of the City of Buffalo. Contaminants identified during the investigation allowed the property to be accepted in to the BCP. Once in the BCP, a RI was complete under approved work plans which identified extensive backfilling of the former Buffalo Cement Co. Ltd. quarry which operated from 1877 to 1948. The Central Park Plaza was constructed in 1958 and in operation until 2011. The Remedial Investigation/Alternative Analysis report, along with the Remedial Action Work Plan (RAWP) were completed and submitted to NYSDEC for review in June 2014. As Project Manager, I was responsible for the oversight of the Phase I/II ESA, BCP application, preparation of the BCP work plans, oversight of the RI activities and preparation of the RI/AA Report and RAWP.

- **Environmental Restoration Project, Batavia Iron & Metal, City of Batavia, New York.** This project involved vacant industrial property previously used to reclaim iron, metal and wire materials. As Project Manager, responsibilities included negotiating the scope of work, developing the work plan, budget preparation, on-Site and off-Site soil and groundwater sampling, IRM implementation and data analysis. A Site Investigation and Remedial Alternatives Report (SI/RAR) was prepared and approved by NYSDEC in June 2012. Due to the significant volume of contaminated soil present (over 4,000 tons of PCB and metal impacted soil), the City of Batavia opted not to foreclose and take ownership. The Proposed Remedial Action Plan (PRAP) was released in February 2013. The Record of Decision (ROD) was in released in Summer 2013 and the site was transferred in the NYSDEC Superfund Program.

- **NYSDEC Superfund & Brownfield Cleanup Programs, Confidential Automotive Components Manufacturer, Lockport, New York.** Assisted an automotive parts manufacturing facility with various environmental issues at their facility for the over 15 years. Responsibilities have included:

    - Completing a Remedial Investigation and Feasibility Study (RI/FS) for a trichloroethylene (TCE) and tetrachloroethene (PCE) plume migrating in bedrock groundwater from a former AST spill. The RI/FS Reports were approved by NYSDEC, a Record of Decision (ROD) has been issued and the remedial alternative selected based on the FS is Monitored Natural Attenuation (MNA). The Record of Decision was issued by NYSDEC in March 2005 identifying monitored natural attenuation as the groundwater remedy. The MNA groundwater sampling has been conducted annually since 2005. The Site Management Plan (September 2011) and Final Engineering Report (March 2012) were approved by NYSDEC and the Certificate of Completion was issued in March 2012.

    - Application and acceptance of three individual sites of the 342 acre facility into the NYSDEC Brownfield Cleanup Program in February 2010. These sites have been investigated under NYSDEC approved work plans to assess contaminated media (soil, groundwater and indoor air) and develop remedial strategies to address the various impacted media. Based on the RI findings these three sites are currently being combined into one BCP Site. Chlorinated solvent groundwater contamination has been identified beneath and connecting the three sites.

    - Conducted a site-wide investigation of the storm sewer system to evaluate for chlorinated solvent groundwater contamination infiltration. The investigation involved: the review of existing plant drawings, collecting storm sewer structure measurements, completing video inspections and reviewing existing storm sewer videos, and storm water sampling during low-flow and high-flow events. Areas of contaminated groundwater infiltration were identified and recommendations were made to the NYSDEC for repair, with their concurrence.

  - Managed the assessment of former manufacturing and warehouse building being converted to use as vendor/supplier park. An environmental assessment identified chlorinated solvents (primarily PCE and TCE) in soil, groundwater and air samples that required remediation. After delineating the extent of soil contamination and completing a pilot-study, a soil vapor extraction and sub-slab depressurization systems (SVE/SSDS) was put into operation to remediate the soil within an approximate 14,000 square foot area and mitigate exposure to vapor intrusion from the impacted soil and groundwater. The building has been repurposed for use as a vendor/supplier park.

  - Completion and management of annual groundwater sampling and compliance reporting for their NYSDEC Major Oil Storage Facility permit.

  - Conducted a soil vapor intrusion assessment prior to the transmittal of a site building to another entity/tenant. The SVI work was completed to determine if the nearby TCE groundwater plume was impacting indoor air of the building for sale. The SVI assessment determined the nearby groundwater plume was not impacting indoor air or sub-slab vapors that required mitigation.

- **NYSDEC Brownfield Cleanup Program, Peters Dry Cleaners, Lockport, New York**. Peter’s Dry Cleaning was located in a residential neighborhood in the City of Lockport. The property was contaminated from historic dry cleaning operations conducted at the site. A Phase II ESA was conducted on the property to determine the extent of contamination in the overburden soils and groundwater. An IRM was undertaken to remove an abandoned UST and associated petroleum contamination. Tetrachloroethene (PCE) contaminated soil was also encountered during the IRM, which changed the IRM waste profile. Peter’s Dry Cleaning entered into the Brownfield Cleanup Program (BCP) in February 2007. NYSDEC Approved work plans were prepared that included the installation of bedrock groundwater monitoring wells, soil probes to delineation off-site soil and groundwater contamination and vapor intrusion sampling at the subject property and adjoining residential structures. The Site Investigation/Remedial Alternative Report was prepared and submitted to NYSDEC. The property owner opted to leave the BCP program and allow NYSDEC take on the responsibility of remediation, which will be completed under the NYS Superfund Program. My responsibilities as project manager included the oversight of the remedial investigation, remedial alternative evaluation/analysis and report preparation.

- **NYSDEC Order on Consent, Remedial Investigation & Feasibility Study, Confidential Client, Dunkirk, New York –** During a building expansion for the installation of a new rotoforge press, and under the guidance of the Site Management Plan, polychlorinated biphenyls (PCBs) were detected in soil and free product was encountered. Under an Order on Consent with the NYSDEC, an RI, IRM and FS were initiated. The IRM entailed the excavation and removal of approximately 6,000 tons of PCB-impacted soil at hazardous levels. The RI/IRM/FS Report has been approved by NYSDEC. A Site Management Plan was developed and approved to ensure institutional and engineering controls are monitored and maintained. My responsibilities as project manager included the oversight of the remedial investigation, preparation of the RI/FS report and SMP.

- **NYSDEC Spills Program, Contract to Closure, Remedial Activities, Commercial Facility, Rochester, New York.** Soil and groundwater at two adjacent properties have been contaminated with petroleum from former gasoline stations which occupied the properties as far back as the early 1950’s.

The client wanted to develop the Site for commercial use as a credit union. Site activities included soil and groundwater sampling investigations, building demolition, preparation of NYSDEC approved work plan to remediate the soil and groundwater, removed soil impacted with free product, performed in-situ chemical oxidation injections to remediate Site groundwater to achieve NYSDEC inactive status. My responsibilities included performing the Site investigations, work plan and budget preparation, remedial implementation of the chemical injections, confirmatory sampling and closure report preparation. The Site received an "inactive" status from NYSDEC and a Credit Union facility had been constructed.

- **Voluntary Cleanup - Commercial Facility, Hamburg, New York**. Responsible for investigation at multi-unit commercial facility with identified chlorinated solvent contamination from a former dry cleaner in one of the units. Tetrachloroethene (PCE) was identified in soil and groundwater samples at the facility at concentrations exceeding NYSDEC regulatory standards. A source area, likely a former drum storage area, was identified outside the building in the shallow soil in the alleyway. Shallow and deep groundwater samples identified shallow groundwater contamination, but a clay confining layer appeared to limit the depth of the contamination. An IRM was completed which included soil removal and disposal and the installation of sub-slab vapor mitigation system to prevent contaminated vapor intrusion into the building.

- **NYSDEC Superfund Standby Contract, Remedial Investigation, Grove Cleaners, Hewlett, New York.** Groundwater at a former dry cleaners site was contaminated with chlorinated solvents. As part of a Remedial Investigation performed a comprehensive gas chromatograph field screening of subsurface soils and groundwater samples to delineate the source of contamination during the on-site characterization studies and collected groundwater samples during off-Site characterization. Responsible for conducting an existing monitoring well assessment, groundwater sampling and interpretation of the hydrogeologic and analytical data for the RI report preparation. This work was completed in accordance with NYSDEC approved site- specific work plans under the NYSDEC Superfund Program.

- **NYSDEC Superfund Standby Contract, Preliminary Site Assessment, Crusher Road Site, Bedford, New York**. Site groundwater was previously found to be contaminated with PCE from an unknown source. Responsible for field investigations which identified that the source of the PCE was unauthorized disposal at the former town dump, which is currently utilized as the town highway department. Field screening with a portable gas chromatograph of subsurface soil and groundwater samples helped delineate the source of contamination during the on and off-site characterization studies.

LORI E. RIKER, P.E.

PROJECT MANAGER

EDUCATION

BASc (Civil Engineering) 1992; University of Waterloo, Ontario, Canada
MASc (Environmental Engineering) 1994; University of Guelph, Ontario, Canada

REGISTRATION AND AFFILIATIONS

Professional Engineer, New York
Certified OSHA 40-Hour Hazardous Waste Site Training
Air and Waste Management Association, Member

SUMMARY OF EXPERIENCE

Ms. Riker has 20 years of environmental and civil engineering experience that has focused on industrial regulatory compliance assistance; Phase I environmental site assessments; hazardous waste site investigations and remedial evaluations; detailed design; and construction administration. Ms. Riker's regulatory compliance experience includes: petroleum bulk storage (PBS) and chemical bulk storage (CBS) auditing and the associated spill prevention reporting; Emergency Planning and Community Right-to-Know Act (EPCRA) Tier II and Toxic Release Inventory (Form R) reporting; Title V air permitting (Title V, State facility, minor facility registrations), compliance reporting, and emission statement preparation; Resource Conservation and Recovery Act (RCRA) hazardous waste reporting; storm water permitting and preparing discharge monitoring reports (DMRs), storm water pollution prevention plans (SWPPPs), and Best Management Practices (BMP) Plans; and hazardous waste annual reporting and reduction plans. Ms. Riker's site investigation and remediation experience has been under various New York State Department of Environmental Conservation (NYSDEC) remedial programs including the: Brownfield Cleanup Program (BCP); RCRA Corrective Action Program; and Voluntary Cleanup Program (VCP).

REPRESENTATIVE PROJECT EXPERIENCE

May 2003 to Present	**Benchmark Environmental Engineering & Science, PLLC**
Nov 1997 to May 2002	**Malcolm Pirnie, Inc.**
Feb 1995 to Oct 1997	**ENVIRON Corporation**

- Assisted in the RCRA Corrective Measures Study (CMS) for the Former Bethlehem Steel Coke Oven Division Site located in Lackawanna, NY. Duties included preparing work plans for Interim Corrective Measures (ICMs); reviewing analytical data obtained for the solid waste management units (SWMUs) and water courses; reviewing reports/assessments prepared by other consultants retained by NYSDEC and other agencies; and evaluating numerous slag/fill and groundwater remedial alternatives and recommending a final remedial approach in the CMS Report.
- Assisted former steel manufacturing facility with regulatory compliance during shutdown of operations in Lackawanna, NY. Current activities for former steel manufacturing company in Lackawanna, NY include: SPDES permitting; Industrial Water System compliance, including successfully obtaining a Water Withdrawal Permit for 50 MGD and implementing required upgrades to the water metering system; and preparing annual RCRA Hazardous Waste Reports.

- Assisted with environmental regulatory compliance audits at Gibraltar Steel's NY facilities, and coordinated audits at Gibraltar Steel's other facilities nationwide. The audits covered major existing environmental regulatory programs, as well as applicable local or state regulations and potential upcoming regulatory requirements.
- Assisted in preparing numerous successful NYSDEC BCP applications for former steel plant sites and industrial/commercial properties in western NY. Prepared Remedial Investigation (RI) Work Plans, RI Reports, Remedial Action Work Plans, Final Engineering Reports, and Site Management Plans. Contaminants of concern primarily include petroleum organics/solvents and heavy metals.
- Providing/managing on-going environmental compliance assistance to scrap metal recycling facilities in NY and PA including: permitting, sampling, inspection, and reporting requirements under the Multi-Sector General Permit (MSGP) for Storm Water Associated with Industrial Activity and NYSDEC State Pollutant Discharge Elimination System (SPDES) Permits; PBS inspections and preparing SPCC Plans; EPCRA Tier II reporting; preparing landfill disposal application; preparing Water Treatment Chemical notifications; hazardous waste annual reporting; and air permitting modifications, compliance reporting, and annual emission statement preparation.
- Providing/managing on-going environmental compliance assistance to industrial facilities including: air permit applications and modifications; storm water permitting, BMP Plan/SWPPP preparation, compliance monitoring, and DMR preparation; water withdrawal and sewer metering reports; PBS registration, SPCC Plan preparation, and tank inspection; and annual hazardous waste reporting.
- Providing environmental compliance assistance to NOCO Energy Corp. for its major petroleum distribution terminal and warehouse in Tonawanda, NY and multiple retail gasoline stations in NY and VT. Specific projects include: storm water permitting and preparation of a SWPPP; preparation of Spill Response, Control & Countermeasure (SPCC) Plans and a Spill Prevention Report (SPR); Title V air permitting assistance and emission statement preparation; EPCRA Form R reporting; review of and recommendations for updating the USCG Facility Response Plan; and permitting and conceptual design for upgrades to a PBS warehouse facility.
- Served as the environmental compliance manager for a porcelain insulator manufacturing facility and completed regulatory reporting requirements including TP550 forms, Form R reports, Tier II reports, hazardous waste reports, storm water permitting, and DMRs.
- Performed environmental compliance audits of multiple retail gasoline station and lube oil shops in western NY, focusing on the NYSDEC PBS regulations, and preparing SPCC Plans and an overall BMP Plan.
- Assisted in performing environmental regulatory compliance audits for numerous active industrial facilities. Responsibilities included researching and interpreting applicable environmental regulations, and preparing reports to summarize the findings and prioritize corrective measures.
- Prepared PBS and CBS applications for tank registration under NYSDEC's bulk storage programs and prepared the associated SPCC Plans and SPRs for industrial facilities.
- Assisted in preparing an SPCC Plan for General Electric Company's Tonawanda facility. Work included review of numerous federal and state regulations pertaining to PCB-contaminated oil and waste.

PUBLICATIONS/PRESENTATIONS

- Riker, L. E., McManus, A. C., "Energize Your Business," presented at the Fall Seminar of the New York Water Environment Association, Genesee Valley Chapter, Industrial Issues Committee, Webster NY, November 1, 2001.
- Riker, L. E., McManus, A. C., Sanders, L. A., "Life After Registration: Integrating Environmental Management Systems into Business and Operating Cultures," Proceedings, 94th Annual Conference and Exhibition of the Air & Waste Management Association, Orlando FL, June 26, 2001.
- Riker, L. E., McManus, K. R., Kreuz, D. E., Mistretta, M. V., "Trash to Treasure: Revitalization of Buffalo's Waterfront," presented at a Conference of the New York State Society of Professional Engineers, Erie/Niagara Chapter, Environmental Affairs Committee, Buffalo NY, January 10, 2001.
- Secker, L. E., Talley, J. W., "Bioremediating a Buffalo Brownfield: A Comparison of Bench-Scale Soil Biotreatability Results to Full-Scale Remediation," Proceedings, Thirtieth Mid-Atlantic Industrial & Hazardous Waste Conference, Villanova University, Philadelphia PA, July 12, 1998.

MICHAEL LESAKOWSKI
SR. PROJECT MANAGER

EDUCATION

Master of Science (Environmental Engineering Science), University of Buffalo, 2008
Bachelor of Science (Biology), State University of New York at Fredonia, 1994

REGISTRATION

40-Hour OSHA Health and Safety Training
Annual 8 Hour OSHA Refreshers
ASTM Training for Commercial Property Transaction Due Diligence

SUMMARY OF EXPERIENCE

Mr. Lesakowski has over 15 years experience in the environmental consulting field at numerous industrial, commercial and hazardous waste sites throughout the northeast United States. A summary of projects Mr. Lesakowski has been involved with include all aspects of New York Brownfield Cleanup Program projects, New York State Superfund Program projects, New York Petroleum Spills Department projects, over 1,000 Phase I Environmental Site Assessments and more than 200 Phase II Site Investigations associated with property acquisition and divestiture and numerous remediation projects ranging from simple underground storage tank (UST) removals to complex groundwater remediation programs. Mr. Lesakowski is proficient in vapor intrusion modeling of chlorinated solvent and petroleum volatile organic compound (VOC) impacted sites. Mr. Lesakowski also has project management and technical consulting experience on several multi-site portfolio environmental due diligence assignments, working with purchasers and lenders to facilitate multi-million dollar real estate transactions. Prior to joining Benchmark, Mr. Lesakowski was a principal in an environmental consulting firm with offices in New York, Pennsylvania, Ohio and Maryland. Mr. Lesakowski is currently managing ten New York Brownfield Cleanup Program sites and several New York Spill Sites. He has managed assessments, investigations and remediation projects on properties with a multitude of historic uses (e.g., petroleum storage terminals, gas stations, automobile dealerships, rail yards, foundries, drycleaners, steel manufacturing, metallurgical plants, metal plating operations, junk yards), media types (surface and subsurface soil, groundwater, sediments, soil vapor, indoor air, building materials) and contaminants (e.g, VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), heavy metals).

NEW YORK BROWNFIELD CLEANUP PROGRAM EXPERIENCE

348 Langner Road Site, West Seneca, New York

- Recently completed a Remedial Investigation and Interim Remedial Measures (IRM) for a property that was formerly developed as a retail gasoline station since the 1940s. Contaminants of concern include petroleum VOCs in soil and groundwater. The IRM included removal of over 8,000-tons of petroleum-impacted soil and removal of eight underground storage tanks (USTs) and related infrastructure and piping. During the remedial work, certain soil that was not impacted was field-screened on-Site, characterized via analytical testing to show that it was not impacted with contaminants of concern, and transported off-Site to an approved destination site with permission from NYSDEC. This screening of on-site materials saved our client over 4,000 cubic yards of material that would have otherwise been sent to a landfill at significant additional cost.

285-295 Niagara Street Site, Buffalo, New York

- Recently completed a Remedial Work for a property that was formerly developed as a bicycle factory from the 1800s, and a car wash and gasoline station since the 1950s. Contaminants of concern include petroleum VOCs in soil and groundwater. The remedial work included removal of approximately 4,500-tons of petroleum-impacted soil and removal of two underground storage tanks (USTs) that were encountered during excavation. During the remedial work, certain soil that was not impacted was field-screened on-Site, characterized via analytical testing to show that it was not impacted with contaminants of concern, and re-used on-Site with permission from NYSDEC. This screening of on-site materials saved our client from disposing of clean material that would have otherwise been sent to a landfill at significant additional cost.

125 Main Street Site, Buffalo, New York

- Recently completed a Remedial Investigation for a property known as the Former Donovan building, located in the City of Buffalo, NY, which was formerly industrial and commercial site, which as filled with miscellaneous historic fill materials. Contaminants of concern include petroleum VOCs, SVOCs and metals in soil. The remedial work was started in 2012 and is expected to be completed in 2013.

301 Franklin Street Site, Olean, New York

- Recently received a certificate of completion (COC) for a NY Brownfield Program Site. As part of the project, Mr. Lesakowski managed a Remedial Investigation and Interim Remedial Measures for a property located within the ExxonMobil Legacy Site (EMSL) area, which was formerly developed as a petroleum refinery. Contaminants of concern include petroleum VOCs, SVOCs and metals in soil and VOCs and SVOCs and non-aqueous phase liquid (NAPL) in groundwater. The IRM included removal of approximately 3,000-tons of metals- and petroleum-impacted soil and removal of 5,800 linear feet of abandoned subsurface piping. Remedial work included soil excavation and disposal; removal of abandoned subsurface piping and infrastructure; installation of a soil vapor extraction system; installation of an active subslab depressurization (ASD) system in the building; and, construction of a soil cover system.

Homer Street Redevelopment Site, Olean, New York

- Recently completed Interim Remedial Measures that included removal of approximately 11,000 linear feet of abandoned subsurface piping and 48 drums of residual piping contents. A Remedial Investigation was previously completed for this property, which is located within the ExxonMobil Legacy Site (EMSL) Works #3 area, which was formerly developed as a petroleum refinery. Contaminants of concern include grossly contaminated soils impacted with tar-like material, petroleum VOCs, SVOCs and metals in soil and VOCs, SVOCS and light non-aqueous phase liquid (LNAPL) in groundwater. Remedial Investigation work completed 2011-2012 included test pit excavations, soil borings/monitoring wells, surface soil, subsurface soil, sediment, surface water and groundwater sampling and delineation of surficial petroleum contamination.

NOCO S-41 Site, Buffalo, NY and Niagara Street and Pennsylvania Avenue Site, Buffalo, NY

- Recently completed a Remedial Investigation (RI), Interim Remedial Measures (IRM) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program for two former gasoline station and automotive repair facilities with significant soil and groundwater petroleum VOC impact. The remediation approach for both sites involves removal of abandoned underground storage tanks, product dispensers and piping, removal of in-ground hydraulic lifts, soil excavation, and extraction and treatment of impacted groundwater. Final Engineering Reports and Site Management Plans were approved by the NYSDEC in December 2009 and Certificates of Completion were also issued in December 2009.

3807 Highland Avenue Site, Niagara Falls, New York

- Completed a Remedial Investigation (RI), Interim Remedial Measures (IRM) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program sites at a historic metallurgical facility and steel factory in Niagara Falls, NY. The Remedial Investigation involved collecting over 100 surface and subsurface soil and sediment samples and installing and sampling groundwater monitoring wells on an approximate 25-acre parcel slated for future mixed used commercial and industrial development. IRMs include excavation of chromium-impacted, arsenic-impacted and SVOC-impacted soil in several areas of the Site, drum and tank removal, catch basin and sump cleaning, smoke stack deposits remediation, and chemical waste removal. A Certificate of Completion was issued in June 2010.

1501 College Avenue Site, Niagara Falls, New York

- A Certificate of Completion was issued in December 2012 for this BCP site. Mr. Lesakowski managed a Remedial Investigation (RI), Interim Remedial Measures (IRM) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program sites at a historic heavy industrial facility in Niagara Falls, NY. The Remedial Investigation involved collecting surface and subsurface soil and sediment samples and installing and sampling groundwater monitoring wells on an approximate 15-acre parcel. IRMs include excavation of petroleum-impacted, PCB-impacted and SVOC-impacted soil in several areas of the Site, removal of galbestos PCB-impacted building materials, abandoned/damaged drum removal, chemical waste removal and a soil cover system.

275 Franklin Street Site

- Currently managing a NYSDEC Brownfield Cleanup Program site formerly used as drycleaner in western New York with significant soil and groundwater chlorinated VOC impact. Soil was successfully remediated using soil vapor extraction (SVE) to unrestricted soil cleanup objectives (SCOs) and groundwater remediation involves in-situ treatment of impacted groundwater. An active sub-slab depressurization system design and installation is planned in the new building during construction.

330 Maple Road Site, Amherst, New York

- Managed a Remedial Investigation (RI) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program for a small-arms shooting range with significant lead and semi-volatile organic compound (SVOC) impact. The RI involved collecting over 1,000 soil samples on 26-acre parcel slated for future mixed-use commercial and residential development. Bench-scale testing was completed to select a substrate to treat the characteristic hazardous soil to below toxicity characteristic leaching procedure (TCLP) thresholds. A Remedial Action Work Plan, which called for in-situ stabilization of characteristic hazardous soil and off-site disposal was prepared and approved by the NYSDEC. The remediation, which achieved a Residential Cleanup, was completed from the summer of 2011 through winter 2012. A certificate of completion was issued in spring 2012.

Seneca Market I, LLC Site, Watkins Glen, New York

- Managed Site Remediation at a former drycleaner, bus garage and asphalt plant under the NYSDEC Brownfield Cleanup Program with significant chlorinated volatile organic compound (cVOC) impact. The remediation approach involved underground tank removal, in-ground hydraulic lift removal, hazardous soil excavation and enhanced biodegradation of groundwater. The Site received its certificate of completion in December 2008. The Property is currently developed with an up-scale hotel. The project is highlighted on NYSDEC website as a Brownfield Success Story.

GLR Holdings Site, Niagara Falls, New York

- Managed a Remedial Investigation (RI), Interim Remedial Measure (IRM) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program for a former automotive repair facility with significant soil and groundwater chlorinated VOC impact. The remediation approach involved negotiated soil and groundwater cleanup objectives, limited soil excavation and enhanced biodegradation of groundwater. The Site received its certificate of completion in February 2008.

2250 Factory Outlet Boulevard Site, Niagara Falls, New York

- Managed Remedial Investigation (RI), Interim Remedial Measure (IRM) and Remedial Alternatives Analysis under the NYSDEC Brownfield Cleanup Program at a former lumber yard with chromium impact in Niagara Falls, NY. The remediation approach involved excavation and off-Site disposal of hazardous and non-hazardous soil. The Site received its certificate of completion in December 2007.

New Seventh Street Site, Buffalo, New York

- Managed the investigation of a former gasoline station and adjacent manufactured gas plant (MGP) as part of one of the largest Brownfield redevelopment projects in western New York. The project involves site redevelopment from a historic MGP site and adjacent gasoline station to a multi-million dollar commercial office complex. Acting on behalf of the developer (Duke Realty) and future tenant (HealthNow New York); preliminary investigations were completed to evaluate the nature and location of contaminants. Subsequent site investigation and remediation was completed via a Remedial Investigation (RI) and Interim Remedial Measures (IRM) under the New York State Brownfield Cleanup Program, saving months and significant cost. As a concurrent assignment, acted as a technical consultant to the developer and future tenant on negotiations and advisement on development of an environmental liability transfer arrangement between the purchaser/tenant (client), seller and a national remediation contractor.

OTHER PERTINENT EXPERIENCE

- Managed a site assessment and site investigations for a portfolio of retail gasoline stations in western New York. Project tasks include a historical review to determine sites' histories, review of previous technical reports, soil and groundwater investigations and remediation cost estimating for site cleanups. This project also involves forensic analyses of soil and groundwater samples to estimate the relative time of historic spills to determine the liability and responsibility for remediation of historic petroleum spills on-site.

- Managed a Phase I/Phase II site investigations for the Buffalo Urban Development Corporation for two parcels in the City of Buffalo encompassing approximately 100-acres. The project involved Phase I ESAs to assess potential historic concerns in a historic heavy industrial area and subsequent soil and groundwater investigations to investigate subsurface environmental conditions. A portion of the property was subsequently developed with an industrial facility.

- Managed environmental due diligence, including Phase I/Phase II investigations of five active service stations in central and eastern upstate New York for a potential purchaser. Phase I ESAs indicated a history of gasoline stations on-site. In conjunction with the purchaser and seller, it was negotiated that a baseline assessment of soil and groundwater impact would be completed to establish responsibility for addressing contamination going forward. The purchaser was able to purchase the sites with no liability for historic petroleum spills on-site.

- Managed investigation and remediation of a former automobile dealership in Rochester, New York. Site investigations, competed with oversight of NYSDEC Spills division, indicated soil impact as a result of leaking gasoline, diesel and waste oil USTs and floor drain discharges. Remedial tasks included a removal of four USTs and associated pump dispensers, closing/sealing interior floor drains and excavation and off-site disposal of 1,500 cubic yards of impacted soil.

- Performed fieldwork at a 50-acre industrial park in western New York. Task included a soil boring and monitoring well installation program, development and sampling of monitoring wells and a hydraulic conductivity assessment. Subsequent remedial tasks included removal of six underground storage tanks and petroleum-impacted soil and a long-term groundwater monitoring plan.

- Performed fieldwork and reporting for RI/FS of NYSDEC superfund site in Long Island, NY. Investigation activities at this former metal plating facility included soil investigation, monitoring well installation and groundwater sampling, hydraulic conductivity testing, and floor drain/cess pool investigation. IRM activities included closure of interior floor drains and removal of heavy metals impacted soil.

ENVIRONMENTAL LIABILITY TRANSFER EXPERIENCE

- Starting in 2010 through present, took the lead role in developing a liability transfer arrangement of a former refinery in New York State. Major tasks included technical review of historic Remedial Investigation data, remedial alternative selection and cost estimating, preparation of technical and liability transfer program proposal and negotiation with Fortune 100 company technical and business representatives. The deal involves a multi-million dollar remedial cleanup that is planned to be completed under the New York Brownfield Cleanup Program.

- Managed environmental consulting and due diligence activities for a purchaser of 182 gasoline service stations in Maryland, Virginia and Washington, DC. Tasks included Phase I ESAs, remediation cost estimating for sites with known impacts and/or on-going remediation and interfacing with the client’s lenders to facilitate a $110 million dollar real estate transaction. An Environmental Liability Transfer arrangement funded by the seller facilitated the additional environmental investigation and remediation of impacted sites.

- Played a key role in developing a liability transfer agreement for the transfer of a 48-site portfolio of gasoline stations with known petroleum impacts. Tasks included Phase I/Phase scoping, technical report review, oversight of remediation cost estimates and interfacing with the attorneys, insurance brokers, client and property sellers to develop and present the liability transfer arrangement.

- Provided technical consulting on behalf of HealthNow New York and Duke Realty for developing a liability transfer agreement for the transfer of a former manufactured gas plant site and gasoline station with significant soil, groundwater and soil vapor petroleum impacts. Tasks included technical report review, remediation cost estimating and interfacing with the attorneys, insurance brokers, client and property sellers to develop the liability transfer arrangement. Benchmark/TurnKey completed the remediation of the former gasoline station portion of the Site.

APPENDIX B

PREVIOUS INVESTIGATION

(PROVIDED ELECTRONICALLY)

Limited Phase II Environmental Investigation

1585 Hertel Avenue
Buffalo, New York

December 2017 B0437-017-001-002

Prepared For:

1585 Hertel LLC

Prepared By:

Benchmark Environmental Engineering & Science, PLLC

2558 Hamburg Turnpike, Suite 300, Buffalo, New York | phone: (716) 856-0635 | fax: (716) 856-0583

LIMITED PHASE II ENVIRONMENTAL INVESTIGATION REPORT

Spill No. 1706962
1585 Hertel Avenue
Buffalo, New York

December 2017 B0437-017-001-002

Prepared for:

1585 Hertel LLC
330 Depew Avenue
Buffalo, New York 14214

Prepared by:

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, New York 14218

LIMITED PHASE II ENVIRONMENTAL INVESTIGATION REPORT

Spill No. 1706962
1585 Hertel Avenue
Buffalo, New York

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Background and Site Description

Benchmark Environmental Engineering & Science, PLLC (Benchmark) performed a Phase II Environmental Investigation on behalf of 1585 Hertel LLC at 1585 Hertel Avenue, Buffalo, New York (Site). 1585 Hertel LLC is interested in redeveloping the Site from its former use as a gas/service station to another use.

The Site is located in an urban setting within the City of Buffalo and has been used as a gasoline service station from late 1930s until the operation was shut down in 2016. As shown on Figure 2, one main structure is present on the Site. The building, a former auto repair shop with three (3) hydraulic lift bays (two below ground and one above ground) is currently vacant.

A recent Phase I Environmental Site Assessment (ESA) completed by Benchmark, identified recognized environmental conditions (RECs) for the Site related to the historic site use as a gas station and repair shop for over 70 years. The scope of work for the investigation was devised based on the RECs identified in the Phase I ESA for the Site, which are summarized below in Section 1.2 and outlined in the Environmental Site Investigation Work Plan which was submitted to the New York State Department of Environmental Conservation (NYSDEC) Bulk Petroleum Storage Division.

1.2 Previous Study

"Phase I Environmental Site Assessment, 1585 Hertel Avenue, Buffalo, New York," completed by Benchmark, for 1585 Hertel Inc., dated October 2017. The 0.18 acre Site was identified as being a vacant former gasoline and service station, used as a portable food cart operation that was mobilized to the Site by Mac Vending, at the time of this assessment.

Benchmark's ESA revealed the following RECs in connection with the Site:

- The historic use of the Site as a petroleum retail operation and automotive repair facility from 1938 until operations ceased in 2016 are considered RECs as subsurface conditions are unknown. Note that prior to construction of the existing gasoline service station in 1963, the Site included a previous gasoline service station in current asphalt paved and pump island areas;

- The Site has an extensive tank history with existing inactive underground storage tanks (USTs), previous generations of USTs, and current/former pump island areas. Evidence indicative of former USTs (i.e., cut suspect vent pipes) was observed during the site reconnaissance. Existing and former USTs and pump islands are considered RECs due to the potential for subsurface impacts;
- The in-ground lift systems observed within the building are considered RECs due to the potential for impacts;
- The staining noted at the Site is considered a REC as visible impacts were noted to earthen ground surfaces proximate to the aboveground storage tank (AST) on the eastern exterior portion of the Site. Further, additional black staining was noted within the building, including a black liquid/sludge within the floor drain system. The exact discharge point and integrity of the floor drain system is unknown thus considered a REC; and,
- The remaining materials noted at the Site, especially the exterior 55-gallon drum with an unknown liquid, are considered RECs as such will require proper handling and off-site disposal. Similarly, electronic wastes such as light ballasts potentially containing PCBs will require proper handling and off-site disposal.

Due to the RECs identified for the Site, Benchmark recommended completion of a Phase II Environmental Site Investigation to assess the RECs identified. The RECs are identified on Figure 2.

2.0 SITE INVESTIGATION ACTIVITIES

2.1 Soil Boring Investigation

On October 18, 2017, Benchmark's subcontractor, Nature's Way Environmental (Nature's Way), mobilized a truck-mounted Earthprobe 200 drill rig equipped with a 1.5-inch diameter, 48 inch long macro-core sampler, to the Site to assess subsurface conditions on the property. As further described in Section 3.0, petroleum impacts were encountered during the drilling activities.

As shown on Figure 3, a total of eight (8) soil borings, designated as SB-1 through SB-8, were completed at the Site. The soil borings were advanced to depths ranging from 10 to 15.5 feet below ground surface (fbgs).

The sample cores were retrieved from the boring locations in clear PVC sleeves to allow for field characterization of the subsurface lithology and collection of soil samples by Benchmark's Geologist. The physical characteristics of the soil borings were classified using the ASTM D2488 Visual-Manual Procedure Description. Soils from each boring were screened via headspace screening using a MiniRae 3000 Photoionization Detector (PID). Visual and/or olfactory observations were noted. The field observations, including lithology, depths, PID scan results, etc., at each investigation location are summarized in the Soil Boring Log sheets provided in Appendix A.

Soil borings SB-1, -2, -4 and -6 were completed proximate to the former pump island location in the northwestern portion of the Site. SB-3 was completed in the area of an existing waste oil UST on the eastern portion of the Site. SB-5 and SB-7 were completed proximate to the gasoline USTs on the southwestern portion of the Site. SB-8 was completed outside the building near the western most service bay where hydraulic lifts were observed to be present in the ground.

Soil samples were selected for laboratory analysis, which included Target Compound List (TCL) plus NYSDEC Commissioners Policy 51 (CP-51) List volatile organic compounds (VOCs) plus tentatively identified compounds (TICs), CP-51 List semi-volatile organic compounds (SVOCs), Resource Conservation and Recovery Act (RCRA) 8 metals and/or polychlorinated biphenyls (PCBs).

Additionally, one (1) surface soil sample (SS-1) was collected from the eastern side of the building where stained soil was observed at ground surface in the vicinity of an AST and drum storage area. The surface soil sample was analyzed for CP-51 List SVOC, RCRA 8 Metals, and PCBs.

The soil samples collected as part of the investigation were transported under chain-of custody command to TestAmerica Laboratories, Inc. (TestAmerica) in Amherst, NY for analysis. Samples were collected in laboratory provided sample jars and cooled to 4 C° prior to transport.

3.0 INVESTIGATION FINDINGS

3.1 Site Geology/Hydrogeology

The overburden geology observed during the soil boring investigation is generally described as fill material overlying presumed native soil consisting of a sandy lean clay (see Soil Boring Logs in Appendix A). The fill materials consisted of various amounts of gravel, sands, silt and reworked native clays. The thickness of the fill material ranged from 1 fbgs (SB-1, -3, -6, -7) to 7.5 fbgs (SB-6). Equipment refusal was not encountered during the soil borings.

Groundwater was not encountered at the eight (8) soil boring locations that ranged in depth from 10 to 15.5 fbgs. Regional groundwater flow is suspected to be westerly towards the Niagara River and along the flow path of Scajaquada Creek. Actual groundwater flow patterns at the Site may be influenced by subsurface features, such as excavations, utilities, and localized fill-conditions.

3.2 Field Observations

Soil samples from the soil boring investigation were observed and scanned via headspace screening for VOCs using a PID. A brief description of the field observations during the boring investigation is presented below:

Investigation Location ID	Environmental Concern Assessed	Highest PID reading (parts per million, ppm) and depth (fbgs)	Other Observations
SB-1	Pump Island - north	429 ppm, 7.5 fbgs.	Petroleum odors 4 to 8 fbgs
SB-2	Pump Island – east	62 ppm, 1.5 fbgs.	Petroleum odors 1 to 3.5 fbgs
SB-3	Waste Oil Tank	38 ppm, 2 fbgs.	Petroleum odors at 2 fbgs
SB-4	Pump Island - south	0.0 ppm throughout boring.	None
SB-5	USTs - south	1 ppm, 3.5 fbgs.	Petroleum odors 3 to 6 fbgs
SB-6	Pump Island - west	898 ppm, 3.5 fbgs.	Staining and strong petroleum odors 3 to 6 fbgs
SB-7	USTs - northwest	791 ppm; 3 fbgs.	Staining and petroleum odors 1 to 4 fbgs
SB-8	North of Building/Hydraulic Lifts	0.0 ppm throughout boring.	None
SS-1	AST, drum, staining on ground surface	Not measured	Surface soil is heavily stained.

3.3 Soil Analytical Results

Table 1 presents a summary of the analytical samples selected for analysis and the analysis completed. Table 2 is a summary of the soil sample analytical results for the samples analyzed. For comparative purposes, Table 2 includes the CP-51 Soil Cleanup Levels for Gasoline Contaminated Soil (CP-51 SCLs)/NYSDEC Part 375 Unrestricted Use Soil Cleanup Objectives (USCOs), Restricted-Residential Use SCOs (RRSCOs) and Commercial Use SCOs (CSCOs). The CP-51 SCLs are typically used for comparison of analytical data involving potential petroleum impact or on sites undergoing petroleum spill cleanup. Part 375 SCOs are specific to the intended reuse of the site and are typically employed for comparison at other remediation sites with NYSDEC oversight, such as Brownfield sites. Based on the current use as a former gasoline station the CP-51 SCLs are applicable. Furthermore, RRSCOs are also considered applicable comparative criteria based on the anticipated future use of the site in a restricted residential capacity. A copy of the laboratory analytical data package is included in Appendix B.

As summarized on Table 2, petroleum VOCs (pVOCs) were detected at concentrations exceeding CP-51 SCLs, RRSCOs and/or CSCOs in soil samples SB-6 (2-4 fbgs), SB-7 (1.5-3.5 fbgs), which were completed in the vicinity of the pump island and existing USTs, respectively. Stained soil, petroleum odors, and the highest PID measurements at the Site were also noted at these two (2) locations.

SVOCs were either non-detect or at concentrations below applicable regulatory criteria.

PCBs were non-detect in the two (2) soil samples analyzed.

Metals were detected in the four (4) samples analyzed soil samples. Barium was detected at SB-2 (0.5-2 fbgs) at a concentration above its CSCO. Arsenic, barium, and lead were detected at surface soil sample, SS-1, at concentrations above their respective CSCOs. Based on the high concentrations of arsenic (164 mg/kg) and lead (1,030 mg/kg) detected in the surface soil, additional analysis may be warranted to determine if the soil present in this area is a characteristic hazardous waste.

3.4 NYSDEC Reporting Obligation

Based on the field observations during the Phase II investigation, it was evident that petroleum impacts where present at the Site, and, as required by law, the NYSDEC was notified and Spill No. 1706962 was assigned to the Site.

4.0 CONCLUSIONS AND RECOMMENDATIONS

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

- Field evidence of petroleum impacts with elevated PID readings, staining and petroleum-like odors were identified in subsurface soil/fill in the vicinity of the pump islands and USTs. Laboratory analytical results also suggest the presence of gasoline-impacted soil in this area. As such, the impacts identified at the Site are reasonably attributed to use of the Site as a gas station and the former gasoline pump island/gasoline USTs.
- As the Site is no longer used for gasoline sales and the owner would like to redevelop the Site for another use, the USTs (heating oil, waste oil, and gasoline), pump islands and hydraulic lifts will need to be removed along with any petroleum-impacted soil. Remedial action is necessary to prepare the Site for redevelopment.
- Elevated arsenic, cadmium, and lead were detected in a surface soil sample collected from the eastern side of the building is the vicinity of an AST and 55-gallon drum where stained soil was also observed. The high levels of arsenic and lead may warrant additional analysis to determine if the soil present in this area is a characteristic hazardous waste.
- A copy of this report should be provided to the NYSDEC for their review and comment. The Site will require remedial action and the gasoline distribution equipment (pump island, piping, and USTs) should be removed from the Site in addition to the petroleum impacted soil present.
- Based on the finding of this limited Phase II investigation, the Site appears to be a candidate for the New York State Brownfield Cleanup Program (BCP).

Figure 4 identifies the locations where remedial action is necessary to be completed prior to redevelopment of the Site.

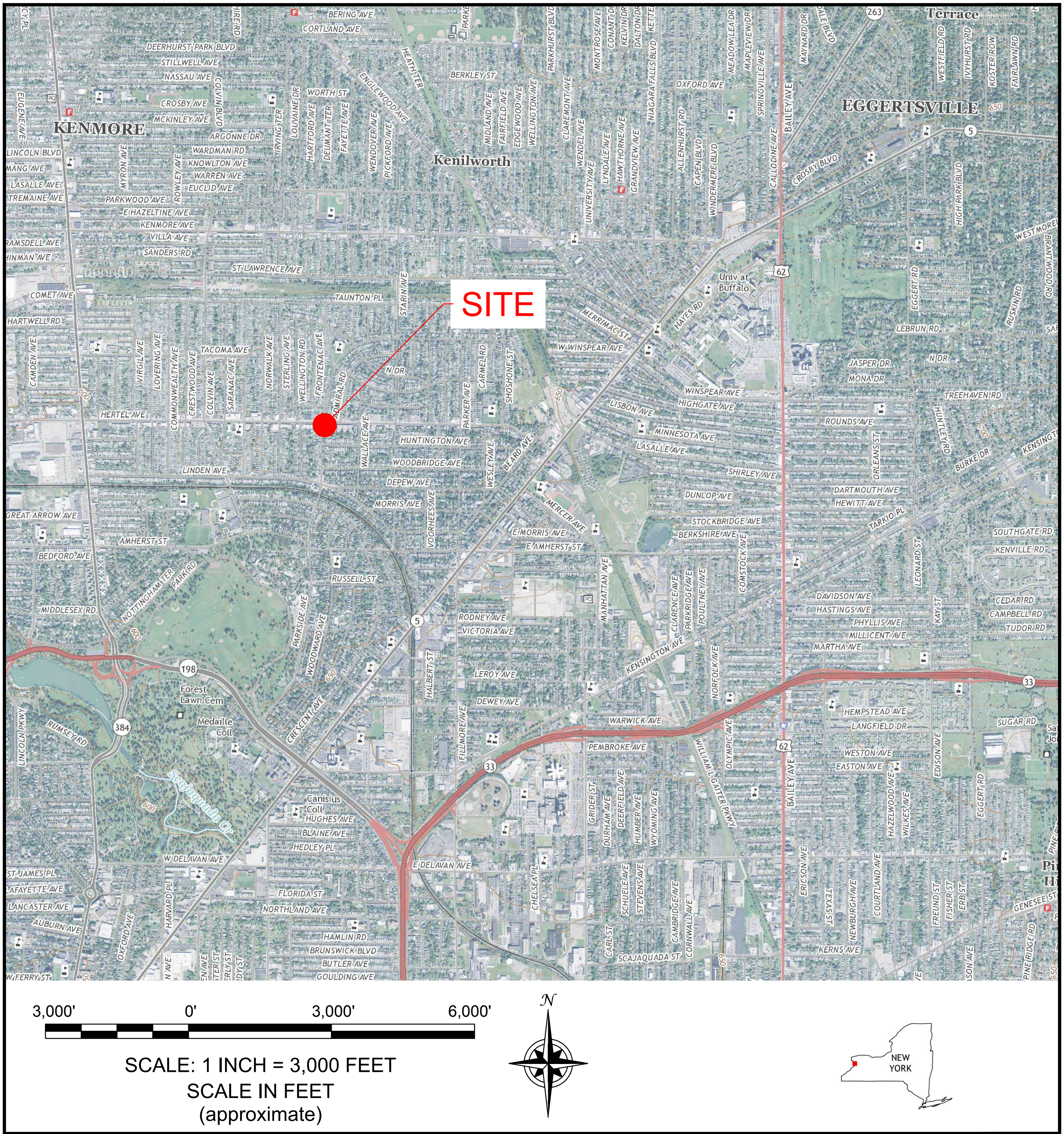
5.0 LIMITATIONS

This report has been prepared for the exclusive use of 1585 Hertel 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 1585 Hertel LLC. Use of or reliance on this report or its findings by any other person or entity is prohibited without written permission of Benchmark Environmental Engineering & Science, PLLC.

FIGURES

F:\CAD\Benchmark\1585 Hertel LLC\Limited Phase II\Figure 1; Site Location and Vicinity Map.dwg

FIGURE 1



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-001-002

DATE: NOVEMBER 2017

DRAFTED BY: CMS-CMC

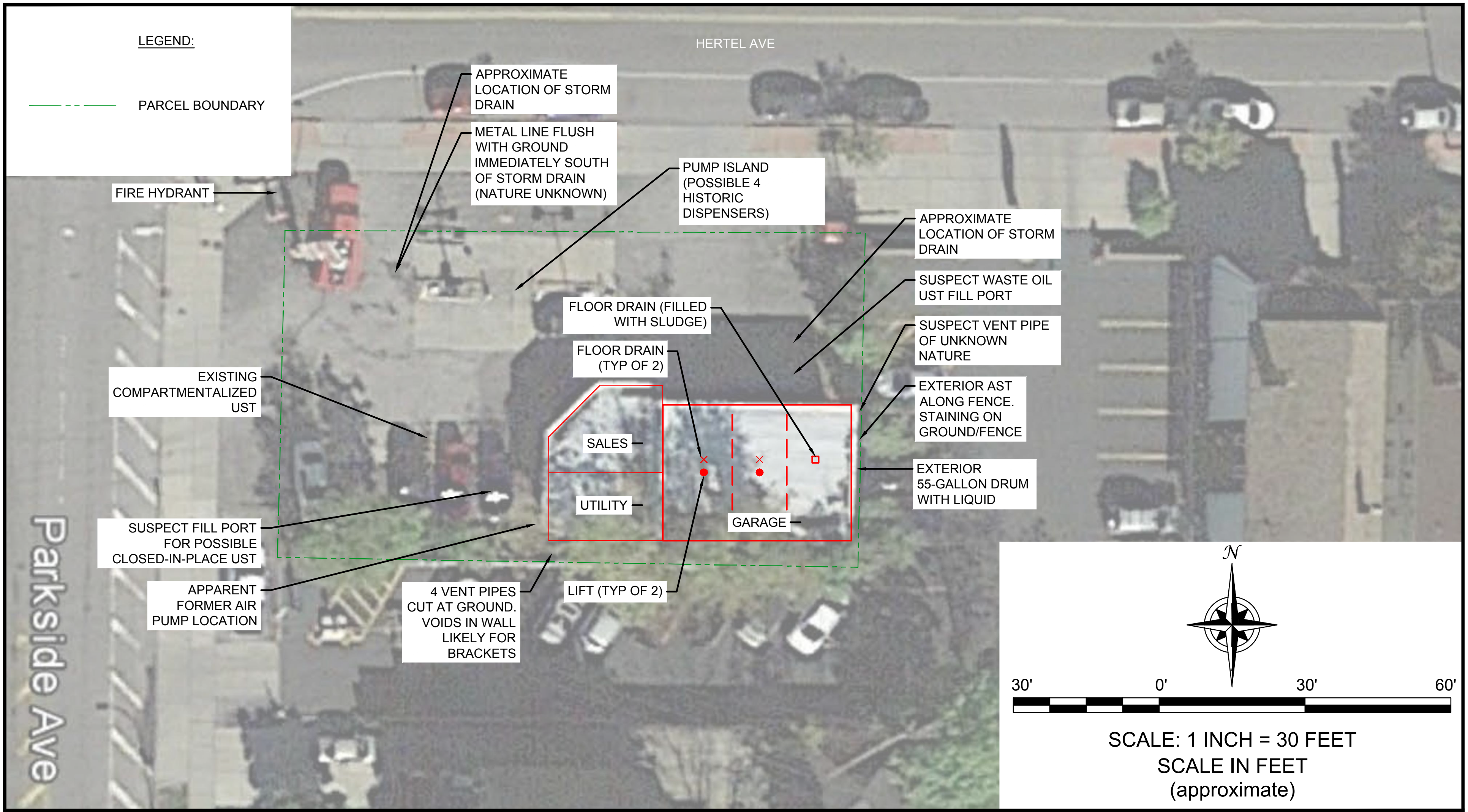
SITE LOCATION AND VICINITY MAP

LIMITED PHASE II ENVIRONMENTAL SITE ASSESSMENT

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

PREPARED FOR
1585 HERTEL LLC

F:\CAD\Benchmark\1585 Hertel LLC\Limited Phase II\Figure 2; Site Investigation Plan.dwg



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: B0437-017-002

DATE: NOVEMBER 2017

DRAFTED BY: CMS

SITE PLAN WITH PHASE I ESA RECs

LIMITED PHASE II ENVIRONMENTAL SITE ASSESSMENT

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

PREPARED FOR

1585 HERTEL LLC

FIGURE 2

F:\CAD\Benchmark\1585 Hertel LLC\Limited Phase II\Figure 3; Boring Locations.dwg

LEGEND:

— - - — - - —	PARCEL BOUNDARY
SB-1 ●	SOIL BORING
SS-1 ◪	SURFACE SOIL SAMPLE

N

30' 0' 30' 60'

SCALE: 1 INCH = 30 FEET
SCALE IN FEET
(approximate)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-001-002

DATE: NOVEMBER 2017

DRAFTED BY: RFL-CMC

BORING LOCATIONS

LIMITED PHASE II ENVIRONMENTAL SITE ASSESSMENT

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

PREPARED FOR

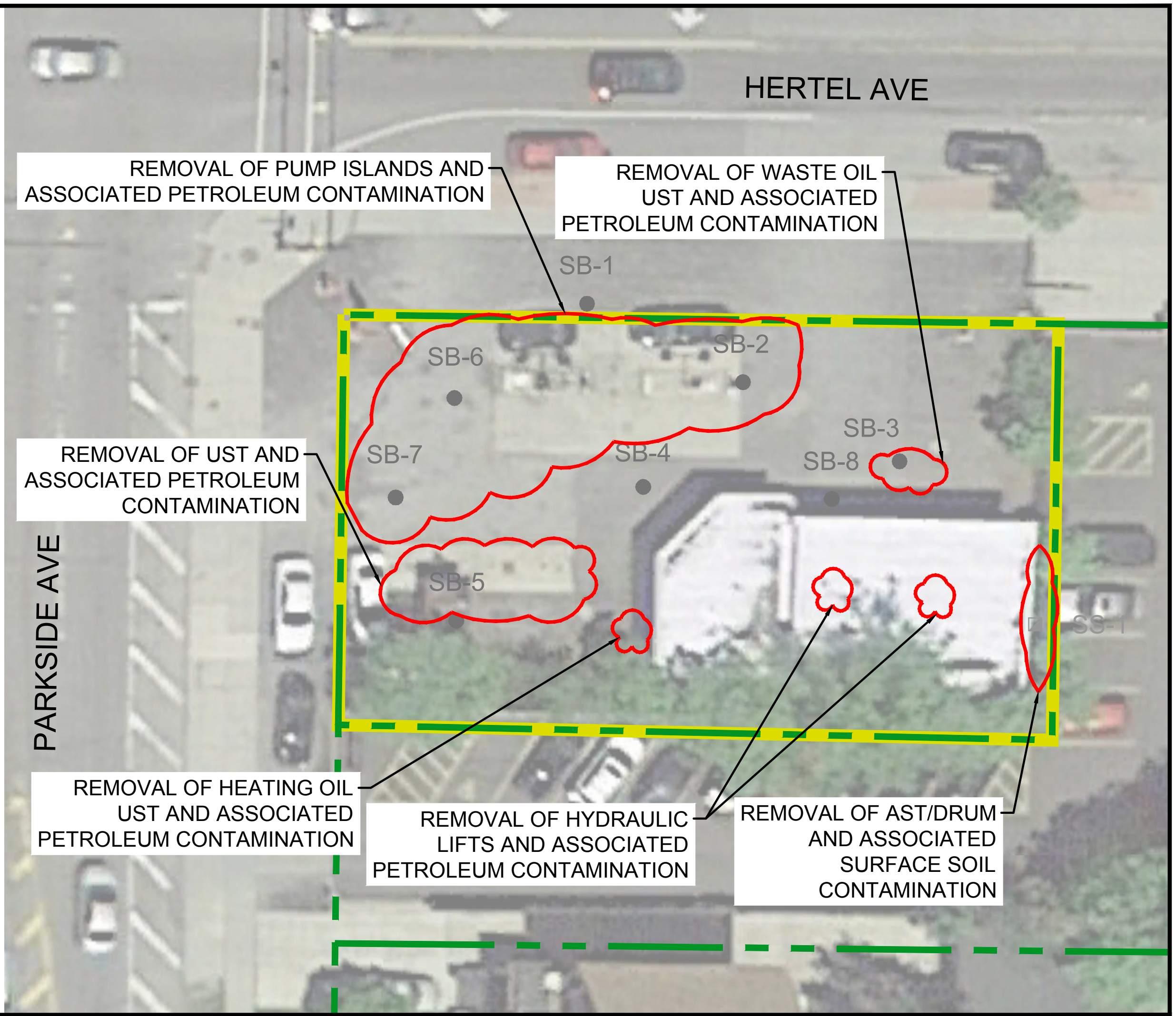
1585 HERTEL LLC

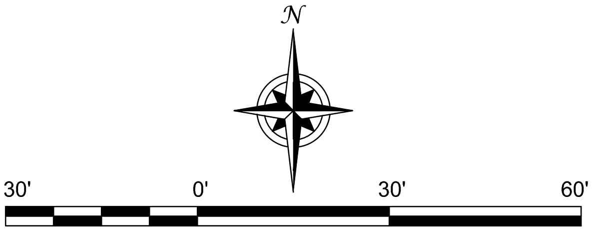
FIGURE 3

F:\CAD\Benchmark\1585 Hertel LLC\Limited Phase II\Figure 4; Areas of Remedial Action.dwg, 12/20/2017 11:10:22 AM, DWG To PDF.pc3

LEGEND:

🟨	PROPERTY BOUNDARY
🟩	PARCEL BOUNDARY
SB-1 ●	SOIL BORING
SS-1 ◪	SURFACE SOIL SAMPLE





SCALE: 1 INCH = 30 FEET
SCALE IN FEET
(approximate)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-001-002

DATE: DECEMBER 2017

DRAFTED BY: RFL-CMC-CCB

AREAS OF REMEDIAL ACTION

LIMITED PHASE II ENVIRONMENTAL SITE ASSESSMENT

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

PREPARED FOR

1585 HERTEL LLC

FIGURE 4

TABLES

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TABLE 1

SUMMARY OF ANALYTICAL SAMPLING PROGRAM

1585 HERTEL AVENUE
BUFFALO, NEW YORK

Sample Identifier	Depth Sampled/ Screened (fbgs)	TCL & NYSDEC CP-51 VOCs	CP-51 SVOCS	RCRA 8 Metals	PCBS
Soil Samples					
SB-1	6 to 8	X			
SB-2	0.5 to 2		X	X	
SB-2	2 to 4	X		X	X
SB-3	2 to 4	X	X	X	
SB-6	2 to 4	X	X		
SB-7	1.5 to 3.5	X			
SB-8	0.5 to 2.5		X	X	
SS-1			X	X	X

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TABLE 2

SUMMARY OF SUBSURFACE SOIL/FILL SAMPLE ANALYTICAL RESULTS
PHASE II ENVIRONMENTAL SITE ASSESSMENT
1278 HERTEL AVENUE
BUFFALO, NY

PARAMETER[1]	**CP-51 & Unrestricted Use SCOs[2]**	**Restricted Residential Use SCOs [3]**	**Commercial Use SCOs[3]**	**SB-1 6-8**	**SB-2 0.5-2**	**SB-2 2-4**	**SB-3 2-4**	**SB-6 2-4**	**SB-7 1.5-3.5**	**SB-8 0.5-2.5**	**SS-1 0-0.2**
				10/18/2017							
Highest Total Volatile Organic Field Readings - parts per million (ppm) mg/Kg											
Total Organic Vapors	--	--	--	**429**	62	38	0	5	**898**	**791**	--
Volatile Organic Compounds (VOCs) - mg/Kg [4]											
1,2,4-Trimethylbenzene	**3.6**	**52**	**190**	ND	--	--	0.0014 J	**12**	**190**	--	--
1,3,5-Trimethylbenzene	**8.4**	**52**	**190**	ND	--	--	0.0004 Jv	2.4	**50**	--	--
Benzene	**0.06**	**4.8**	**44**	ND	--	--	ND	ND	**3**	--	--
Ethylbenzene	**1**	**41**	**390**	0.0032 J	--	--	0.001 J	0.400 J	**41**	--	--
Isopropylbenzene (Cumene)	**2.3**	**--**	**--**	0.038	--	--	0.00088 J	0.240 J	**5.4**	--	--
Methyl tert butyl ether (MTBE)	**0.93**	**100**	**500**	0.0014 J	--	--	ND	ND	ND	--	--
n-Butylbenzene	**12**	**100**	**500**	0.065	--	--	0.0059	1.9	**18**	--	--
n-Propylbenzene	**3.9**	**100**	**500**	0.15	--	--	0.00095 J	1	**18**	--	--
p-Isopropyltoluene	**--**	**--**	**--**	ND	--	--	ND	0.220 J	2.2	--	--
sec-Butylbenzene	**11**	**100**	**500**	0.025	--	--	0.0066	0.290 J	ND	--	--
tert-Butylbenzene	**5.9**	**100**	**500**	0.0008 J	--	--	0.00077 J	ND	ND	--	--
Toluene	**0.7**	**100**	**500**	ND	--	--	0.00046 J	ND	**11**	--	--
Total Xylenes	**0.26**	**100**	**500**	0.0016 J	--	--	0.0035 J	**1.1 J**	**320**	--	--
Total Tentatively Identified Compounds	**--**	**--**	**--**	1.71	--	--	0.38	ND	ND	--	--
Semi-Volatile Organic Compounds (SVOCs) - mg/Kg [4]											
Benzo(ghi)perylene	**100**	**100**	**500**	--	0.21 J	--	ND	ND	--	ND	ND
Chrysene	**1**	**3.9**	**56**	--	ND	--	0.061 J	ND	--	ND	ND
Naphthalene	**12**	**100**	**500**	--	ND	--	ND	0.870 J	--	ND	ND
Total PCBS - mg/Kg											
	0.1	**1**	**1**	--	--	ND	--	--	--	--	ND
Total Metals - mg/Kg											
Arsenic	**13**	**16**	**16**	--	11.2	7.3	4.3	--	--	3.2	**164**
Barium	**350**	**400**	**400**	--	**488**	108 F1	135	--	--	157	**414**
Cadmium	**2.5**	**4.3**	**9.3**	--	0.29	ND	ND	--	--	ND	**3.6**
Chromium	**30**	**180**	**1500**	--	6.2	5.6	28.9	--	--	**35.9**	**39.7**
Lead	**63**	**400**	**1000**	--	**223**	7.2	15.8	--	--	45.7	**1030**
Mercury	**0.18**	**0.81**	**2.8**	--	ND	ND	ND	--	--	0.067	0.051
Selenium	**3.9**	**180**	**1500**	--	ND	ND	ND	--	--	ND	ND
Silver	**2**	**180**	**1500**	--	ND	ND	ND	--	--	ND	ND

Notes:

1. Only those parameters detected at a minimum of one sample location are presented in this table; other compounds were reported as non-detect.
2. Values per NYSDEC CP-51 Soil Cleanup Levels (SCL) and Part 375 Unrestricted Soil Cleanup Objectives (SCOs).
2. Values per NYSDEC Part 375 Restricted Use Soil Cleanup Objectives (SCOs).
4. Sample results were reported by the laboratory in ug/kg and converted to mg/kg for comparisons to SCOs.

Definitions:

ND = Parameter not detected above laboratory detection limit.
"--" = No value available for the parameter; Parameter not analysed for.
J = Estimated value; result is less than the sample quantitation limit but greater than zero.

🟩 **Bold**	= Result exceeds Unrestricted Use SCOs.
🟦 **Bold**	= Result exceeds Restricted Residential Use SCOs.
🟨 **Bold**	= Result exceeds Commercial Use SCOs.

APPENDIX A

SOIL BORING LOGS

Project No: 0437-017-001-002

Borehole Number: SB-1

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC

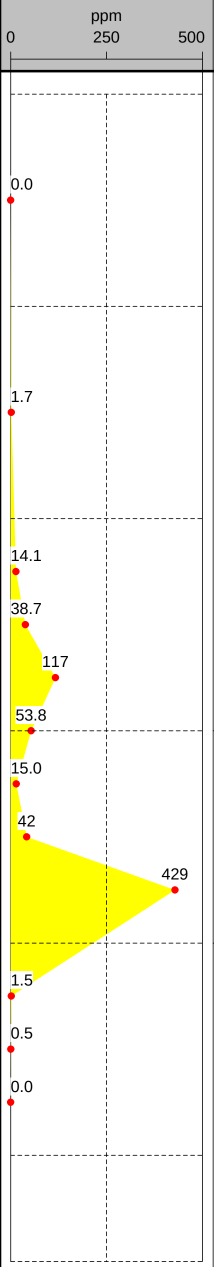
Logged By: TAB

Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE				PID VOCs ppm	Lab Sample	Well Completion Details or Remarks
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol			
0.0	0.0 0.0	Ground Surface							
	-0.5 0.5	***Asphalt*** Asphalt							
	-1.0 1.0	***Poorly Graded Gravel with Sand (Sub-base)*** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.					0.0		
		Sandy Lean Clay Reddish brown, moist, mostly low plasticity fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff.	C1	NA	3.9		1.7		
	-4.0 4.0	As above, petroleum like odor, medium plasticity.	C2	NA	4.0		14.1 38.7 117 53.8 15.0 42 429	Sample Location	
5.0									
	-8.0 8.0	As above, slight petroleum like odor. End of boring at 10.0 fbgs.	C3	NA	2.0		1.5 0.5 0.0		
10.0	-10.0 10.0	End of Borehole							



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push

Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-002

Borehole Number: SB-2

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC.

Logged By: TAB

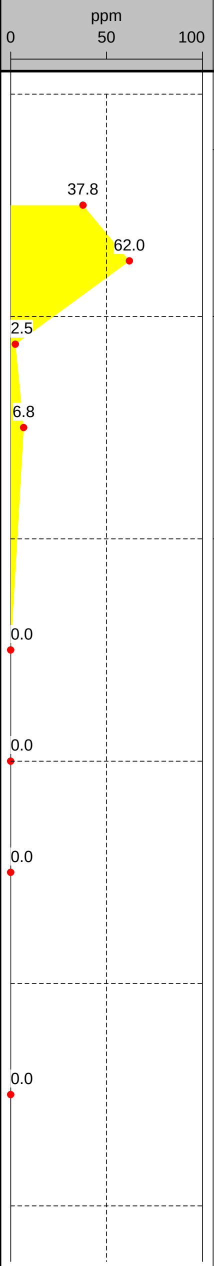
Site Location: 1585 Hertel Ave. Buffalo NY

Checked By:

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE				
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Lab Sample	Well Completion Details or Remarks
	0.0	Ground Surface					
0.0	0.0 -0.5	**Asphalt** Asphalt	C1	NA	4.0		
	0.5 -1.0	**Poorly Graded Gravel with Sand (Sub-base)** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.				Sample Location	
	1.0 -2.0	**Poorly Graded Fine Sand (bedding sand)** Brown, moist, mostly fine sand, trace non-plastic fines, loose, medium dense, petroleum like odor.					
	2.0 -2.5	**Lean Clay with Sand (Reworked)** Reddish brown, moist, mostly medium plasticty fines, little fine sand, medium toughness, medium dry strength, firm.				Sample Location	
	2.5 -3.5	**Poorly Graded Fine Sand (bedding sand)** Black, wet (3.0 fbgs) perched, mostly fine sand, trace non-plastic fines, loose, slight petroleum like odor.					
	3.5 -4.0	**Sandy Lean Clay** Reddish brown, moist, mostly low plasticty fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff.					
5.0	4.0 -8.0	As above, medium plasticity.	C2	NA	3.8		
	8.0 -10.0	As above. End of boring at 10.0 fbgs.	C3	NA	0.6		
10.0	10.0	End of Borehole					

PID VOCs



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-002

Borehole Number: SB-3

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel Ave LLC

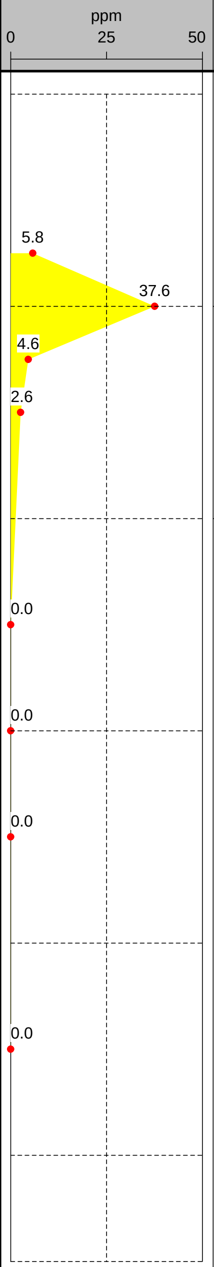
Logged By: TAB

Site Location: 1585 Hertel Buffalo NY

Checked By: CZB

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE						
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	PID VOCs ppm 0 25 50	Lab Sample	Well Completion Details or Remarks
0.0	0.0 0.0	Ground Surface ***Asphalt*** Asphalt	C1	NA	3.5				
	-0.5 0.5	***Poorly Graded Gravel with Sand (sub-base)*** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.							
	-1.0 1.0	***Sandy Lean Clay*** Reddish brown, moist, mostly low plasticity fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff, petroleum like odors.						Sample Location	
	-4.0 4.0	As above, medium plasticity, no petroleum like odors.	C2	NA	4.0				
5.0									
	-8.0 8.0	As above. End of boring at 10.0 fbgs.	C3	NA	2.0				
10.0	-10.0 10.0	End of Borehole							



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push

Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-002

Borehole Number: SB-4

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC

Logged By: TAB

Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE						
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	PID VOCs ppm (0 – 12.5 – 25)	Lab Sample	Well Completion Details or Remarks
0.0	0.0 0.0	Ground Surface							
	-0.5 0.5	***Asphalt*** Asphalt	C1	NA	2.8		0.0 0.0 0.0		
	-1.0 1.0	***Poorly Graded Gravel with Sand (Sub-base)*** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.							
	-2.5 2.5	***Sandy Lean Clay (Reworked)*** Reddish brown, moist, mostly low plasticty fines, little fine sand, medium toughness, medium dry strength, stiff.							
	-3.0 3.0	***Fill*** Black, wet, mostly concrete chips mixed with angular fine gravel, loose.							
5.0	-4.0 4.0	***Sandy Lean Clay*** Reddish brown, moist, mostly low plasticty fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff. As above, medium plasticity.	C2	NA	3.5		0.0 0.0 0.0		
10.0	-8.0 8.0	As above.	C3	NA	3.2		0.0 0.0 0.0		
	-12.0 12.0	As above. End of boring at 14.0 fbgs.	C4	NA	2.0		0.0		
	-14.0 14.0	End of Borehole							

Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-002

Borehole Number: SB-5

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC

Logged By: TAB

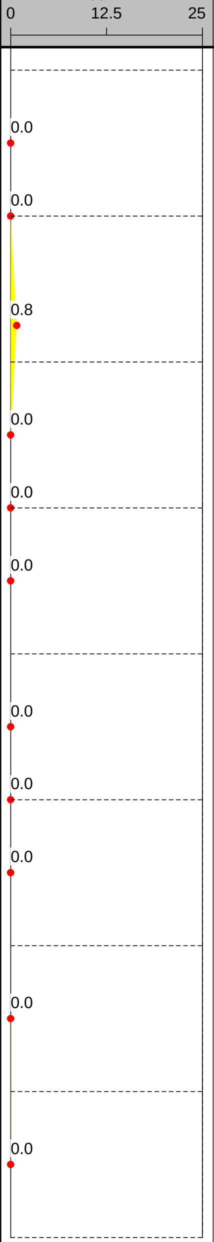
Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE						
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	PID VOCs ppm (0 – 12.5 – 25)	Lab Sample	Well Completion Details or Remarks
0.0	0.0	Ground Surface							
	0.0 -0.5 0.5	***Asphalt*** Asphalt	C1	NA	1.8				
	-1.0 1.0	***Poorly Graded Gravel with Sand (sub-base_*** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.					0.0		
	-2.0 2.0	***Sandy Lean Clay (Reworked)*** Reddish brown, moist, mostly low plasticity fines, little fine sand, medium toughness, medium dry strength, stiff.					0.0 0.8		
5.0	-4.0 4.0	***Peastone bedding*** Grey, wet (perched), mostly fine sand, some fine gravel (peastone), loose, slight petroleum odor. As above, trace fine sand.	C2	NA	1.2		0.0 0.0 0.0		
	-7.5 7.5	***Sandy Lean Clay*** Reddish brown, moist, mostly low plasticity fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff.							
10.0	-8.0 8.0	As above, medium plasticity.	C3	NA	3.7		0.0 0.0 0.0		
15.0	-12.0 12.0	As above. End of boring at 15.5 fbgs.	C4	NA	3.5		0.0 0.0		
	-15.5 15.5	End of Borehole							



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001

Borehole Number: SB-6

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel Ave LLC

Logged By: TAB

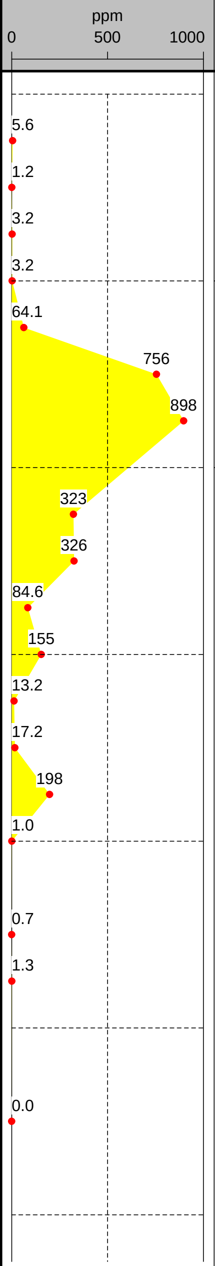
Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE						
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	PID VOCs ppm	Lab Sample	Well Completion Details or Remarks
	0.0 0.0	Ground Surface							
0.0	-0.5 0.5	***Asphalt*** Asphalt	C1	NA	3.8		5.6		
	-1.0 1.0	***Poorly Graded Gravel with Sand (sub-base)*** Dark grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.					1.2 3.2		
	-2.0 2.0	***Sandy Lean Clay*** Dark grey,stained, moist, mostly low plasticty fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff, petroleum odor. As above, reddish brown.					3.2 64.1 756 898	Sample Location	
5.0	-4.0 4.0	As above, medium plasticity.	C2	NA	4.0		323 326 84.6 155 13.2 17.2 198		
	-8.0 8.0	As above, slight petroleum odor.	C3	NA	2.0		1.0 0.7 1.3		
10.0	-10.0 10.0	As above, no odor. End of boring at 12.0 fbgs. In an attempt to find depth of equipment refusal an expendable drillers tip was pushed to a depth of 28.0 fbgs. Equipment refusal depth was not encountered.	C4	NA	2.0		0.0		
	-12.0 12.0	End of Borehole							



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-002

Borehole Number: SB-7

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC

Logged By: TAB

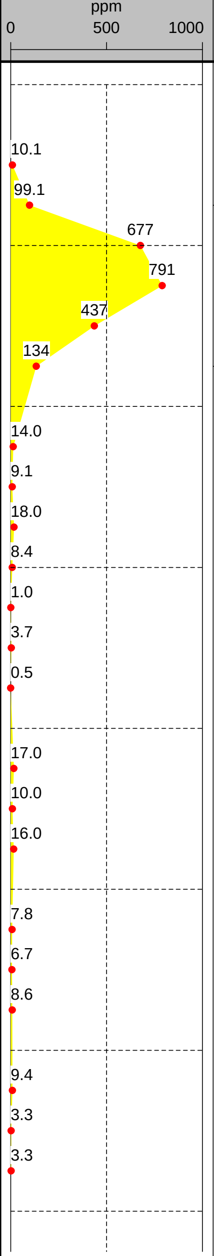
Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE				PID VOCs ppm	Lab Sample	Well Completion Details or Remarks
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol			
0.0	0.0 0.0	Ground Surface							
	-0.5 0.5	***Asphalt*** Asphalt	C1	NA	3.8		10.1 99.1 677 791 437 134	Sample Location	
	-1.0 1.0	***Poorly Graded Gravel with Sand (sub-base)*** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.							
	-2.0 2.0	***Sandy Lean Clay*** Dark grey, stained, moist, mostly low plasticty fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff, petroleum odor. As above, reddish brown.							
5.0	-4.0 4.0	As above, medium plasticity, slight petroleum odor.	C2	NA	4.0		14.0 9.1 18.0 8.4 1.0 3.7 0.5		
	-8.0 8.0	As above.	C3	NA	2.0		17.0 10.0 16.0		
10.0	-10.0 10.0	As above, no odor below 12.0 fbgs.	C4	NA	2.0		7.8 6.7 8.6		
		End of boring at 14.0 fbgs.	C5	NA	2.0		9.4 3.3 3.3		
	-14.0 14.0	End of Borehole							



Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

Project No: 0437-017-001-200

Borehole Number: SB-8

Project: Phase II investigation

A.K.A.:

Client: 1585 Hertel LLC

Logged By: TAB

Site Location: 1585 Hertel Ave. Buffalo NY

Checked By: CZB

Benchmark Environmental Engineering & Science, PLLC
2558 Hamburg Turnpike, Suite 300
Buffalo, NY 14218
(716) 856-0599

SUBSURFACE PROFILE			SAMPLE						
Depth (fbgs)	Elev. /Depth	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	PID VOCs ppm 0 12.5 25	Lab Sample	Well Completion Details or Remarks
0.0	0.0 0.0	Ground Surface							
	-0.5 0.5	**Asphalt** Asphalt	C1	NA	3.1				
	-1.5 1.5	**Poorly Graded Gravel with Sand (sub-base).** Dark Grey/grey, moist, mostly fine gravel (angular limestone), some fine to coarse sand, loose, medium dense.					0.0		
	-3.0 3.0	**Lean Clay with Sand** Grey, moist, mostly medium plasticity fines, few fine sand, medium toughness medium, dry strength, stiff.					0.0	Sample Location	
	-4.0 4.0	**Sandy Lean Clay** Reddish brown, moist, mostly low plasticity fines, little fine sand, trace fine gravel (sub-rounded), medium toughness, medium dry strength, very stiff.					0.0		
5.0	-8.0 8.0	As above, medium plasticity.	C2	NA	4.0		0.0 0.0 0.0		
10.0	-12.0 12.0	As above.	C3	NA	3.6		0.1 0.1 0.1		
	-14.0 14.0	As above. End of boring at 14.0 fbgs.	C4	NA	2.0		0.8 0.4		
		End of Borehole							

Drilled By: Natures Way
Drill Rig Type: Earth Probe 200
Drill Method: Direct Push
Comments:
Drill Date(s): 10/18/17

Hole Size: 3.0-inch
Stick-up: NA
Datum: NA

Sheet: 1 of 1

APPENDIX B

LABORATORY ANALYTICAL REPORT

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Buffalo
10 Hazelwood Drive
Amherst, NY 14228-2298
Tel: (716)691-2600

TestAmerica Job ID: 480-126164-1
Client Project/Site: Benchmark - 1585 Hertel Ave site
Revision: 1

For:
Turnkey Environmental Restoration, LLC
2558 Hamburg Turnpike
Suite 300
Lackawanna, New York 14218

Attn: Mr. Christopher Z Boron

Authorized for release by:
11/13/2017 2:39:40 PM

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

The test results in this report meet all 2003 NELAC and 2009 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

Definitions/Glossary

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

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
F1	MS and/or MSD Recovery is outside acceptance limits.
F2	MS/MSD RPD exceeds control limits

GC/MS VOA TICs

Qualifier	Qualifier Description
J	Indicates an Estimated Value for TICs
N	Presumptive evidence of material.
T	Result is a tentatively identified compound (TIC) and an estimated value.
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
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
X	Surrogate is outside control limits

GC Semi VOA

Qualifier	Qualifier Description
X	Surrogate is outside control limits

Metals

Qualifier	Qualifier Description
F1	MS and/or MSD Recovery is outside acceptance 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
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)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
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)

Case Narrative

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

Job ID: 480-126164-1

Laboratory: TestAmerica Buffalo

Narrative

Job Narrative
480-126164-1

Comments
This report has been revised to add tentatively identified compounds (TICs) to the method 8260 analysis .

Receipt
The samples were received on 10/19/2017 12:28 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 3.1° C.

GC/MS VOA
Method(s) 8260C: The following sample was analyzed using medium level soil analysis and diluted due to the nature of the sample matrix: SB-6 (2-4) (480-126164-5). Elevated reporting limits (RLs) are reported.

Method(s) 8260C: The following samples was analyzed using medium level soil analysis and diluted to bring the concentration of target analytes within the calibration range: SB-7 (1.5-2.5) (480-126164-6). 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(s) 8270D: The continuing calibration verification (CCV) associated with batch 480-383167 recovered above the upper control limit for Benzo[b]fluoranthene. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: SB-2 (0.5-2.0) (480-126164-2), SB-3 (2-4) (480-126164-4), SB-6 (2-4) (480-126164-5), SB-8 (0.5-3.5) (480-126164-7) and SS-1 (480-126164-8).

Method(s) 8270D: The following samples was diluted due to color and, viscosity: SB-2 (0.5-2.0) (480-126164-2), SB-6 (2-4) (480-126164-5), SB-8 (0.5-3.5) (480-126164-7) and SS-1 (480-126164-8). Elevated reporting limits (RL) are provided.

Method(s) 8270D: The following sample required a dilution due to the nature of the sample matrix: SS-1 (480-126164-8). Because of this dilution, the surrogate spike concentration in the sample was reduced to a level where the recovery calculation does not provide useful information.

Method(s) 8270D: Three surrogates are used for this analysis. The laboratory's SOP allows one of these surrogates to be outside acceptance criteria without performing re-extraction/re-analysis. The following sample contained an allowable number of surrogate compounds outside limits: SB-2 (0.5-2.0) (480-126164-2). These results have been reported and qualified.

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

GC Semi VOA
Method(s) 8082A: Surrogate recovery for the following samples was outside control limits: SS-1 (480-126164-8). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

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

Metals
Method(s) 6010C: The following samples were diluted due to the presence of Total Iron which interferes with Cadmium, Chromium, and Lead: SB-8 (0.5-3.5) (480-126164-7) and SS-1 (480-126164-8). 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.

Organic Prep
Method(s) 3550C: Due to the matrix, the following sample could not be concentrated to the final method required volume: SS-1 (480-126164-8). The reporting limits (RLs) are elevated proportionately.

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

Client Sample ID: SB-1 (6-8) Lab Sample ID: 480-126164-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Ethylbenzene	3.2	J	5.6	0.39	ug/Kg	1	☼	8260C	Total/NA
Isopropylbenzene	38		5.6	0.85	ug/Kg	1	☼	8260C	Total/NA
Methyl tert-butyl ether	1.4	J	5.6	0.55	ug/Kg	1	☼	8260C	Total/NA
m-Xylene & p-Xylene	1.6	J	11	0.95	ug/Kg	1	☼	8260C	Total/NA
n-Butylbenzene	65		5.6	0.49	ug/Kg	1	☼	8260C	Total/NA
N-Propylbenzene	150		5.6	0.45	ug/Kg	1	☼	8260C	Total/NA
sec-Butylbenzene	25		5.6	0.49	ug/Kg	1	☼	8260C	Total/NA
tert-Butylbenzene	0.80	J	5.6	0.59	ug/Kg	1	☼	8260C	Total/NA
Xylenes, Total	1.6	J	11	0.95	ug/Kg	1	☼	8260C	Total/NA

Client Sample ID: SB-2 (0.5-2.0) Lab Sample ID: 480-126164-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Benzo[g,h,i]perylene	210	J	1900	200	ug/Kg	10	☼	8270D	Total/NA
Arsenic	11.2		2.2		mg/Kg	1	☼	6010C	Total/NA
Barium	488		0.55		mg/Kg	1	☼	6010C	Total/NA
Cadmium	0.29		0.22		mg/Kg	1	☼	6010C	Total/NA
Chromium	6.2		0.55		mg/Kg	1	☼	6010C	Total/NA
Lead	223		1.1		mg/Kg	1	☼	6010C	Total/NA

Client Sample ID: SB-2 (2-4) Lab Sample ID: 480-126164-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	7.3		2.2		mg/Kg	1	☼	6010C	Total/NA
Barium	108	F1	0.56		mg/Kg	1	☼	6010C	Total/NA
Chromium	5.6		0.56		mg/Kg	1	☼	6010C	Total/NA
Lead	7.2		1.1		mg/Kg	1	☼	6010C	Total/NA

Client Sample ID: SB-3 (2-4) Lab Sample ID: 480-126164-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	1.4	J	5.8	1.1	ug/Kg	1	☼	8260C	Total/NA
1,3,5-Trimethylbenzene	0.40	J	5.8	0.37	ug/Kg	1	☼	8260C	Total/NA
Ethylbenzene	1.0	J	5.8	0.40	ug/Kg	1	☼	8260C	Total/NA
Isopropylbenzene	0.88	J	5.8	0.87	ug/Kg	1	☼	8260C	Total/NA
m-Xylene & p-Xylene	2.7	J	12	0.97	ug/Kg	1	☼	8260C	Total/NA
n-Butylbenzene	5.9		5.8	0.50	ug/Kg	1	☼	8260C	Total/NA
N-Propylbenzene	0.95	J	5.8	0.46	ug/Kg	1	☼	8260C	Total/NA
o-Xylene	0.81	J	5.8	0.76	ug/Kg	1	☼	8260C	Total/NA
sec-Butylbenzene	6.6		5.8	0.50	ug/Kg	1	☼	8260C	Total/NA
tert-Butylbenzene	0.77	J	5.8	0.60	ug/Kg	1	☼	8260C	Total/NA
Toluene	0.46	J	5.8	0.44	ug/Kg	1	☼	8260C	Total/NA
Xylenes, Total	3.5	J	12	0.97	ug/Kg	1	☼	8260C	Total/NA
Chrysene	61	J	200	44	ug/Kg	1	☼	8270D	Total/NA
Arsenic	4.3		2.4		mg/Kg	1	☼	6010C	Total/NA
Barium	135		0.59		mg/Kg	1	☼	6010C	Total/NA
Chromium	28.9		0.59		mg/Kg	1	☼	6010C	Total/NA
Lead	15.8		1.2		mg/Kg	1	☼	6010C	Total/NA

Client Sample ID: SB-6 (2-4) Lab Sample ID: 480-126164-5

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: SB-6 (2-4) (Continued) — Lab Sample ID: 480-126164-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,2,4-Trimethylbenzene	12000		610	170	ug/Kg	5	☼	8260C	Total/NA
1,3,5-Trimethylbenzene	2400		610	180	ug/Kg	5	☼	8260C	Total/NA
4-Isopropyltoluene	220	J	610	210	ug/Kg	5	☼	8260C	Total/NA
Ethylbenzene	400	J	610	180	ug/Kg	5	☼	8260C	Total/NA
Isopropylbenzene	240	J	610	91	ug/Kg	5	☼	8260C	Total/NA
m-Xylene & p-Xylene	900	J	1200	340	ug/Kg	5	☼	8260C	Total/NA
n-Butylbenzene	1900		610	180	ug/Kg	5	☼	8260C	Total/NA
N-Propylbenzene	1000		610	160	ug/Kg	5	☼	8260C	Total/NA
o-Xylene	220	J	610	79	ug/Kg	5	☼	8260C	Total/NA
sec-Butylbenzene	290	J	610	220	ug/Kg	5	☼	8260C	Total/NA
Xylenes, Total	1100	J	1200	340	ug/Kg	5	☼	8260C	Total/NA
Naphthalene	870	J	970	130	ug/Kg	5	☼	8270D	Total/NA

Client Sample ID: SB-7 (1.5-3.5) — Lab Sample ID: 480-126164-6

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
1,3,5-Trimethylbenzene	50000	F1	1200	370	ug/Kg	10	☼	8260C	Total/NA
4-Isopropyltoluene	2200	F1	1200	410	ug/Kg	10	☼	8260C	Total/NA
Benzene	3000	F1	1200	230	ug/Kg	10	☼	8260C	Total/NA
Ethylbenzene	41000	F1	1200	350	ug/Kg	10	☼	8260C	Total/NA
Isopropylbenzene	5400	F1	1200	180	ug/Kg	10	☼	8260C	Total/NA
n-Butylbenzene	18000	F1	1200	350	ug/Kg	10	☼	8260C	Total/NA
N-Propylbenzene	18000	F1	1200	320	ug/Kg	10	☼	8260C	Total/NA
Toluene	11000	F1	1200	330	ug/Kg	10	☼	8260C	Total/NA
1,2,4-Trimethylbenzene - DL	190000		4900	1400	ug/Kg	40	☼	8260C	Total/NA
m-Xylene & p-Xylene - DL	240000		9700	2700	ug/Kg	40	☼	8260C	Total/NA
o-Xylene - DL	79000		4900	630	ug/Kg	40	☼	8260C	Total/NA
Xylenes, Total - DL	320000		9700	2700	ug/Kg	40	☼	8260C	Total/NA

Client Sample ID: SB-8 (0.5-3.5) — Lab Sample ID: 480-126164-7

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	3.2		2.8		mg/Kg	1	☼	6010C	Total/NA
Barium	157		0.71		mg/Kg	1	☼	6010C	Total/NA
Chromium	35.9		3.6		mg/Kg	5	☼	6010C	Total/NA
Lead	45.7		7.1		mg/Kg	5	☼	6010C	Total/NA
Mercury	0.067		0.028		mg/Kg	1	☼	7471B	Total/NA

Client Sample ID: SS-1 — Lab Sample ID: 480-126164-8

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	164		2.3		mg/Kg	1	☼	6010C	Total/NA
Barium	414		0.59		mg/Kg	1	☼	6010C	Total/NA
Cadmium	3.6		1.2		mg/Kg	5	☼	6010C	Total/NA
Chromium	39.7		2.9		mg/Kg	5	☼	6010C	Total/NA
Lead	1030		5.9		mg/Kg	5	☼	6010C	Total/NA
Mercury	0.051		0.020		mg/Kg	1	☼	7471B	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: SB-1 (6-8)

Lab Sample ID: 480-126164-1

Date Collected: 10/18/17 09:04
Date Received: 10/19/17 12:28

Matrix: Solid
Percent Solids: 87.3

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		5.6	1.1	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
1,3,5-Trimethylbenzene	ND		5.6	0.36	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
4-Isopropyltoluene	ND		5.6	0.45	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Benzene	ND		5.6	0.28	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Ethylbenzene	**3.2**	**J**	5.6	0.39	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Isopropylbenzene	**38**		5.6	0.85	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Methyl tert-butyl ether	**1.4**	**J**	5.6	0.55	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
m-Xylene & p-Xylene	**1.6**	**J**	11	0.95	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
n-Butylbenzene	**65**		5.6	0.49	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
N-Propylbenzene	**150**		5.6	0.45	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
o-Xylene	ND		5.6	0.73	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
sec-Butylbenzene	**25**		5.6	0.49	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
tert-Butylbenzene	**0.80**	**J**	5.6	0.59	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Toluene	ND		5.6	0.43	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1
Xylenes, Total	**1.6**	**J**	11	0.95	ug/Kg	☼	10/25/17 09:12	10/25/17 19:12	1

Tentatively Identified Compound	*Est. Result*	*Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Heptane, 2-methyl-	*74*	*T J N*	*ug/Kg*	☼	*6.09*	*592-27-8*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Benzene, 1,2-diethyl-	*120*	*T J N*	*ug/Kg*	☼	*10.55*	*135-01-3*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Indane	*220*	*T J N*	*ug/Kg*	☼	*10.60*	*496-11-7*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Benzene, 1-ethyl-2,4-dimethyl-	*310*	*T J N*	*ug/Kg*	☼	*10.96*	*874-41-9*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
1-Phenyl-1-butene	*120*	*T J N*	*ug/Kg*	☼	*11.09*	*824-90-8*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Benzene, 1,2,4,5-tetramethyl-	*200*	*T J N*	*ug/Kg*	☼	*11.30*	*95-93-2*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Benzene, 2-ethenyl-1,4-dimethyl-	*360*	*T J N*	*ug/Kg*	☼	*11.72*	*2039-89-6*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Unknown	*110*	*T J*	*ug/Kg*	☼	*11.97*		*10/25/17 09:12*	*10/25/17 19:12*	*1*
Unknown	*79*	*T J*	*ug/Kg*	☼	*12.08*		*10/25/17 09:12*	*10/25/17 19:12*	*1*
Naphthalene, 2-methyl-	*120*	*T J N*	*ug/Kg*	☼	*13.28*	*91-57-6*	*10/25/17 09:12*	*10/25/17 19:12*	*1*

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*64 - 126*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
4-Bromofluorobenzene (Surr)	*96*		*72 - 126*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Dibromofluoromethane (Surr)	*100*		*60 - 140*	*10/25/17 09:12*	*10/25/17 19:12*	*1*
Toluene-d8 (Surr)	*95*		*71 - 125*	*10/25/17 09:12*	*10/25/17 19:12*	*1*

Client Sample ID: SB-2 (0.5-2.0)

Lab Sample ID: 480-126164-2

Date Collected: 10/18/17 09:33

Matrix: Solid

Date Received: 10/19/17 12:28

Percent Solids: 89.4

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		1900	270	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Acenaphthylene	ND		1900	240	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Anthracene	ND		1900	460	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Benzo[a]anthracene	ND		1900	190	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Benzo[a]pyrene	ND		1900	270	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Benzo[b]fluoranthene	ND		1900	300	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Benzo[g,h,i]perylene	**210**	**J**	1900	200	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Benzo[k]fluoranthene	ND		1900	240	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Chrysene	ND		1900	420	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Dibenz(a,h)anthracene	ND		1900	330	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Fluoranthene	ND		1900	200	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Fluorene	ND		1900	220	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Indeno[1,2,3-cd]pyrene	ND		1900	230	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Naphthalene	ND		1900	240	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Phenanthrene	ND		1900	270	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10
Pyrene	ND		1900	220	ug/Kg	☼	10/20/17 14:03	10/22/17 19:28	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*87*		*60 - 120*	*10/20/17 14:03*	*10/22/17 19:28*	*10*
Nitrobenzene-d5 (Surr)	*86*		*53 - 120*	*10/20/17 14:03*	*10/22/17 19:28*	*10*
p-Terphenyl-d14 (Surr)	*58*	*X*	*65 - 121*	*10/20/17 14:03*	*10/22/17 19:28*	*10*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**11.2**		2.2		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Barium	**488**		0.55		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Cadmium	**0.29**		0.22		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Chromium	**6.2**		0.55		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Lead	**223**		1.1		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Selenium	ND		4.4		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1
Silver	ND		0.66		mg/Kg	☼	10/23/17 14:51	10/25/17 10:16	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.022		mg/Kg	☼	10/25/17 13:55	10/25/17 17:16	1

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

Client Sample ID: SB-2 (2-4)

Date Collected: 10/18/17 09:47
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-3

Matrix: Solid
Percent Solids: 90.4

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.25	0.048	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1221	ND		0.25	0.048	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1232	ND		0.25	0.048	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1242	ND		0.25	0.048	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1248	ND		0.25	0.048	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1254	ND		0.25	0.12	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1
PCB-1260	ND		0.25	0.12	mg/Kg	☼	10/20/17 08:34	10/23/17 17:29	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene	*110*		*60 - 154*	*10/20/17 08:34*	*10/23/17 17:29*	*1*
DCB Decachlorobiphenyl	*123*		*65 - 174*	*10/20/17 08:34*	*10/23/17 17:29*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**7.3**		2.2		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Barium	**108**	**F1**	0.56		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Cadmium	ND		0.22		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Chromium	**5.6**		0.56		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Lead	**7.2**		1.1		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Selenium	ND		4.5		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1
Silver	ND		0.67		mg/Kg	☼	10/23/17 14:51	10/25/17 10:19	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.022		mg/Kg	☼	10/25/17 13:55	10/25/17 17:19	1

Client Sample Results

Client: Turnkey Environmental Restoration, LLC
Project/Site: Benchmark - 1585 Hertel Ave site

TestAmerica Job ID: 480-126164-1

Client Sample ID: SB-3 (2-4)

Date Collected: 10/18/17 10:23
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-4
Matrix: Solid
Percent Solids: 85.7

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	**1.4**	**J**	5.8	1.1	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
1,3,5-Trimethylbenzene	**0.40**	**J**	5.8	0.37	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
4-Isopropyltoluene	ND		5.8	0.47	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Benzene	ND		5.8	0.28	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Ethylbenzene	**1.0**	**J**	5.8	0.40	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Isopropylbenzene	**0.88**	**J**	5.8	0.87	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Methyl tert-butyl ether	ND		5.8	0.57	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
m-Xylene & p-Xylene	**2.7**	**J**	12	0.97	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
n-Butylbenzene	**5.9**		5.8	0.50	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
N-Propylbenzene	**0.95**	**J**	5.8	0.46	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
o-Xylene	**0.81**	**J**	5.8	0.76	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
sec-Butylbenzene	**6.6**		5.8	0.50	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
tert-Butylbenzene	**0.77**	**J**	5.8	0.60	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Toluene	**0.46**	**J**	5.8	0.44	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1
Xylenes, Total	**3.5**	**J**	12	0.97	ug/Kg	☼	10/26/17 14:02	10/26/17 15:50	1

Tentatively Identified Compound	*Est. Result*	*Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Unknown	*29*	*T J*	*ug/Kg*	☼	*9.82*		*10/26/17 14:02*	*10/26/17 15:50*	*1*
Indan, 1-methyl-	*36*	*T J N*	*ug/Kg*	☼	*11.09*	*767-58-8*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
trans-Decalin, 2-methyl-	*25*	*T J N*	*ug/Kg*	☼	*11.19*	*1000152-47-3*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
Benzene, 1,2,4,5-tetramethyl-	*55*	*T J N*	*ug/Kg*	☼	*11.31*	*95-93-2*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
Undecane, 2,6-dimethyl-	*67*	*T J N*	*ug/Kg*	☼	*11.69*	*17301-23-4*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
Unknown	*26*	*T J*	*ug/Kg*	☼	*11.77*		*10/26/17 14:02*	*10/26/17 15:50*	*1*
Unknown	*34*	*T J*	*ug/Kg*	☼	*11.97*		*10/26/17 14:02*	*10/26/17 15:50*	*1*
Unknown	*29*	*T J*	*ug/Kg*	☼	*12.08*		*10/26/17 14:02*	*10/26/17 15:50*	*1*
Unknown	*46*	*T J*	*ug/Kg*	☼	*12.15*		*10/26/17 14:02*	*10/26/17 15:50*	*1*
Unknown	*33*	*T J*	*ug/Kg*	☼	*13.03*		*10/26/17 14:02*	*10/26/17 15:50*	*1*

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*91*		*64 - 126*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
4-Bromofluorobenzene (Surr)	*95*		*72 - 126*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
Dibromofluoromethane (Surr)	*95*		*60 - 140*	*10/26/17 14:02*	*10/26/17 15:50*	*1*
Toluene-d8 (Surr)	*96*		*71 - 125*	*10/26/17 14:02*	*10/26/17 15:50*	*1*

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		200	29	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Acenaphthylene	ND		200	25	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Anthracene	ND		200	48	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Benzo[a]anthracene	ND		200	20	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Benzo[a]pyrene	ND		200	29	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Benzo[b]fluoranthene	ND		200	31	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Benzo[g,h,i]perylene	ND		200	21	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Benzo[k]fluoranthene	ND		200	25	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Chrysene	**61**	**J**	200	44	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Dibenz(a,h)anthracene	ND		200	34	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Fluoranthene	ND		200	21	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Fluorene	ND		200	23	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Indeno[1,2,3-cd]pyrene	ND		200	24	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1

Client Sample Results

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

Client Sample ID: SB-3 (2-4)

Lab Sample ID: 480-126164-4

Date Collected: 10/18/17 10:23

Matrix: Solid

Date Received: 10/19/17 12:28

Percent Solids: 85.7

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		200	25	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Phenanthrene	ND		200	29	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1
Pyrene	ND		200	23	ug/Kg	☼	10/20/17 14:03	10/22/17 19:54	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*78*		*60 - 120*	*10/20/17 14:03*	*10/22/17 19:54*	*1*
Nitrobenzene-d5 (Surr)	*71*		*53 - 120*	*10/20/17 14:03*	*10/22/17 19:54*	*1*
p-Terphenyl-d14 (Surr)	*89*		*65 - 121*	*10/20/17 14:03*	*10/22/17 19:54*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**4.3**		2.4		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Barium	**135**		0.59		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Cadmium	ND		0.24		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Chromium	**28.9**		0.59		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Lead	**15.8**		1.2		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Selenium	ND		4.7		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1
Silver	ND		0.71		mg/Kg	☼	10/23/17 14:51	10/25/17 10:38	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.023		mg/Kg	☼	10/25/17 13:55	10/25/17 17:21	1

Client Sample Results

Client: Turnkey Environmental Restoration, LLC
Project/Site: Benchmark - 1585 Hertel Ave site

TestAmerica Job ID: 480-126164-1

Client Sample ID: SB-6 (2-4)

Date Collected: 10/18/17 12:54
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-5

Matrix: Solid
Percent Solids: 86.2

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	**12000**		610	170	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
1,3,5-Trimethylbenzene	**2400**		610	180	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
4-Isopropyltoluene	**220**	**J**	610	210	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Benzene	ND		610	120	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Ethylbenzene	**400**	**J**	610	180	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Isopropylbenzene	**240**	**J**	610	91	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Methyl tert-butyl ether	ND		610	230	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
m-Xylene & p-Xylene	**900**	**J**	1200	340	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
n-Butylbenzene	**1900**		610	180	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
N-Propylbenzene	**1000**		610	160	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
o-Xylene	**220**	**J**	610	79	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
sec-Butylbenzene	**290**	**J**	610	220	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Toluene	ND		610	160	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
Xylenes, Total	**1100**	**J**	1200	340	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5
tert-Butylbenzene	ND		610	170	ug/Kg	☼	10/25/17 11:14	10/31/17 03:52	5

Tentatively Identified Compound	*Est. Result*	*Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*	☼			*10/25/17 11:14*	*10/31/17 03:52*	*5*

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*95*		*53 - 146*	*10/25/17 11:14*	*10/31/17 03:52*	*5*
4-Bromofluorobenzene (Surr)	*102*		*49 - 148*	*10/25/17 11:14*	*10/31/17 03:52*	*5*
Toluene-d8 (Surr)	*97*		*50 - 149*	*10/25/17 11:14*	*10/31/17 03:52*	*5*
Dibromofluoromethane (Surr)	*90*		*60 - 140*	*10/25/17 11:14*	*10/31/17 03:52*	*5*

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		970	140	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Acenaphthylene	ND		970	130	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Anthracene	ND		970	240	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Benzo[a]anthracene	ND		970	97	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Benzo[a]pyrene	ND		970	140	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Benzo[b]fluoranthene	ND		970	150	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Benzo[g,h,i]perylene	ND		970	100	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Benzo[k]fluoranthene	ND		970	130	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Chrysene	ND		970	220	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Dibenz(a,h)anthracene	ND		970	170	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Fluoranthene	ND		970	100	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Fluorene	ND		970	110	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Indeno[1,2,3-cd]pyrene	ND		970	120	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Naphthalene	**870**	**J**	970	130	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Phenanthrene	ND		970	140	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5
Pyrene	ND		970	110	ug/Kg	☼	10/20/17 14:03	10/22/17 20:20	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*84*		*60 - 120*	*10/20/17 14:03*	*10/22/17 20:20*	*5*
Nitrobenzene-d5 (Surr)	*74*		*53 - 120*	*10/20/17 14:03*	*10/22/17 20:20*	*5*
p-Terphenyl-d14 (Surr)	*80*		*65 - 121*	*10/20/17 14:03*	*10/22/17 20:20*	*5*

Client Sample ID: SB-7 (1.5-3.5)

Lab Sample ID: 480-126164-6

Date Collected: 10/18/17 14:10

Matrix: Solid

Date Received: 10/19/17 12:28

Percent Solids: 85.5

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,3,5-Trimethylbenzene	**50000**	**F1**	1200	370	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
4-Isopropyltoluene	**2200**	**F1**	1200	410	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
Benzene	**3000**	**F1**	1200	230	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
Ethylbenzene	**41000**	**F1**	1200	350	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
Isopropylbenzene	**5400**	**F1**	1200	180	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
Methyl tert-butyl ether	ND	F1	1200	460	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
n-Butylbenzene	**18000**	**F1**	1200	350	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
N-Propylbenzene	**18000**	**F1**	1200	320	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
sec-Butylbenzene	ND	F1	1200	450	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
Toluene	**11000**	**F1**	1200	330	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10
tert-Butylbenzene	ND	F1 F2	1200	340	ug/Kg	☼	10/25/17 11:14	10/31/17 04:19	10

Tentatively Identified Compound	*Est. Result*	*Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*	☼			*10/25/17 11:14*	*10/31/17 04:19*	*10*

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*96*		*53 - 146*	*10/25/17 11:14*	*10/31/17 04:19*	*10*
4-Bromofluorobenzene (Surr)	*103*		*49 - 148*	*10/25/17 11:14*	*10/31/17 04:19*	*10*
Toluene-d8 (Surr)	*99*		*50 - 149*	*10/25/17 11:14*	*10/31/17 04:19*	*10*
Dibromofluoromethane (Surr)	*96*		*60 - 140*	*10/25/17 11:14*	*10/31/17 04:19*	*10*

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	**190000**		4900	1400	ug/Kg	☼	10/25/17 11:14	10/31/17 11:41	40
m-Xylene & p-Xylene	**240000**		9700	2700	ug/Kg	☼	10/25/17 11:14	10/31/17 11:41	40
o-Xylene	**79000**		4900	630	ug/Kg	☼	10/25/17 11:14	10/31/17 11:41	40
Xylenes, Total	**320000**		9700	2700	ug/Kg	☼	10/25/17 11:14	10/31/17 11:41	40

Tentatively Identified Compound	*Est. Result*	*Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*	☼			*10/25/17 11:14*	*10/31/17 11:41*	*40*

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*95*		*53 - 146*	*10/25/17 11:14*	*10/31/17 11:41*	*40*
4-Bromofluorobenzene (Surr)	*101*		*49 - 148*	*10/25/17 11:14*	*10/31/17 11:41*	*40*
Toluene-d8 (Surr)	*97*		*50 - 149*	*10/25/17 11:14*	*10/31/17 11:41*	*40*
Dibromofluoromethane (Surr)	*94*		*60 - 140*	*10/25/17 11:14*	*10/31/17 11:41*	*40*

Client Sample Results

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

Client Sample ID: SB-8 (0.5-3.5)

Date Collected: 10/18/17 15:23
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-7

Matrix: Solid
Percent Solids: 69.5

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		1200	180	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Acenaphthylene	ND		1200	160	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Anthracene	ND		1200	300	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Benzo[a]anthracene	ND		1200	120	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Benzo[a]pyrene	ND		1200	180	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Benzo[b]fluoranthene	ND		1200	190	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Benzo[g,h,i]perylene	ND		1200	130	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Benzo[k]fluoranthene	ND		1200	160	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Chrysene	ND		1200	270	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Dibenz(a,h)anthracene	ND		1200	210	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Fluoranthene	ND		1200	130	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Fluorene	ND		1200	140	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Indeno[1,2,3-cd]pyrene	ND		1200	150	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Naphthalene	ND		1200	160	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Phenanthrene	ND		1200	180	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5
Pyrene	ND		1200	140	ug/Kg	☼	10/20/17 14:03	10/22/17 20:46	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*88*		*60 - 120*	*10/20/17 14:03*	*10/22/17 20:46*	*5*
Nitrobenzene-d5 (Surr)	*76*		*53 - 120*	*10/20/17 14:03*	*10/22/17 20:46*	*5*
p-Terphenyl-d14 (Surr)	*80*		*65 - 121*	*10/20/17 14:03*	*10/22/17 20:46*	*5*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**3.2**		2.8		mg/Kg	☼	10/23/17 14:51	10/25/17 10:52	1
Barium	**157**		0.71		mg/Kg	☼	10/23/17 14:51	10/25/17 10:52	1
Cadmium	ND		1.4		mg/Kg	☼	10/23/17 14:51	10/25/17 10:56	5
Chromium	**35.9**		3.6		mg/Kg	☼	10/23/17 14:51	10/25/17 10:56	5
Lead	**45.7**		7.1		mg/Kg	☼	10/23/17 14:51	10/25/17 10:56	5
Selenium	ND		5.7		mg/Kg	☼	10/23/17 14:51	10/25/17 10:52	1
Silver	ND		0.85		mg/Kg	☼	10/23/17 14:51	10/25/17 10:52	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.067**		0.028		mg/Kg	☼	10/25/17 13:55	10/25/17 17:22	1

Client Sample ID: SS-1

Lab Sample ID: 480-126164-8

Date Collected: 10/18/17 15:40
Date Received: 10/19/17 12:28
Matrix: Solid
Percent Solids: 94.8

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

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		130000	19000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Acenaphthylene	ND		130000	17000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Anthracene	ND		130000	33000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Benzo[a]anthracene	ND		130000	13000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Benzo[a]pyrene	ND		130000	19000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Benzo[b]fluoranthene	ND		130000	21000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Benzo[g,h,i]perylene	ND		130000	14000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Benzo[k]fluoranthene	ND		130000	17000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Chrysene	ND		130000	29000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Dibenz(a,h)anthracene	ND		130000	23000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Fluoranthene	ND		130000	14000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Fluorene	ND		130000	15000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Indeno[1,2,3-cd]pyrene	ND		130000	16000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Naphthalene	ND		130000	17000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Phenanthrene	ND		130000	19000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50
Pyrene	ND		130000	15000	ug/Kg	☼	10/20/17 14:03	10/22/17 21:13	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*0*	*X*	*60 - 120*	*10/20/17 14:03*	*10/22/17 21:13*	*50*
Nitrobenzene-d5 (Surr)	*0*	*X*	*53 - 120*	*10/20/17 14:03*	*10/22/17 21:13*	*50*
p-Terphenyl-d14 (Surr)	*0*	*X*	*65 - 121*	*10/20/17 14:03*	*10/22/17 21:13*	*50*

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.25	0.049	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1221	ND		0.25	0.049	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1232	ND		0.25	0.049	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1242	ND		0.25	0.049	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1248	ND		0.25	0.049	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1254	ND		0.25	0.12	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1
PCB-1260	ND		0.25	0.12	mg/Kg	☼	10/20/17 08:34	10/23/17 17:44	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene	*58*	*X*	*60 - 154*	*10/20/17 08:34*	*10/23/17 17:44*	*1*
DCB Decachlorobiphenyl	*67*		*65 - 174*	*10/20/17 08:34*	*10/23/17 17:44*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**164**		2.3		mg/Kg	☼	10/23/17 14:51	10/25/17 10:59	1
Barium	**414**		0.59		mg/Kg	☼	10/23/17 14:51	10/25/17 10:59	1
Cadmium	**3.6**		1.2		mg/Kg	☼	10/23/17 14:51	10/25/17 11:03	5
Chromium	**39.7**		2.9		mg/Kg	☼	10/23/17 14:51	10/25/17 11:03	5
Lead	**1030**		5.9		mg/Kg	☼	10/23/17 14:51	10/25/17 11:03	5
Selenium	ND		4.7		mg/Kg	☼	10/23/17 14:51	10/25/17 10:59	1
Silver	ND		0.70		mg/Kg	☼	10/23/17 14:51	10/25/17 10:59	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.051**		0.020		mg/Kg	☼	10/25/17 13:55	10/25/17 17:26	1

Surrogate Summary

Client: Turnkey Environmental Restoration, LLC TestAmerica Job ID: 480-126164-1
Project/Site: Benchmark - 1585 Hertel Ave site

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

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

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

		Percent Surrogate Recovery (Acceptance Limits)			
Lab Sample ID	**Client Sample ID**	**12DCE (64-126)**	**BFB (72-126)**	**DBFM (60-140)**	**TOL (71-125)**
480-126164-1	SB-1 (6-8)	101	96	100	95
480-126164-4	SB-3 (2-4)	91	95	95	96
LCS 480-383680/1-A	Lab Control Sample	116	116	121	111
LCS 480-383999/1-A	Lab Control Sample	94	106	101	104
MB 480-383680/2-A	Method Blank	115	109	111	103
MB 480-383999/2-A	Method Blank	92	105	100	100

Surrogate Legend

12DCE = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

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

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

		Percent Surrogate Recovery (Acceptance Limits)			
Lab Sample ID	**Client Sample ID**	**12DCE (53-146)**	**BFB (49-148)**	**DBFM (60-140)**	**TOL (50-149)**
480-126164-5	SB-6 (2-4)	95	102	90	97
480-126164-6	SB-7 (1.5-3.5)	96	103	96	99
480-126164-6 - DL	SB-7 (1.5-3.5)	95	101	94	97
LCS 480-383716/1-A	Lab Control Sample	109	96	92	93
LCS 480-384677/5	Lab Control Sample	96	99	93	96
LCS 480-384735/5	Lab Control Sample	95	101	95	98
MB 480-383716/2-A	Method Blank	112	97	90	95
MB 480-384677/7	Method Blank	100	99	94	97

Surrogate Legend

12DCE = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

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

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

		Percent Surrogate Recovery (Acceptance Limits)		
Lab Sample ID	**Client Sample ID**	**FBP (60-120)**	**NBZ (53-120)**	**TPH (65-121)**
480-126164-2	SB-2 (0.5-2.0)	87	86	58 X
480-126164-4	SB-3 (2-4)	78	71	89
480-126164-5	SB-6 (2-4)	84	74	80
480-126164-7	SB-8 (0.5-3.5)	88	76	80
480-126164-8	SS-1	0 X	0 X	0 X
LCS 480-382977/2-A	Lab Control Sample	80	82	100
MB 480-382977/1-A	Method Blank	81	75	98

Surrogate Legend

FBP = 2-Fluorobiphenyl

NBZ = Nitrobenzene-d5 (Surr)
TPH = p-Terphenyl-d14 (Surr)

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Matrix: Solid

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)	
		TCX1	DCB1
Lab Sample ID	**Client Sample ID**	(60-154)	(65-174)
480-126164-3	SB-2 (2-4)	110	123
480-126164-8	SS-1	58 X	67
LCS 480-382878/2-A	Lab Control Sample	124	133
LCS 480-382878/3-A	Lab Control Sample	146	143
MB 480-382878/1-A	Method Blank	105	114

Surrogate Legend

TCX = Tetrachloro-m-xylene
DCB = DCB Decachlorobiphenyl

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

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

Lab Sample ID: MB 480-383680/2-A
Matrix: Solid
Analysis Batch: 383669

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383680

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		5.0	0.96	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
1,3,5-Trimethylbenzene	ND		5.0	0.32	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
4-Isopropyltoluene	ND		5.0	0.40	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Benzene	ND		5.0	0.25	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Ethylbenzene	ND		5.0	0.35	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Isopropylbenzene	ND		5.0	0.75	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Methyl tert-butyl ether	ND		5.0	0.49	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
m-Xylene & p-Xylene	ND		10	0.84	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
n-Butylbenzene	ND		5.0	0.44	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
N-Propylbenzene	ND		5.0	0.40	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
o-Xylene	ND		5.0	0.65	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
sec-Butylbenzene	ND		5.0	0.44	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Toluene	ND		5.0	0.38	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
tert-Butylbenzene	ND		5.0	0.52	ug/Kg		10/25/17 09:12	10/25/17 12:05	1
Xylenes, Total	ND		10	0.84	ug/Kg		10/25/17 09:12	10/25/17 12:05	1

Tentatively Identified Compound	*MB Est. Result*	*MB Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*				*10/25/17 09:12*	*10/25/17 12:05*	*1*

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*115*		*64 - 126*	*10/25/17 09:12*	*10/25/17 12:05*	*1*
4-Bromofluorobenzene (Surr)	*109*		*72 - 126*	*10/25/17 09:12*	*10/25/17 12:05*	*1*
Toluene-d8 (Surr)	*103*		*71 - 125*	*10/25/17 09:12*	*10/25/17 12:05*	*1*
Dibromofluoromethane (Surr)	*111*		*60 - 140*	*10/25/17 09:12*	*10/25/17 12:05*	*1*

Lab Sample ID: LCS 480-383680/1-A
Matrix: Solid
Analysis Batch: 383669

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383680

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	50.0	53.0		ug/Kg		106	74 - 120
1,3,5-Trimethylbenzene	50.0	53.2		ug/Kg		106	74 - 120
4-Isopropyltoluene	50.0	53.4		ug/Kg		107	74 - 120
Benzene	50.0	55.9		ug/Kg		112	79 - 127
Ethylbenzene	50.0	54.1		ug/Kg		108	80 - 120
Isopropylbenzene	50.0	51.8		ug/Kg		104	72 - 120
Methyl tert-butyl ether	50.0	57.9		ug/Kg		116	63 - 125
m-Xylene & p-Xylene	50.0	55.7		ug/Kg		111	70 - 130
n-Butylbenzene	50.0	52.2		ug/Kg		104	70 - 120
N-Propylbenzene	50.0	51.6		ug/Kg		103	70 - 130
o-Xylene	50.0	54.9		ug/Kg		110	70 - 130
sec-Butylbenzene	50.0	52.3		ug/Kg		105	74 - 120
Toluene	50.0	53.8		ug/Kg		108	74 - 128
tert-Butylbenzene	50.0	51.9		ug/Kg		104	73 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*116*		*64 - 126*

QC Sample Results

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

Lab Sample ID: LCS 480-383680/1-A
Matrix: Solid
Analysis Batch: 383669

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383680

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
4-Bromofluorobenzene (Surr)	*116*		*72 - 126*
Toluene-d8 (Surr)	*111*		*71 - 125*
Dibromofluoromethane (Surr)	*121*		*60 - 140*

Lab Sample ID: MB 480-383716/2-A
Matrix: Solid
Analysis Batch: 383699

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383716

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		100	28	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
1,3,5-Trimethylbenzene	ND		100	30	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
4-Isopropyltoluene	ND		100	34	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Benzene	ND		100	19	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Ethylbenzene	ND		100	29	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Isopropylbenzene	ND		100	15	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Methyl tert-butyl ether	ND		100	38	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
m-Xylene & p-Xylene	ND		200	55	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
n-Butylbenzene	ND		100	29	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
N-Propylbenzene	ND		100	26	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
o-Xylene	ND		100	13	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
sec-Butylbenzene	ND		100	37	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Toluene	ND		100	27	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
tert-Butylbenzene	ND		100	28	ug/Kg		10/25/17 11:14	10/25/17 14:31	1
Xylenes, Total	ND		200	55	ug/Kg		10/25/17 11:14	10/25/17 14:31	1

Tentatively Identified Compound	*MB Est. Result*	*MB Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrahydrofuran	*125*	*J*	*ug/Kg*		*4.68*	*109-99-9*	*10/25/17 11:14*	*10/25/17 14:31*	*1*
Tentatively Identified Compound	*None*		*ug/Kg*				*10/25/17 11:14*	*10/25/17 14:31*	*1*

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*112*		*53 - 146*	*10/25/17 11:14*	*10/25/17 14:31*	*1*
4-Bromofluorobenzene (Surr)	*97*		*49 - 148*	*10/25/17 11:14*	*10/25/17 14:31*	*1*
Toluene-d8 (Surr)	*95*		*50 - 149*	*10/25/17 11:14*	*10/25/17 14:31*	*1*
Dibromofluoromethane (Surr)	*90*		*60 - 140*	*10/25/17 11:14*	*10/25/17 14:31*	*1*

Lab Sample ID: LCS 480-383716/1-A
Matrix: Solid
Analysis Batch: 383699

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383716

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	2500	2380		ug/Kg		95	77 - 127
1,3,5-Trimethylbenzene	2500	2370		ug/Kg		95	79 - 120
4-Isopropyltoluene	2500	2510		ug/Kg		101	80 - 120
Benzene	2500	2280		ug/Kg		91	77 - 125
Ethylbenzene	2500	2600		ug/Kg		104	78 - 124
Isopropylbenzene	2500	2260		ug/Kg		91	76 - 120
Methyl tert-butyl ether	2500	2160		ug/Kg		86	67 - 137

QC Sample Results

Client: Turnkey Environmental Restoration, LLC
Project/Site: Benchmark - 1585 Hertel Ave site

TestAmerica Job ID: 480-126164-1

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

Lab Sample ID: LCS 480-383716/1-A
Matrix: Solid
Analysis Batch: 383699

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383716

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
m-Xylene & p-Xylene	2500	2490		ug/Kg		100	77 - 125
n-Butylbenzene	2500	2420		ug/Kg		97	80 - 120
N-Propylbenzene	2500	2400		ug/Kg		96	76 - 120
o-Xylene	2500	2570		ug/Kg		103	80 - 124
sec-Butylbenzene	2500	2370		ug/Kg		95	79 - 120
Toluene	2500	2440		ug/Kg		98	75 - 124
tert-Butylbenzene	2500	2540		ug/Kg		101	78 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*109*		*53 - 146*
4-Bromofluorobenzene (Surr)	*96*		*49 - 148*
Toluene-d8 (Surr)	*93*		*50 - 149*
Dibromofluoromethane (Surr)	*92*		*60 - 140*

Lab Sample ID: MB 480-383999/2-A
Matrix: Solid
Analysis Batch: 383959

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383999

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		5.0	0.96	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
1,3,5-Trimethylbenzene	ND		5.0	0.32	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
4-Isopropyltoluene	ND		5.0	0.40	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Benzene	ND		5.0	0.25	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Ethylbenzene	ND		5.0	0.35	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Isopropylbenzene	ND		5.0	0.75	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Methyl tert-butyl ether	ND		5.0	0.49	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
m-Xylene & p-Xylene	ND		10	0.84	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
n-Butylbenzene	ND		5.0	0.44	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
N-Propylbenzene	ND		5.0	0.40	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
o-Xylene	ND		5.0	0.65	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
sec-Butylbenzene	ND		5.0	0.44	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Toluene	ND		5.0	0.38	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
tert-Butylbenzene	ND		5.0	0.52	ug/Kg		10/26/17 10:00	10/26/17 14:37	1
Xylenes, Total	ND		10	0.84	ug/Kg		10/26/17 10:00	10/26/17 14:37	1

Tentatively Identified Compound	*MB Est. Result*	*MB Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*				*10/26/17 10:00*	*10/26/17 14:37*	*1*

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*92*		*64 - 126*	*10/26/17 10:00*	*10/26/17 14:37*	*1*
4-Bromofluorobenzene (Surr)	*105*		*72 - 126*	*10/26/17 10:00*	*10/26/17 14:37*	*1*
Toluene-d8 (Surr)	*100*		*71 - 125*	*10/26/17 10:00*	*10/26/17 14:37*	*1*
Dibromofluoromethane (Surr)	*100*		*60 - 140*	*10/26/17 10:00*	*10/26/17 14:37*	*1*

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

Lab Sample ID: LCS 480-383999/1-A
Matrix: Solid
Analysis Batch: 383959

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383999

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	50.0	48.1		ug/Kg		96	74 - 120
1,3,5-Trimethylbenzene	50.0	48.2		ug/Kg		96	74 - 120
4-Isopropyltoluene	50.0	49.2		ug/Kg		98	74 - 120
Benzene	50.0	49.5		ug/Kg		99	79 - 127
Ethylbenzene	50.0	49.1		ug/Kg		98	80 - 120
Isopropylbenzene	50.0	47.8		ug/Kg		96	72 - 120
Methyl tert-butyl ether	50.0	47.9		ug/Kg		96	63 - 125
m-Xylene & p-Xylene	50.0	50.3		ug/Kg		101	70 - 130
n-Butylbenzene	50.0	47.9		ug/Kg		96	70 - 120
N-Propylbenzene	50.0	47.1		ug/Kg		94	70 - 130
o-Xylene	50.0	50.9		ug/Kg		102	70 - 130
sec-Butylbenzene	50.0	48.7		ug/Kg		97	74 - 120
Toluene	50.0	48.6		ug/Kg		97	74 - 128
tert-Butylbenzene	50.0	49.1		ug/Kg		98	73 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*94*		*64 - 126*
4-Bromofluorobenzene (Surr)	*106*		*72 - 126*
Toluene-d8 (Surr)	*104*		*71 - 125*
Dibromofluoromethane (Surr)	*101*		*60 - 140*

Lab Sample ID: MB 480-384677/7
Matrix: Solid
Analysis Batch: 384677

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

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,4-Trimethylbenzene	ND		1.0	0.28	ug/Kg			10/30/17 20:31	1
1,3,5-Trimethylbenzene	ND		1.0	0.30	ug/Kg			10/30/17 20:31	1
4-Isopropyltoluene	ND		1.0	0.34	ug/Kg			10/30/17 20:31	1
Benzene	ND		1.0	0.19	ug/Kg			10/30/17 20:31	1
Ethylbenzene	ND		1.0	0.29	ug/Kg			10/30/17 20:31	1
Isopropylbenzene	ND		1.0	0.15	ug/Kg			10/30/17 20:31	1
Methyl tert-butyl ether	ND		1.0	0.38	ug/Kg			10/30/17 20:31	1
m-Xylene & p-Xylene	ND		2.0	0.55	ug/Kg			10/30/17 20:31	1
n-Butylbenzene	ND		1.0	0.29	ug/Kg			10/30/17 20:31	1
N-Propylbenzene	ND		1.0	0.26	ug/Kg			10/30/17 20:31	1
o-Xylene	ND		1.0	0.13	ug/Kg			10/30/17 20:31	1
sec-Butylbenzene	ND		1.0	0.37	ug/Kg			10/30/17 20:31	1
Toluene	ND		1.0	0.27	ug/Kg			10/30/17 20:31	1
tert-Butylbenzene	ND		1.0	0.28	ug/Kg			10/30/17 20:31	1
Xylenes, Total	ND		2.0	0.55	ug/Kg			10/30/17 20:31	1

Tentatively Identified Compound	*MB Est. Result*	*MB Qualifier*	*Unit*	*D*	*RT*	*CAS No.*	*Prepared*	*Analyzed*	*Dil Fac*
Tentatively Identified Compound	*None*		*ug/Kg*					*10/30/17 20:31*	*1*

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*53 - 146*		*10/30/17 20:31*	*1*

QC Sample Results

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

Lab Sample ID: MB 480-384677/7

Matrix: Solid
Analysis Batch: 384677

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

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*99*		*49 - 148*		*10/30/17 20:31*	*1*
Toluene-d8 (Surr)	*97*		*50 - 149*		*10/30/17 20:31*	*1*
Dibromofluoromethane (Surr)	*94*		*60 - 140*		*10/30/17 20:31*	*1*

Lab Sample ID: LCS 480-384677/5

Matrix: Solid
Analysis Batch: 384677

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

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	25.0	23.8		ug/Kg		95	77 - 127
1,3,5-Trimethylbenzene	25.0	23.4		ug/Kg		93	79 - 120
4-Isopropyltoluene	25.0	22.1		ug/Kg		88	80 - 120
Benzene	25.0	21.2		ug/Kg		85	77 - 125
Ethylbenzene	25.0	22.4		ug/Kg		89	78 - 124
Isopropylbenzene	25.0	22.2		ug/Kg		89	76 - 120
Methyl tert-butyl ether	25.0	24.6		ug/Kg		98	67 - 137
m-Xylene & p-Xylene	25.0	22.1		ug/Kg		88	77 - 125
n-Butylbenzene	25.0	22.4		ug/Kg		89	80 - 120
N-Propylbenzene	25.0	21.4		ug/Kg		85	76 - 120
o-Xylene	25.0	22.2		ug/Kg		89	80 - 124
sec-Butylbenzene	25.0	21.5		ug/Kg		86	79 - 120
Toluene	25.0	20.7		ug/Kg		83	75 - 124
tert-Butylbenzene	25.0	22.5		ug/Kg		90	78 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*96*		*53 - 146*
4-Bromofluorobenzene (Surr)	*99*		*49 - 148*
Toluene-d8 (Surr)	*96*		*50 - 149*
Dibromofluoromethane (Surr)	*93*		*60 - 140*

Lab Sample ID: LCS 480-384735/5

Matrix: Solid
Analysis Batch: 384735

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

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2,4-Trimethylbenzene	25.0	25.9		ug/Kg		103	77 - 127
1,3,5-Trimethylbenzene	25.0	26.4		ug/Kg		106	79 - 120
4-Isopropyltoluene	25.0	25.9		ug/Kg		103	80 - 120
Benzene	25.0	23.5		ug/Kg		94	77 - 125
Ethylbenzene	25.0	24.9		ug/Kg		100	78 - 124
Isopropylbenzene	25.0	26.3		ug/Kg		105	76 - 120
Methyl tert-butyl ether	25.0	25.1		ug/Kg		101	67 - 137
m-Xylene & p-Xylene	25.0	23.9		ug/Kg		96	77 - 125
n-Butylbenzene	25.0	26.4		ug/Kg		106	80 - 120
N-Propylbenzene	25.0	25.2		ug/Kg		101	76 - 120
o-Xylene	25.0	24.3		ug/Kg		97	80 - 124
sec-Butylbenzene	25.0	25.0		ug/Kg		100	79 - 120
Toluene	25.0	23.6		ug/Kg		94	75 - 124

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

Lab Sample ID: LCS 480-384735/5
Matrix: Solid
Analysis Batch: 384735

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

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
tert-Butylbenzene	25.0	25.9		ug/Kg		104	78 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*95*		*53 - 146*
4-Bromofluorobenzene (Surr)	*101*		*49 - 148*
Toluene-d8 (Surr)	*98*		*50 - 149*
Dibromofluoromethane (Surr)	*95*		*60 - 140*

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

Lab Sample ID: MB 480-382977/1-A
Matrix: Solid
Analysis Batch: 383167

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 382977

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		170	24	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Acenaphthylene	ND		170	21	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Anthracene	ND		170	41	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Benzo[a]anthracene	ND		170	17	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Benzo[a]pyrene	ND		170	24	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Benzo[b]fluoranthene	ND		170	26	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Benzo[g,h,i]perylene	ND		170	18	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Benzo[k]fluoranthene	ND		170	21	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Chrysene	ND		170	37	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Dibenz(a,h)anthracene	ND		170	29	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Fluoranthene	ND		170	18	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Fluorene	ND		170	19	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Indeno[1,2,3-cd]pyrene	ND		170	20	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Naphthalene	ND		170	21	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Phenanthrene	ND		170	24	ug/Kg		10/20/17 14:03	10/22/17 16:50	1
Pyrene	ND		170	19	ug/Kg		10/20/17 14:03	10/22/17 16:50	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*81*		*60 - 120*	*10/20/17 14:03*	*10/22/17 16:50*	*1*
Nitrobenzene-d5 (Surr)	*75*		*53 - 120*	*10/20/17 14:03*	*10/22/17 16:50*	*1*
p-Terphenyl-d14 (Surr)	*98*		*65 - 121*	*10/20/17 14:03*	*10/22/17 16:50*	*1*

Lab Sample ID: LCS 480-382977/2-A
Matrix: Solid
Analysis Batch: 383167

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 382977

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	1620	1400		ug/Kg		86	62 - 120
Acenaphthylene	1620	1380		ug/Kg		85	58 - 121
Anthracene	1620	1490		ug/Kg		92	62 - 120
Benzo[a]anthracene	1620	1560		ug/Kg		96	65 - 120
Benzo[a]pyrene	1620	1580		ug/Kg		98	64 - 120

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

Lab Sample ID: LCS 480-382977/2-A
Matrix: Solid
Analysis Batch: 383167

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 382977

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzo[b]fluoranthene	1620	1620		ug/Kg		100	64 - 120
Benzo[g,h,i]perylene	1620	1380		ug/Kg		85	45 - 145
Benzo[k]fluoranthene	1620	1630		ug/Kg		100	65 - 120
Chrysene	1620	1530		ug/Kg		95	64 - 120
Dibenz(a,h)anthracene	1620	1430		ug/Kg		88	54 - 132
Fluoranthene	1620	1540		ug/Kg		95	62 - 120
Fluorene	1620	1440		ug/Kg		89	63 - 120
Indeno[1,2,3-cd]pyrene	1620	1410		ug/Kg		87	56 - 134
Naphthalene	1620	1250		ug/Kg		77	55 - 120
Phenanthrene	1620	1540		ug/Kg		95	60 - 120
Pyrene	1620	1570		ug/Kg		97	61 - 133

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl	*80*		*60 - 120*
Nitrobenzene-d5 (Surr)	*82*		*53 - 120*
p-Terphenyl-d14 (Surr)	*100*		*65 - 121*

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography

Lab Sample ID: MB 480-382878/1-A
Matrix: Solid
Analysis Batch: 383309

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 382878

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.19	0.037	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1221	ND		0.19	0.037	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1232	ND		0.19	0.037	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1242	ND		0.19	0.037	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1248	ND		0.19	0.037	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1254	ND		0.19	0.088	mg/Kg		10/20/17 08:34	10/23/17 15:26	1
PCB-1260	ND		0.19	0.088	mg/Kg		10/20/17 08:34	10/23/17 15:26	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene	*105*		*60 - 154*	*10/20/17 08:34*	*10/23/17 15:26*	*1*
DCB Decachlorobiphenyl	*114*		*65 - 174*	*10/20/17 08:34*	*10/23/17 15:26*	*1*

Lab Sample ID: LCS 480-382878/2-A
Matrix: Solid
Analysis Batch: 383309

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 382878

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Tetrachloro-m-xylene	*124*		*60 - 154*
DCB Decachlorobiphenyl	*133*		*65 - 174*

Method: 8082A - Polychlorinated Biphenyls (PCBs) by Gas Chromatography (Continued)

Lab Sample ID: LCS 480-382878/3-A
Matrix: Solid
Analysis Batch: 383309

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 382878

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
PCB-1016	1.98	2.19		mg/Kg		110	51 - 185
PCB-1260	1.98	2.70		mg/Kg		136	61 - 184

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Tetrachloro-m-xylene	*146*		*60 - 154*
DCB Decachlorobiphenyl	*143*		*65 - 174*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 480-383281/1-A
Matrix: Solid
Analysis Batch: 383788

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383281

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		1.9		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Barium	ND		0.47		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Cadmium	ND		0.19		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Chromium	ND		0.47		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Lead	ND		0.94		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Selenium	ND		3.8		mg/Kg		10/23/17 14:51	10/25/17 10:09	1
Silver	ND		0.56		mg/Kg		10/23/17 14:51	10/25/17 10:09	1

Lab Sample ID: LCSSRM 480-383281/2-A
Matrix: Solid
Analysis Batch: 383788

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383281

Analyte	Spike Added	LCSSRM Result	LCSSRM Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	100	93.71		mg/Kg		93.7	69.6 - 131.0
Barium	217	194.5		mg/Kg		89.6	73.7 - 128.1
Cadmium	83.7	73.51		mg/Kg		87.8	73.2 - 131.4
Chromium	107	100.6		mg/Kg		94.0	69.4 - 134.6
Lead	88.4	96.11		mg/Kg		108.7	69.9 - 130.1
Selenium	87.7	79.50		mg/Kg		90.6	64.1 - 135.7
Silver	41.4	34.65		mg/Kg		83.7	65.9 - 133.8

Lab Sample ID: 480-126164-3 MS
Matrix: Solid
Analysis Batch: 383788

Client Sample ID: SB-2 (2-4)
Prep Type: Total/NA
Prep Batch: 383281

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	7.3		45.9	50.05		mg/Kg	☼	93	75 - 125
Barium	108	F1	45.9	84.83	F1	mg/Kg	☼	-50	75 - 125
Cadmium	ND		45.9	45.62		mg/Kg	☼	99	75 - 125

Method: 6010C - Metals (ICP) (Continued)

Lab Sample ID: 480-126164-3 MS
Matrix: Solid
Analysis Batch: 383788

Client Sample ID: SB-2 (2-4)
Prep Type: Total/NA
Prep Batch: 383281

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Chromium	5.6		45.9	51.02		mg/Kg	☼	99	75 - 125
Lead	7.2		45.9	54.35		mg/Kg	☼	103	75 - 125
Selenium	ND		45.9	43.17		mg/Kg	☼	94	75 - 125
Silver	ND		11.5	10.39		mg/Kg	☼	91	75 - 125

Lab Sample ID: 480-126164-3 MSD
Matrix: Solid
Analysis Batch: 383788

Client Sample ID: SB-2 (2-4)
Prep Type: Total/NA
Prep Batch: 383281

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	7.3		41.9	44.74		mg/Kg	☼	89	75 - 125	11	20
Barium	108	F1	41.9	82.29	F1	mg/Kg	☼	-61	75 - 125	3	20
Cadmium	ND		41.9	40.99		mg/Kg	☼	98	75 - 125	11	20
Chromium	5.6		41.9	45.74		mg/Kg	☼	96	75 - 125	11	20
Lead	7.2		41.9	49.63		mg/Kg	☼	101	75 - 125	9	20
Selenium	ND		41.9	38.92		mg/Kg	☼	93	75 - 125	10	20
Silver	ND		10.5	9.24		mg/Kg	☼	88	75 - 125	12	20

Method: 7471B - Mercury (CVAA)

Lab Sample ID: MB 480-383104/1-A
Matrix: Solid
Analysis Batch: 383820

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383104

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.019		mg/Kg		10/25/17 13:55	10/25/17 16:07	1

Lab Sample ID: LCSSRM 480-383104/2-A ^10
Matrix: Solid
Analysis Batch: 383820

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383104

Analyte	Spike Added	LCSSRM Result	LCSSRM Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	12.6	9.98		mg/Kg		79.2	44.4 - 128.6

Lab Sample ID: MB 480-383105/1-A
Matrix: Solid
Analysis Batch: 383820

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 383105

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.021		mg/Kg		10/25/17 13:55	10/25/17 16:49	1

Lab Sample ID: LCSSRM 480-383105/2-A ^10
Matrix: Solid
Analysis Batch: 383820

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 383105

Analyte	Spike Added	LCSSRM Result	LCSSRM Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	12.6	10.16		mg/Kg		80.6	44.4 - 128.6

QC Association Summary

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

GC/MS VOA

Analysis Batch: 383669

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-1	SB-1 (6-8)	Total/NA	Solid	8260C	383680
MB 480-383680/2-A	Method Blank	Total/NA	Solid	8260C	383680
LCS 480-383680/1-A	Lab Control Sample	Total/NA	Solid	8260C	383680

Prep Batch: 383680

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-1	SB-1 (6-8)	Total/NA	Solid	5035A_L	
MB 480-383680/2-A	Method Blank	Total/NA	Solid	5035A_L	
LCS 480-383680/1-A	Lab Control Sample	Total/NA	Solid	5035A_L	

Analysis Batch: 383699

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 480-383716/2-A	Method Blank	Total/NA	Solid	8260C	383716
LCS 480-383716/1-A	Lab Control Sample	Total/NA	Solid	8260C	383716

Prep Batch: 383716

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-5	SB-6 (2-4)	Total/NA	Solid	5035A_H	
480-126164-6	SB-7 (1.5-3.5)	Total/NA	Solid	5035A_H	
480-126164-6 - DL	SB-7 (1.5-3.5)	Total/NA	Solid	5035A_H	
MB 480-383716/2-A	Method Blank	Total/NA	Solid	5035A_H	
LCS 480-383716/1-A	Lab Control Sample	Total/NA	Solid	5035A_H	

Analysis Batch: 383959

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-4	SB-3 (2-4)	Total/NA	Solid	8260C	383999
MB 480-383999/2-A	Method Blank	Total/NA	Solid	8260C	383999
LCS 480-383999/1-A	Lab Control Sample	Total/NA	Solid	8260C	383999

Prep Batch: 383999

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-4	SB-3 (2-4)	Total/NA	Solid	5035A_L	
MB 480-383999/2-A	Method Blank	Total/NA	Solid	5035A_L	
LCS 480-383999/1-A	Lab Control Sample	Total/NA	Solid	5035A_L	

Analysis Batch: 384677

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-5	SB-6 (2-4)	Total/NA	Solid	8260C	383716
480-126164-6	SB-7 (1.5-3.5)	Total/NA	Solid	8260C	383716
MB 480-384677/7	Method Blank	Total/NA	Solid	8260C	
LCS 480-384677/5	Lab Control Sample	Total/NA	Solid	8260C	

Analysis Batch: 384735

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-6 - DL	SB-7 (1.5-3.5)	Total/NA	Solid	8260C	383716
LCS 480-384735/5	Lab Control Sample	Total/NA	Solid	8260C	

GC/MS Semi VOA

Prep Batch: 382977

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	3550C	
480-126164-4	SB-3 (2-4)	Total/NA	Solid	3550C	
480-126164-5	SB-6 (2-4)	Total/NA	Solid	3550C	
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	3550C	
480-126164-8	SS-1	Total/NA	Solid	3550C	
MB 480-382977/1-A	Method Blank	Total/NA	Solid	3550C	
LCS 480-382977/2-A	Lab Control Sample	Total/NA	Solid	3550C	

Analysis Batch: 383167

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	8270D	382977
480-126164-4	SB-3 (2-4)	Total/NA	Solid	8270D	382977
480-126164-5	SB-6 (2-4)	Total/NA	Solid	8270D	382977
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	8270D	382977
480-126164-8	SS-1	Total/NA	Solid	8270D	382977
MB 480-382977/1-A	Method Blank	Total/NA	Solid	8270D	382977
LCS 480-382977/2-A	Lab Control Sample	Total/NA	Solid	8270D	382977

GC Semi VOA

Prep Batch: 382878

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-3	SB-2 (2-4)	Total/NA	Solid	3550C	
480-126164-8	SS-1	Total/NA	Solid	3550C	
MB 480-382878/1-A	Method Blank	Total/NA	Solid	3550C	
LCS 480-382878/2-A	Lab Control Sample	Total/NA	Solid	3550C	
LCS 480-382878/3-A	Lab Control Sample	Total/NA	Solid	3550C	

Analysis Batch: 383309

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-3	SB-2 (2-4)	Total/NA	Solid	8082A	382878
480-126164-8	SS-1	Total/NA	Solid	8082A	382878
MB 480-382878/1-A	Method Blank	Total/NA	Solid	8082A	382878
LCS 480-382878/2-A	Lab Control Sample	Total/NA	Solid	8082A	382878
LCS 480-382878/3-A	Lab Control Sample	Total/NA	Solid	8082A	382878

Metals

Prep Batch: 383104

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 480-383104/1-A	Method Blank	Total/NA	Solid	7471A	
LCSSRM 480-383104/2-A ^1	Lab Control Sample	Total/NA	Solid	7471A	

Prep Batch: 383105

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	7471B	
480-126164-3	SB-2 (2-4)	Total/NA	Solid	7471B	
480-126164-4	SB-3 (2-4)	Total/NA	Solid	7471B	
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	7471B	
480-126164-8	SS-1	Total/NA	Solid	7471B	

Metals (Continued)

Prep Batch: 383105 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 480-383105/1-A	Method Blank	Total/NA	Solid	7471B	
LCSSRM 480-383105/2-A ^1	Lab Control Sample	Total/NA	Solid	7471B	

Prep Batch: 383281

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	3050B	
480-126164-3	SB-2 (2-4)	Total/NA	Solid	3050B	
480-126164-4	SB-3 (2-4)	Total/NA	Solid	3050B	
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	3050B	
480-126164-8	SS-1	Total/NA	Solid	3050B	
MB 480-383281/1-A	Method Blank	Total/NA	Solid	3050B	
LCSSRM 480-383281/2-A	Lab Control Sample	Total/NA	Solid	3050B	
480-126164-3 MS	SB-2 (2-4)	Total/NA	Solid	3050B	
480-126164-3 MSD	SB-2 (2-4)	Total/NA	Solid	3050B	

Analysis Batch: 383788

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	6010C	383281
480-126164-3	SB-2 (2-4)	Total/NA	Solid	6010C	383281
480-126164-4	SB-3 (2-4)	Total/NA	Solid	6010C	383281
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	6010C	383281
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	6010C	383281
480-126164-8	SS-1	Total/NA	Solid	6010C	383281
480-126164-8	SS-1	Total/NA	Solid	6010C	383281
MB 480-383281/1-A	Method Blank	Total/NA	Solid	6010C	383281
LCSSRM 480-383281/2-A	Lab Control Sample	Total/NA	Solid	6010C	383281
480-126164-3 MS	SB-2 (2-4)	Total/NA	Solid	6010C	383281
480-126164-3 MSD	SB-2 (2-4)	Total/NA	Solid	6010C	383281

Analysis Batch: 383820

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	7471B	383105
480-126164-3	SB-2 (2-4)	Total/NA	Solid	7471B	383105
480-126164-4	SB-3 (2-4)	Total/NA	Solid	7471B	383105
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	7471B	383105
480-126164-8	SS-1	Total/NA	Solid	7471B	383105
MB 480-383104/1-A	Method Blank	Total/NA	Solid	7471B	383104
MB 480-383105/1-A	Method Blank	Total/NA	Solid	7471B	383105
LCSSRM 480-383104/2-A ^1	Lab Control Sample	Total/NA	Solid	7471B	383104
LCSSRM 480-383105/2-A ^1	Lab Control Sample	Total/NA	Solid	7471B	383105

General Chemistry

Analysis Batch: 382817

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-2	SB-2 (0.5-2.0)	Total/NA	Solid	Moisture	
480-126164-3	SB-2 (2-4)	Total/NA	Solid	Moisture	
480-126164-4	SB-3 (2-4)	Total/NA	Solid	Moisture	
480-126164-5	SB-6 (2-4)	Total/NA	Solid	Moisture	
480-126164-6	SB-7 (1.5-3.5)	Total/NA	Solid	Moisture	

General Chemistry (Continued)

Analysis Batch: 382817 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-7	SB-8 (0.5-3.5)	Total/NA	Solid	Moisture	
480-126164-8	SS-1	Total/NA	Solid	Moisture	

Analysis Batch: 383741

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
480-126164-1	SB-1 (6-8)	Total/NA	Solid	Moisture	

Client Sample ID: SB-1 (6-8)

Date Collected: 10/18/17 09:04
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	383741	10/25/17 11:53	CDC	TAL BUF

Client Sample ID: SB-1 (6-8)

Date Collected: 10/18/17 09:04
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-1
Matrix: Solid
Percent Solids: 87.3

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_L			383680	10/25/17 09:12	CDC	TAL BUF
Total/NA	Analysis	8260C		1	383669	10/25/17 19:12	CDC	TAL BUF

Client Sample ID: SB-2 (0.5-2.0)

Date Collected: 10/18/17 09:33
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-2 (0.5-2.0)

Date Collected: 10/18/17 09:33
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-2
Matrix: Solid
Percent Solids: 89.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3550C			382977	10/20/17 14:03	BEK	TAL BUF
Total/NA	Analysis	8270D		10	383167	10/22/17 19:28	DMR	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		1	383788	10/25/17 10:16	LMH	TAL BUF
Total/NA	Prep	7471B			383105	10/25/17 13:55	EMB	TAL BUF
Total/NA	Analysis	7471B		1	383820	10/25/17 17:16	BMB	TAL BUF

Client Sample ID: SB-2 (2-4)

Date Collected: 10/18/17 09:47
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-2 (2-4)

Date Collected: 10/18/17 09:47
Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-3
Matrix: Solid
Percent Solids: 90.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3550C			382878	10/20/17 08:34	NMC	TAL BUF

Lab Chronicle

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

Client Sample ID: SB-2 (2-4)
Lab Sample ID: 480-126164-3
Date Collected: 10/18/17 09:47
Matrix: Solid
Date Received: 10/19/17 12:28
Percent Solids: 90.4

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8082A		1	383309	10/23/17 17:29	JMO	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		1	383788	10/25/17 10:19	LMH	TAL BUF
Total/NA	Prep	7471B			383105	10/25/17 13:55	EMB	TAL BUF
Total/NA	Analysis	7471B		1	383820	10/25/17 17:19	BMB	TAL BUF

Client Sample ID: SB-3 (2-4)
Lab Sample ID: 480-126164-4
Date Collected: 10/18/17 10:23
Matrix: Solid
Date Received: 10/19/17 12:28

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-3 (2-4)
Lab Sample ID: 480-126164-4
Date Collected: 10/18/17 10:23
Matrix: Solid
Date Received: 10/19/17 12:28
Percent Solids: 85.7

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_L			383999	10/26/17 14:02	LCH	TAL BUF
Total/NA	Analysis	8260C		1	383959	10/26/17 15:50	CDC	TAL BUF
Total/NA	Prep	3550C			382977	10/20/17 14:03	BEK	TAL BUF
Total/NA	Analysis	8270D		1	383167	10/22/17 19:54	DMR	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		1	383788	10/25/17 10:38	LMH	TAL BUF
Total/NA	Prep	7471B			383105	10/25/17 13:55	EMB	TAL BUF
Total/NA	Analysis	7471B		1	383820	10/25/17 17:21	BMB	TAL BUF

Client Sample ID: SB-6 (2-4)
Lab Sample ID: 480-126164-5
Date Collected: 10/18/17 12:54
Matrix: Solid
Date Received: 10/19/17 12:28

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-6 (2-4)
Lab Sample ID: 480-126164-5
Date Collected: 10/18/17 12:54
Matrix: Solid
Date Received: 10/19/17 12:28
Percent Solids: 86.2

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			383716	10/25/17 11:14	CDC	TAL BUF
Total/NA	Analysis	8260C		5	384677	10/31/17 03:52	AMM	TAL BUF
Total/NA	Prep	3550C			382977	10/20/17 14:03	BEK	TAL BUF
Total/NA	Analysis	8270D		5	383167	10/22/17 20:20	DMR	TAL BUF

Client Sample ID: SB-7 (1.5-3.5)

Lab Sample ID: 480-126164-6

Date Collected: 10/18/17 14:10
Date Received: 10/19/17 12:28
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-7 (1.5-3.5)

Lab Sample ID: 480-126164-6

Date Collected: 10/18/17 14:10
Date Received: 10/19/17 12:28
Matrix: Solid
Percent Solids: 85.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035A_H			383716	10/25/17 11:14	CDC	TAL BUF
Total/NA	Analysis	8260C		10	384677	10/31/17 04:19	AMM	TAL BUF
Total/NA	Prep	5035A_H	DL		383716	10/25/17 11:14	CDC	TAL BUF
Total/NA	Analysis	8260C	DL	40	384735	10/31/17 11:41	LCH	TAL BUF

Client Sample ID: SB-8 (0.5-3.5)

Lab Sample ID: 480-126164-7

Date Collected: 10/18/17 15:23
Date Received: 10/19/17 12:28
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Client Sample ID: SB-8 (0.5-3.5)

Lab Sample ID: 480-126164-7

Date Collected: 10/18/17 15:23
Date Received: 10/19/17 12:28
Matrix: Solid
Percent Solids: 69.5

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3550C			382977	10/20/17 14:03	BEK	TAL BUF
Total/NA	Analysis	8270D		5	383167	10/22/17 20:46	DMR	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		1	383788	10/25/17 10:52	LMH	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		5	383788	10/25/17 10:56	LMH	TAL BUF
Total/NA	Prep	7471B			383105	10/25/17 13:55	EMB	TAL BUF
Total/NA	Analysis	7471B		1	383820	10/25/17 17:22	BMB	TAL BUF

Client Sample ID: SS-1

Lab Sample ID: 480-126164-8

Date Collected: 10/18/17 15:40
Date Received: 10/19/17 12:28
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	382817	10/19/17 20:14	MDH	TAL BUF

Lab Chronicle

Client Sample ID: SS-1

Date Collected: 10/18/17 15:40

Date Received: 10/19/17 12:28

Lab Sample ID: 480-126164-8

Matrix: Solid

Percent Solids: 94.8

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3550C			382977	10/20/17 14:03	BEK	TAL BUF
Total/NA	Analysis	8270D		50	383167	10/22/17 21:13	DMR	TAL BUF
Total/NA	Prep	3550C			382878	10/20/17 08:34	NMC	TAL BUF
Total/NA	Analysis	8082A		1	383309	10/23/17 17:44	JMO	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		1	383788	10/25/17 10:59	LMH	TAL BUF
Total/NA	Prep	3050B			383281	10/23/17 14:51	EMB	TAL BUF
Total/NA	Analysis	6010C		5	383788	10/25/17 11:03	LMH	TAL BUF
Total/NA	Prep	7471B			383105	10/25/17 13:55	EMB	TAL BUF
Total/NA	Analysis	7471B		1	383820	10/25/17 17:26	BMB	TAL BUF

Laboratory References:

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

Accreditation/Certification Summary

Client: Turnkey Environmental Restoration, LLC
TestAmerica Job ID: 480-126164-1
Project/Site: Benchmark - 1585 Hertel Ave site

Laboratory: TestAmerica Buffalo

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

Authority	**Program**	**EPA Region**	**Identification Number**	**Expiration Date**
New York	NELAP	2	10026	03-31-18

The following analytes are included in this report, but accreditation/certification is not offered by the governing authority:

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

Method Summary

Client: Turnkey Environmental Restoration, LLC
Project/Site: Benchmark - 1585 Hertel Ave site

TestAmerica Job ID: 480-126164-1

Method	Method Description	Protocol	Laboratory
8260C	Volatile Organic Compounds by GC/MS	SW846	TAL BUF
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL BUF
8082A	Polychlorinated Biphenyls (PCBs) by Gas Chromatography	SW846	TAL BUF
6010C	Metals (ICP)	SW846	TAL BUF
7471B	Mercury (CVAA)	SW846	TAL BUF
Moisture	Percent Moisture	EPA	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 = TestAmerica Buffalo, 10 Hazelwood Drive, Amherst, NY 14228-2298, TEL (716)691-2600

Sample Summary

Client: Turnkey Environmental Restoration, LLC
Project/Site: Benchmark - 1585 Hertel Ave site

TestAmerica Job ID: 480-126164-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
480-126164-1	SB-1 (6-8)	Solid	10/18/17 09:04	10/19/17 12:28
480-126164-2	SB-2 (0.5-2.0)	Solid	10/18/17 09:33	10/19/17 12:28
480-126164-3	SB-2 (2-4)	Solid	10/18/17 09:47	10/19/17 12:28
480-126164-4	SB-3 (2-4)	Solid	10/18/17 10:23	10/19/17 12:28
480-126164-5	SB-6 (2-4)	Solid	10/18/17 12:54	10/19/17 12:28
480-126164-6	SB-7 (1.5-3.5)	Solid	10/18/17 14:10	10/19/17 12:28
480-126164-7	SB-8 (0.5-3.5)	Solid	10/18/17 15:23	10/19/17 12:28
480-126164-8	SS-1	Solid	10/18/17 15:40	10/19/17 12:28

Chain of Custody Record

Temperature on Receipt ______

Drinking Water? Yes☐ No☐

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124 (1007)

Client Benchmark Eng	Project Manager Chris Boron	Date 10/19/17	Chain of Custody Number 284239
Address 2558 Hamburg Turnpike	Telephone Number (Area Code)/Fax Number (716) 818-8358	Lab Number	Page ______ of ______
City Lackawanna	State NY	Zip Code 14218	Site Contact T. Behrendt
Lab Contact B. Fischer	Project Name and Location (State) 0437-017-001	Carrier/Waybill Number	Contract/Purchase Order/Quote No.

Analysis (Attach list if more space is needed)

Special Instructions/ Conditions of Receipt

480-126164 COC

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		CP-51 VOC 8260	CP-51 SVOC 8270	RCRA METALS	PCBs							
SB-1 (6-8)	10/18/17	904				X		X							X										
SB-2 (0.5-2.0)		933				X		X								X	X								
SB-2 (2-4)		947				X		X									X	X							
SB-3 (2-4)		1023				X		X							X	X	X								
SB-6 (2-4)		1254				X		X							X	X									
SB-7 (1.5-3.5)		1410				X		X							X										
SB-8 (0.5-2.5)		1523				X		X								X	X								
SS-1		1540				X		X								X	X	X							

Possible Hazard Identification

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

Sample Disposal

☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other STD

QC Requirements (Specify)

1. Relinquished By	Date 10/19/17	Time 900	1. Received By	Date 10.19.17	Time 1350 ~~1300~~
2. Relinquished By	Date 10.19.17	Time 1228	2. Received By	Date 10/19/17	Time 1228
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments 3.1 #1

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Login Sample Receipt Checklist

Client: Turnkey Environmental Restoration, LLC

Job Number: 480-126164-1

Login Number: 126164

List Source: TestAmerica Buffalo

List Number: 1

Creator: Janish, Carl M

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	
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	bmtk
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	N/A	
Chlorine Residual checked.	N/A	

APPENDIX C

PROJECT DOCUMENTATION FORMS

INSPECTOR'S DAILY REPORT

CONTRACTOR			
CLIENT		DATE:	

LOCATION				DAY		JOB NO.	
WEATHER		TEMP	° F	START		END	

WORK PERFORMED:

CONTRACTOR ACTIVITIES:

[PUT CONTRACTOR ACTIVITIES HERE, BE SPECIFIC. TYPE OF EQUIPMENT, ACTIVITIES PERFORMED, BY WHOM, LOCATION OF LANDFILL ETC.]

TURNKEY ACTIVITIES:

[PUT ENGINEER ACTIVITIES HERE, BE SPECIFIC. TYPE OF EQUIPMENT, ACTIVITIES AND TESTING PERFORMED, SAMPLES COLLECTED, BY WHOM, LOCATION OF LANDFILL ETC.]

TEST PERFORMED		*QA PERSONNEL* SIGNATURE			
PICTURES TAKEN	none	REPORT NO.			
VISITORS	none	SHEET	1	OF	

TurnKey
Environmental
Restoration, LLC

INSPECTOR’S DAILY REPORT

CONTRACTOR							
CLIENT				DATE:			
LOCATION				DAY		JOB NO.	
WEATHER		TEMP	° F	START		END	

INSPECTOR'S DAILY REPORT

MEETINGS HELD & RESULTS:

CONTRACTOR'S WORK FORCE AND EQUIPMENT

DESCRIPTION	*H*	#	*DESCRIPTION*	*H*	#	*DESCRIPTION*	*H*	#	*DESCRIPTION*	*H*	#
Field Engineer						Equipment			Front Loader Ton		
Superintendent			Ironworker			Generators			Bulldozer		
						Welding Equip.			DJ Dump truck		
Laborer-Foreman			Carpenter						Water Truck		
Laborer									Backhoe		
Operating Engineer			Concrete Finisher						Excavator		
						Roller			Pad foot roller		
Carpenter						Paving Equipment					
						Air Compressor					

REMARKS:

REFERENCES TO OTHER FORMS:

SAMPLES COLLECTED:					
SAMPLE NUMBER					
APPROX. LOCATION OF STOCKPILE					
NO. OF STOCKPILE					
DATE OF COLLECTION					
CLIMATOLOGIC CONDITIONS					
FIELD OBSERVATION		SHEET		OF	

DAILY LOG				
	DATE			
	REPORT NO.			
	PAGE	OF		

Date:

Project:

Job No:

Location:

CQA Monitor(s):

Client:

Contractor:

Contractor's Supervisor:

PROBLEM IDENTIFICATION REPORT

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

DAILY LOG	DATE			
	REPORT NO.			
	PAGE	OF		

CORRECTIVE MEASURES REPORT

Date:
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:

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

SITE-SPECIFIC HEALTH AND SAFETY PLAN

SITE HEALTH AND SAFETY PLAN
for
BROWNFIELD CLEANUP PROGRAM
RI/IRM ACTIVITIES

1585 HERTEL AVENUE SITE

BUFFALO, NEW YORK

December 2017 0437-017-001-004

Prepared for:

1585 HERTEL LLC

1585 HERTEL AVENUE SITE
HEALTH AND SAFETY PLAN FOR RI/IRM ACTIVITIES

ACKNOWLEDGEMENT

Plan Reviewed by (initial):

Corporate Health and Safety Director: Thomas H. Forbes, P.E.

Project Manager: Christopher Boron

Designated Site Safety and Health Officer: Christopher Boron

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

1585 HERTEL AVENUE SITE
HEALTH AND SAFETY PLAN FOR RI/IRM ACTIVITIES

TABLE OF CONTENTS

1585 HERTEL AVENUE SITE
HEALTH AND SAFETY PLAN FOR RI/IRM ACTIVITIES

TABLE OF CONTENTS

1585 HERTEL AVENUE SITE
HEALTH AND SAFETY PLAN FOR RI/IRM ACTIVITIES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

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 Environmental Engineering & Science, PLLC and TurnKey Environmental Restoration, LLC employees (referred to jointly hereafter as "Benchmark-TurnKey") during Remedial Investigation (RI) and Interim Remedial Measures (IRM) activities at the 1585 Hertel Avenue Site (Site) located in the 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 consists of one (1) parcel (SBL No. 78.74-3-1) totaling ±0.18 acres, at the southwest corner of Hertel and Parkside Avenues, in the City of Buffalo, Erie County, New York. The Site is currently improved with one (1), 1 story commercial building formerly used as an automobile repair shop which will be demolished prior to redevelopment. The remaining portion of the Site consists of asphalt and concrete surface cover as the Site was also used for retail gasoline sales. The gasoline underground storage tanks (USTs) and pump islands (minus the actual pumps) still remain at the Site.

The Site has a long history of being utilized for retail gasoline sales and automobile repair use since the late 1930s. Prior to construction of the existing gasoline service station in 1963, the Site included a previous gasoline service station in current asphalt paved and pump island areas in the northern portion of the Site.

Previous environmental investigations completed at the Site have identified elevated levels of volatile organic compounds (VOCs) and metals at concentrations exceeding applicable regulatory guidelines, specifically Part 375 Residential Soil Cleanup Objectives (RSCOs).

1.3 Known and Suspected Environmental Conditions

The Site is located at the southeast corner of Hertel Avenue and Parkside Avenue in a mixed-use area of the North Park area in the City of Buffalo. The Site is a vacant former gas station and automotive repair facility. The gasoline and waste oil USTs and gasoline pump islands are still present at the Site.

Findings of the Phase II are detailed below:

- Based on the field observations during the Phase II, it was evident that petroleum impacts where present at the Site, and, as required by law, the NYSDEC was notified and Spill No. 1706962 was assigned to the Site.
- Petroleum volatile organic compounds (pVOCs) were detected at concentrations exceeding CP-51 Soil Cleanup Levels (SCLs), 6NYCRR Part 375 Restricted Residential Soil Cleanup Objectives (RRSCOs) and/or Commercial Soil Cleanup Objectives (CSCOs) in soil samples SB-6 (2-4 fbgs), SB-7 (1.5-3.5 fbgs), which were completed in the vicinity of the pump island and existing USTs, respectively (see Figure 7). Stained soil, petroleum odors, and the highest photoionization detector (PID) measurements were also noted at these two (2) locations.
- Metals were detected in the four (4) samples analyzed soil samples. Cadmium was detected at SB-2 (0.5-2 fbgs) at concentrations above its respective CSCO. Arsenic, cadmium, and lead were detected at surface soil sample, SS-1, at concentrations above their respective CSCOs. Based on the high concentrations of arsenic (164 milligrams per kilogram (mg/kg)) and lead (1,030 mg/kg) detected in the surface soil, additional analysis may be warranted to determine if the soil present in this area is a characteristic hazardous waste.

The RI will be performed in support of the BCP to further determine the nature and extent of impacts from these known environmental conditions and determine if other exist on this parcel. As part of the RI, an IRM will be completed to immediately address known environmental impacts related to past uses of the Site. An IRM will quickly mitigate risks to public health and the environment attributable to petroleum contamination at the Site. Impacted soil will be removed and impacted groundwater (if encountered) will be extracted and treated during the IRM.

1.4 Parameters of Interest

Based on the previous investigations, constituents of potential concern (COPCs) in soil and, potentially groundwater, at the Site include:

- **Volatile Organic Compounds (VOCs) –** VOCs present at elevated concentration may include petroleum-related VOCs, such as 1,2,4- and 1,3,5-trimethylbenzene, isopropylbenzene, ethylbenzene, n-propylbenzene, and xylenes.

- **Inorganic Compound –** The inorganic COPCs potentially present at elevated concentrations are arsenic, barium, and lead.

1.5 Overview of RI/IRM Activities

Benchmark-TurnKey personnel will be on-site to observe and perform RI and IRM activities. The field activities to be completed as part of the RI and IRM are described below.

Remedial Investigation Activities

1. **Subsurface Soil Sampling:** Benchmark-TurnKey will advance soil borings 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.

Potential IRM Activities

1. **Soil Excavation:** The remediation contractor would perform soil excavation activities.

2. **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.

3. **Backfilling:** The remediation contractor would coordinate and perform backfilling activities, as necessary.

4. **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. Christopher Boron.*** 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. Christopher Boron***. The qualified alternate SSHO is ***Mr. Nathan Munley.*** 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, 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, VOC and inorganic 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.

- **1,2,4-Trimethylbenzene (CAS #95-63-6)** is a common gasoline additive. Acute exposure predominantly results in skin irritation and inhalation causes chemical pneumonitis. Symptoms include headache, dizziness, fatigue, muscular weakness, drowsiness.

- **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.

- **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.

- **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.

- **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.

- **Barium (CAS #7440-39-3)** a naturally occurring alkaline earth metal that appears silver-yellow when exposed to air. Barium sulfate and barium carbonate are often found in nature and sometimes found naturally in drinking water and food. Other compounds, such as barium chloride, barium nitrate, and barium hydroxide, are manufactured from barium sulfate. Barium sulfate is used in drilling muds and to make paints, bricks, tiles, glass, and rubber. Barium carbonate, barium chloride, and barium hydroxide, are used to make ceramics, insect and rat poisons, and additives for oils and fuels; in the treatment of boiler water; in the production of barium greases; as a component in sealants, paper manufacturing, and sugar refining; in animal and vegetable oil refining. Ingestion of barium may result in: vomiting, abdominal cramps, diarrhea, difficulties in breathing, increased, or decreased blood pressure, numbness around the face, and muscle weakness.

- **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 protective clothing (Section 7.0), safe work practices (Section 6.0), and proper decontamination procedures (Section 12.0).

3.2 Physical Hazards

RI/IRM field activities at the 1585 Hertel Avenue 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 Appendix 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 downwind portion of the Site perimeter will be conducted. This will provide a real-time method for determination of vapor and/or particulate releases to the surrounding community as a result of ground intrusive investigation work.

Ground intrusive activities are defined in the Generic Community Air Monitoring Plan and attached as Appendix 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 Attachment 1), 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 (Appendix C):

- **ORGANIC VAPOR PERIMETER MONITORING:**
  - If the sustained ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone exceeds 5 ppm above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the sustained organic vapor decreases below 5 ppm over background, work activities can resume with continued monitoring.
  - If the sustained ambient air concentration of organic vapors at the downwind perimeter of the exclusion zone are greater than 5 ppm over background but less than 25 ppm 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 (Appendix 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 Appendix A.

- <u>**EXPLOSIVE VAPORS:**</u>
  - <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.

- <u>**AIRBORNE PARTICULATE COMMUNITY AIR MONITORING**</u>

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 (Appendix 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 and decommissioning records, 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 H2 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:

- 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 Appendix 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 Appendix A. The hospital route map is presented within Appendix 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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

TURNKEY
ENVIRONMENTAL
RESTORATION, LLC

TABLE 1

TOXICITY DATA FOR CONSTITUENTS OF POTENTIAL CONCERN

1585 HERTEL ELMWOOD AVENUE SITE

Buffalo, New York

Parameter	Synonyms	CAS No.	Code	Concentration Limits [1]		
				PEL	TLV	IDLH
Volatile Organic Compounds (VOCs): ppm						
1,2,4-Trimethylbenzene	Pseudocumene	95-63-6	*none*	25	25	--
Benzene	Benzol, Phenyl hydride	71-43-2	*none*	1	0.5	500
Ethylbenzene	Ethylbenzol, Phenylethane	100-41-4	*none*	100	100	800
Xylene, Total	o-, m-, p-isomers	1330-20-7	*none*	100	100	900
Inorganic Compounds: mg/m [2]						
Arsenic	*none*	7440-38-2	*Ca*	0.01	0.01	5
Barium	*none*	7440-39-3	*none*	--	0.5	--
Lead	*none*	7439-92-1	*none*	0.05	0.15	100

Notes:

1. Concentration limits as reported by NIOSH Pocket Guide to Chemical Hazards, February 2004 (NIOSH Publication No. 97-140, 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:

Ca = NIOSH considers constituent to be a potential occupational carcinogen.
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 ho
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

TABLE 2

POTENTIAL ROUTES OF EXPOSURE TO THE CONSTITUENTS OF POTENTIAL CONCERN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

Activity [1]	Direct Contact with Soil/Fill	Inhalation of Vapors or Dust	Direct Contact with Groundwater
Remedial Investigation Tasks			
1. Subsurface Soil Sampling	x	x	
2. Monitoring Well Installation/Development and Sampling	x	x	x
Interim Remedial Measures Tasks			
1. Soil Excavation	x	x	
2. Backfilling	x	x	
3. Verification Sampling	x	x	
4. 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 RI/IRM TASKS

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

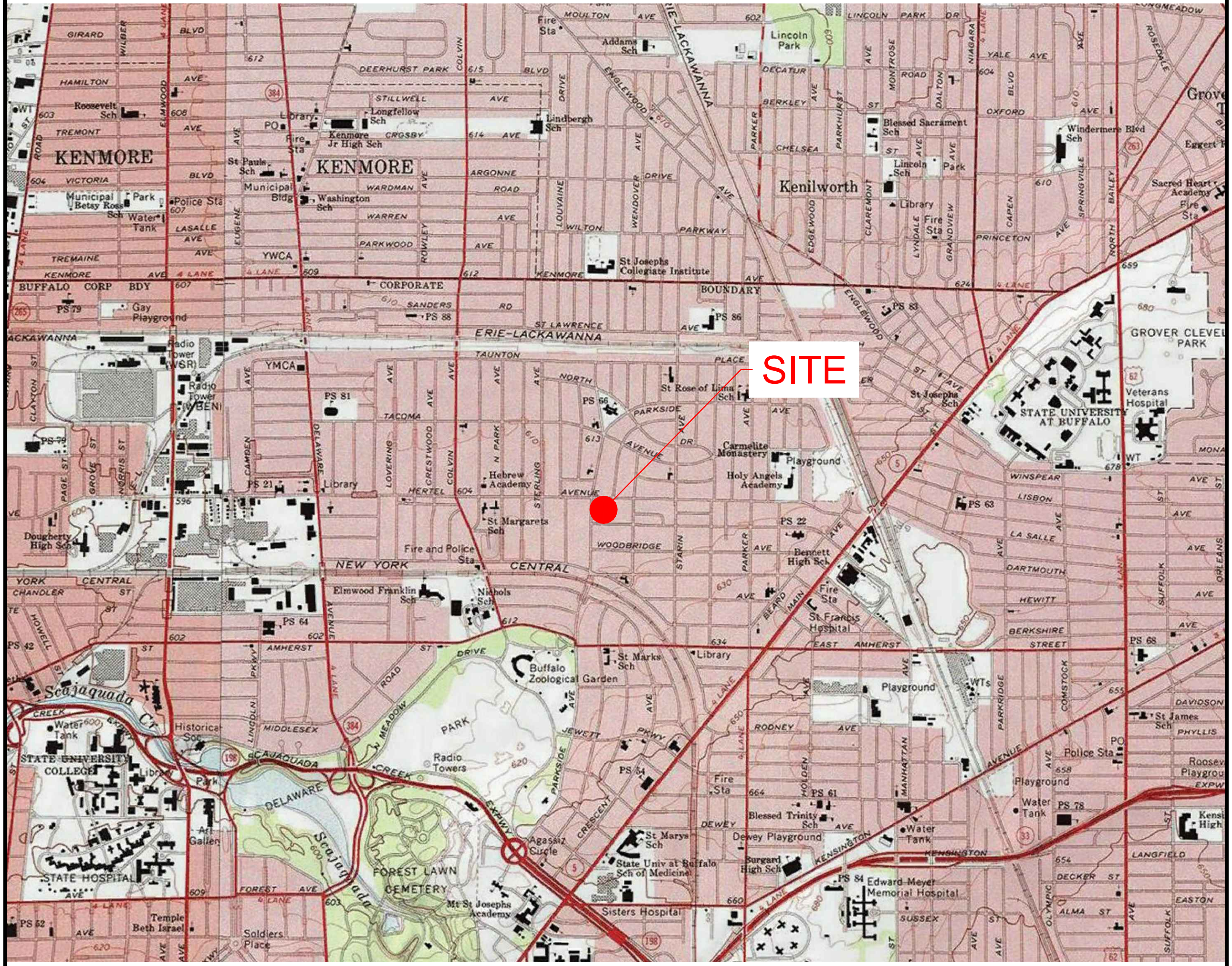
Activity	Respiratory Protection [1]	Clothing	Gloves [2]	Boots [2, 3]	Other Required PPE/Modifications [2, 4]
Remedial Investigation Tasks					
1. Subsurface Soil Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Monitoring Well Installation/Development and Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	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

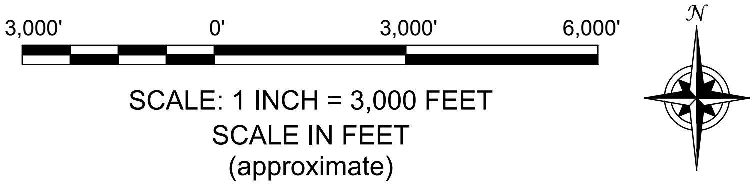
Notes:
1. Respiratory equipment shall conform to guidelines presented in Section 7.0 of this HASP. The Level C requirement is an air-purifying respirator equiped with organic compound/acid gas/dust cartridge.
2. HH = hardhat; L= Latex; L/N = latex inner glove, nitrile outer glove; N = Nitrile; S = Saranex; 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

F:\CAD\Benchmark\1585 Hertel LLC\Health and Safety Plan\Figure 1 - Site Location and Vicinity Map.dwg

FIGURE 1





SCALE: 1 INCH = 3,000 FEET

SCALE IN FEET

(approximate)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: B0437-017-001

DATE: JANUARY 2018

DRAFTED BY: CMS-CMC

SITE LOCATION AND VICINITY MAP

BROWNFIELD CLEANUP PROGRAM
HEALTH AND SAFETY PLAN

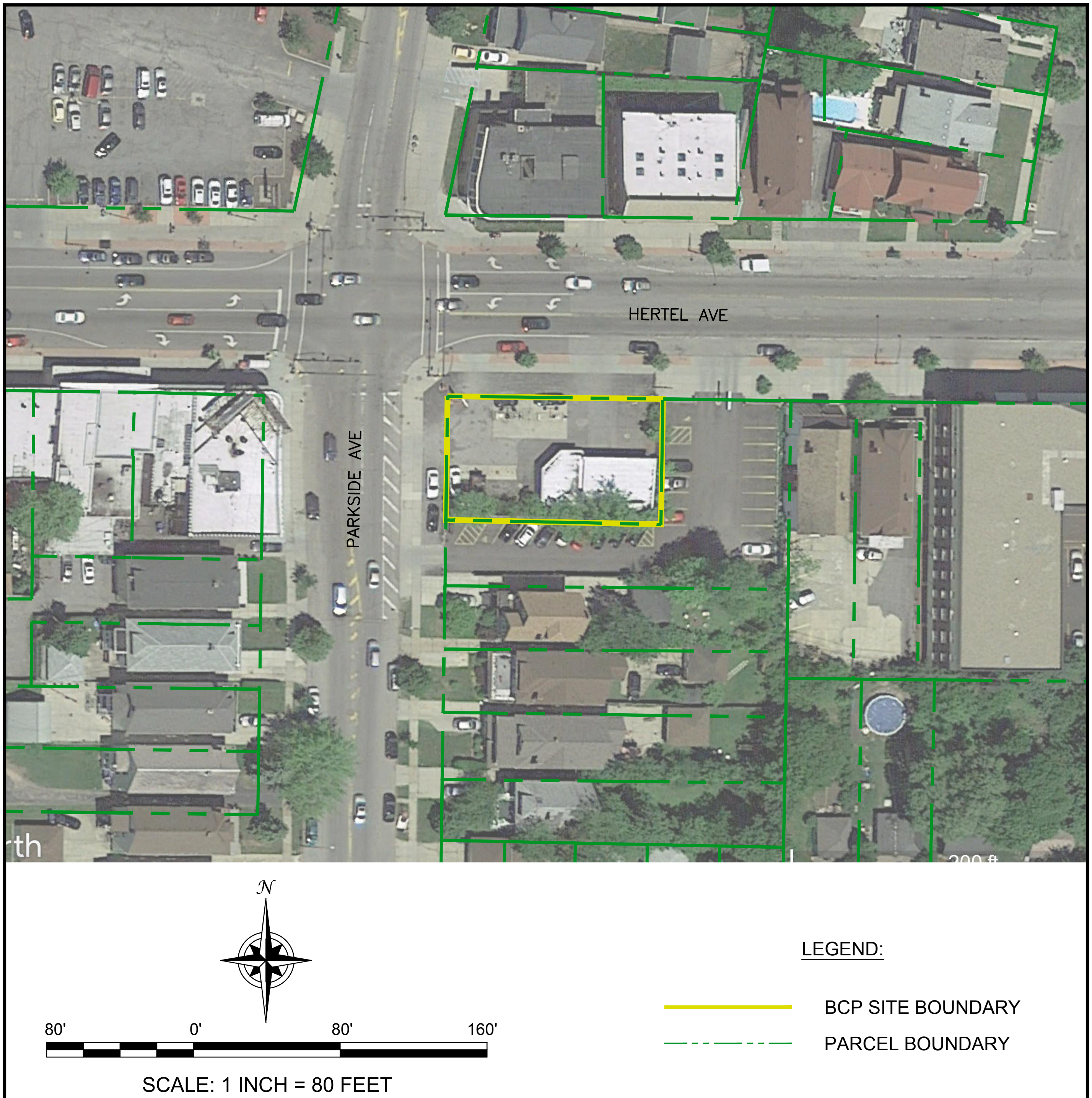
1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

PREPARED FOR

1585 HERTEL LLC

F:\CAD\Benchmark\1585 Hertel LLC\Health and Safety Plan\Figure 2; Site Plan (Aerial).dwg

FIGURE 2



SCALE: 1 INCH = 80 FEET
SCALE IN FEET
(approximate)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-017-001

DATE: JANUARY 2018

DRAFTED BY: CMC

SITE PLAN (AERIAL)

BROWNFIELD CLEANUP PROGRAM
HEALTH AND SAFETY PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

DISCLAIMER:
PROPERTY OF BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC. 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 ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC.

ATTACHMENT A

EMERGENCY RESPONSE PLAN

EMERGENCY RESPONSE PLAN
for
BROWNFIELD CLEANUP PROGRAM
RI/IRM ACTIVITIES

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK

December 2017

0437-017-001-004

Prepared for:

1585 HERTEL LLC

1585 HERTEL AVENUE SITE
HEALTH AND SAFETY PLAN FOR RI/IRM 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 Remedial Investigation (RI) and Interim Remedial Measures (IRM) activities at the 1585 Hertel Avenue Street Site in Buffalo, New York. 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.

<u>Type of Emergency</u>:

1. Medical, due to physical injury

<u>Source of Emergency</u>:

1. Slip/trip/fall

<u>Location of Source</u>:

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	2 (minimum)	All heavy equipment and Site Vehicle

Emergency PPE	Quantity	Location
Full-face respirator	1 for each worker	Site Vehicle
Chemical-resistant suits	4 (minimum)	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-TurnKey personnel field vehicle.

5.0 EMERGENCY CONTACTS

The following identifies the emergency contacts for this ERP.

Emergency Telephone Numbers:

Project Manager: ***Christopher Boron***
Work: (716) 856-0599
Mobile: (716) 864-2726

Corporate Health and Safety Director: ***Thomas H. Forbes***
Work: (716) 856-0599
Mobile: (716) 864-1730

Site Safety and Health Officer (SSHO): ***Christopher Boron***
Work: (716) 856-0599
Mobile: (716) 864-2726

Alternate SSHO: ***Nathan Munley***
Work: (716) 856-0635
Mobile: (716) 289-1072

SISTERS HOSPITAL (ER):	(716) 862-1000
FIRE:	911
AMBULANCE:	911
BUFFALO 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:

1585 Hertel Avenue
Buffalo, New York 14216
Site Phone Number: Benchmark 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 (***Christopher Boron*** or ***Nathan Munley***) 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 Hospital (see Figure 1):

The following directions describe the best route from the Site to Sisters:

- Travel south on Parkside Avenue
- Turn left (east) onto Robie Street
- Turn right (south) onto Main Street and turn left (east) into the hospital (1.6 miles total)

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.

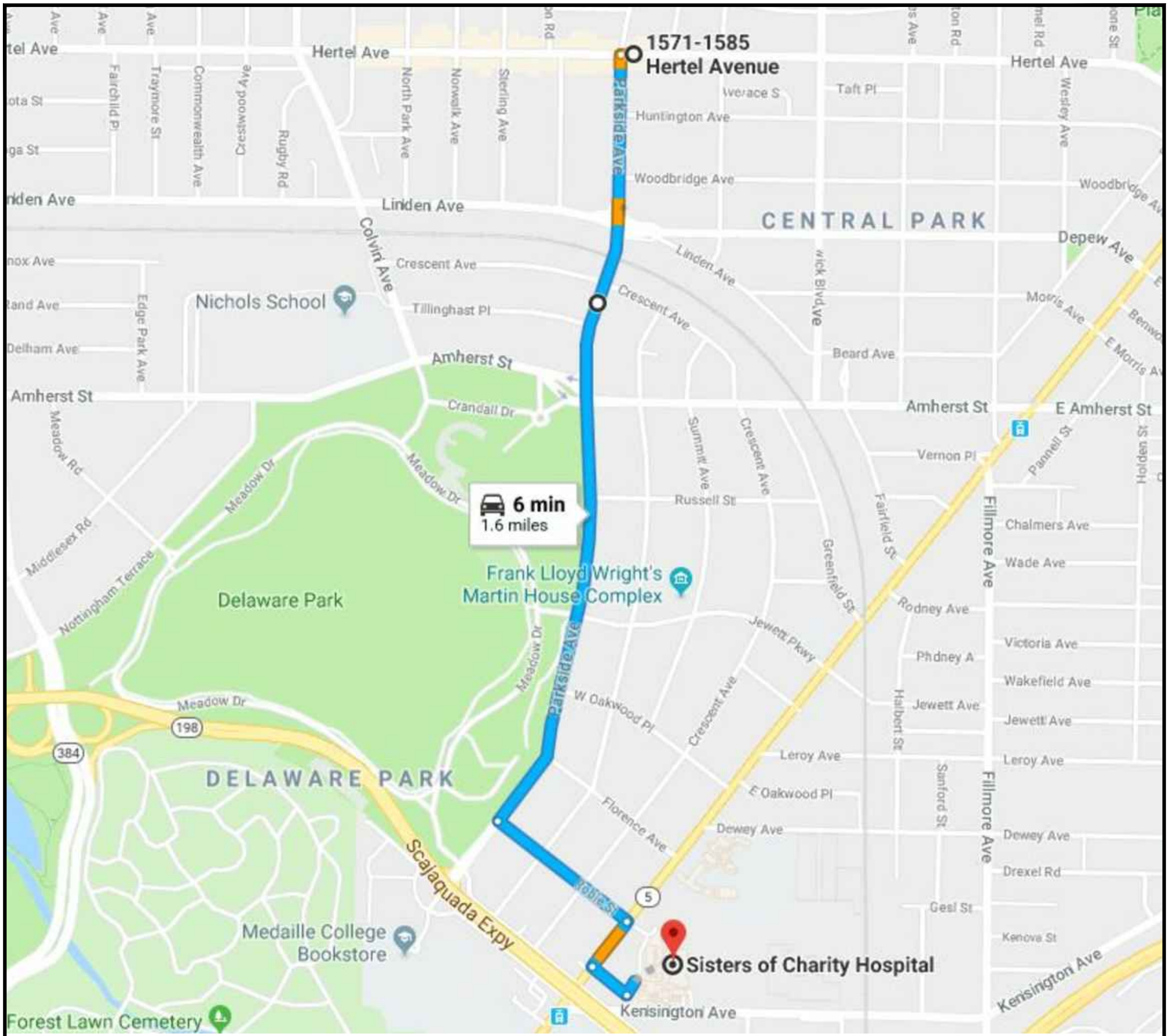
10.0 EMERGENCY RESPONSE TRAINING

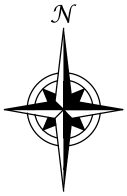
All persons who enter the worksite, including visitors, shall receive a site-specific briefing about anticipated emergency situations and the emergency procedures by the SSHO. Where this site relies on off-site organizations for emergency response, the training of personnel in those off-site organizations has been evaluated and is deemed adequate for response to this site.

FIGURES

F:\CAD\Benchmark\1585 Hertel LLC\Health and Safety Plan\Emergency Response Plan\Figure 1; Hospital Route Map.dwg

FIGURE 1





DIRECTIONS:

- TRAVEL SOUTH ON PARKSIDE AVENUE
- TURN LEFT (EAST) ONTO ROBIE STREET
- TURN RIGHT (SOUTH) ONTO MAIN STREET AND TURN LEFT (EAST) INTO THE HOSPITAL

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

PROJECT NO.: 0437-017-001

DATE: JANUARY 2017

DRAFTED BY: CMC

HOSPITAL ROUTE MAP

BROWNFIELD CLEANUP PROGRAM
EMERGENCY RESPONSE PLAN

1585 HERTEL AVENUE SITE
BUFFALO, NEW YORK
PREPARED FOR
1585 HERTEL LLC

ATTACHMENT B

HOT WORK PERMIT FORM

TurnKey
Environmental
Restoration, LLC

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 C1
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 C2
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° C (14 to 122° F);

(m) Particulate levels will be monitored upwind and immediately downwind at the working site and integrated over a period not to exceed 15 minutes.

4. In order to ensure the validity of the fugitive dust measurements performed, there must be appropriate Quality Assurance/Quality Control (QA/QC). It is the responsibility of the remedial party to adequately supplement QA/QC Plans to include the following critical features: periodic instrument calibration, operator training, daily instrument performance (span) checks, and a record keeping plan.

5. The action level will be established at 150 ug/m3 (15 minutes average). While conservative,

this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m3, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. Corrective measures may include increasing the level of personal protection for on-site personnel and implementing additional dust suppression techniques (see paragraph 7). Should the action level of 150 ug/m3 continue to be exceeded work must stop and DER must be notified as provided in the site design or remedial work plan. The notification shall include a description of the control measures implemented to prevent further exceedances.

6. It must be recognized that the generation of dust from waste or contaminated soil that migrates off-site, has the potential for transporting contaminants off-site. There may be situations when dust is being generated and leaving the site and the monitoring equipment does not measure PM10 at or above the action level. Since this situation has the potential to allow for the migration of contaminants off-site, it is unacceptable. While it is not practical to quantify total suspended particulates on a real-time basis, it is appropriate to rely on visual observation. If dust is observed leaving the working site, additional dust suppression techniques must be employed. Activities that have a high dusting potential--such as solidification and treatment involving materials like kiln dust and lime--will require the need for special measures to be considered.

7. The following techniques have been shown to be effective for the controlling of the generation and migration of dust during construction activities:

(a) Applying water on haul roads;
(b) Wetting equipment and excavation faces;
(c) Spraying water on buckets during excavation and dumping;
(d) Hauling materials in properly tarped or watertight containers;
(e) Restricting vehicle speeds to 10 mph;
(f) Covering excavated areas and material after excavation activity ceases; and
(g) Reducing the excavation size and/or number of excavations.

Experience has shown that the chance of exceeding the 150ug/m3 action level is remote when the above-mentioned techniques are used. When techniques involving water application are used, care must be taken not to use excess water, which can result in unacceptably wet conditions. Using atomizing sprays will prevent overly wet conditions, conserve water, and provide an effective means of suppressing the fugitive dust.

8. The evaluation of weather conditions is necessary for proper fugitive dust control. When extreme wind conditions make dust control ineffective, as a last resort remedial actions may need to be suspended. There may be situations that require fugitive dust suppression and particulate monitoring requirements with action levels more stringent than those provided above. Under some circumstances, the contaminant concentration and/or toxicity may require additional monitoring to protect site personnel and the public. Additional integrated sampling and chemical analysis of the dust may also be in order. This must be evaluated when a health and safety plan is developed and when appropriate suppression and monitoring requirements are established for protection of health and the environment.

APPENDIX E

FIELD OPERATING PROCEDURES

(PROVIDED ELECTRONICALLY)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

   Grout Slurry Composition (% Weight)

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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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 Pers[illegible]el:
Drill Rig Type:	

DECOMMISSIONING PROCE[illegible]ES

Time	Description of Field Activiti[illegible]

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:**

Benchmark
Environmental
Engineering &
Science, PLLC

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)

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Project No.:

Client:

Date:

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:**

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Calibration and Maintenance of Portable Field Turbidity Meter

FOP 009.0

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)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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/					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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 total 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	

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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[illegible]		< 0.4 [illegible] [illegible]00 800		
☐ Sp. Cond. meter	uS mS		Myron L Company Ultra Meter 6P	[illegible]		______ mS @ 25 °C		
☐ PID	ppm		MinRAE 20[illegible]	[illegible]		open air zero _____ ppm Iso. Gas		MIBK response factor = 1.0
☐ Dissolved Oxygen	ppm		YSI Model 5[illegible]	[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:

$$CFmix = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + ... Xi/CFi)$$

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-pentafluoropropane (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	$C8H_{18}O$			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.

Therminol® is a registered Trademark of Solutia, Inc.

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				

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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)

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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/H					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

SOIL/SEDIMEI
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] exa[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] 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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

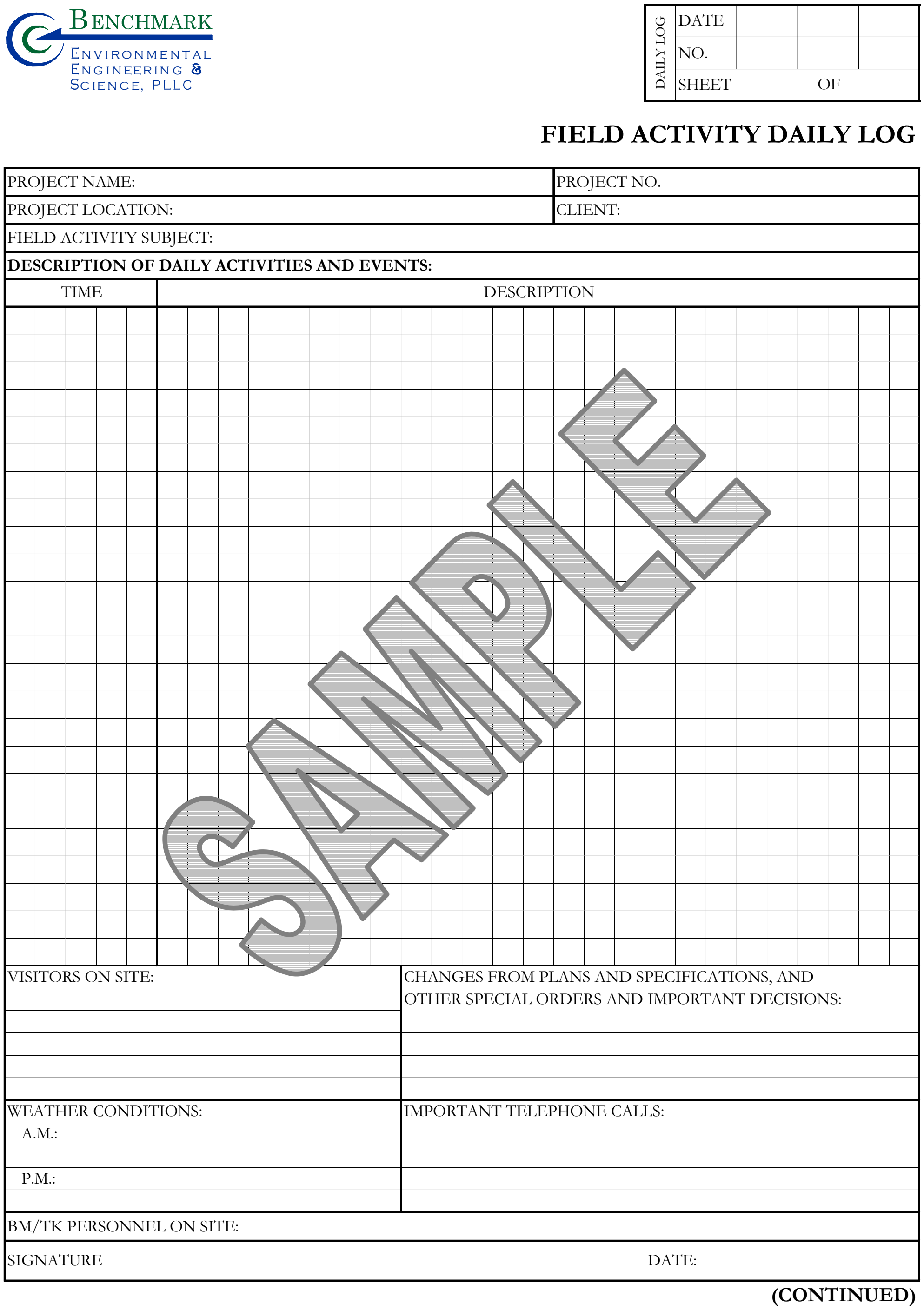
The form should be signed daily by both the Benchmark field supervisor and the driller's representative, and provided to the Benchmark Field Team Leader.

Other Project Field Forms

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)



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

DAILY LOG	DATE			
	NO.			
	SHEET	OF		

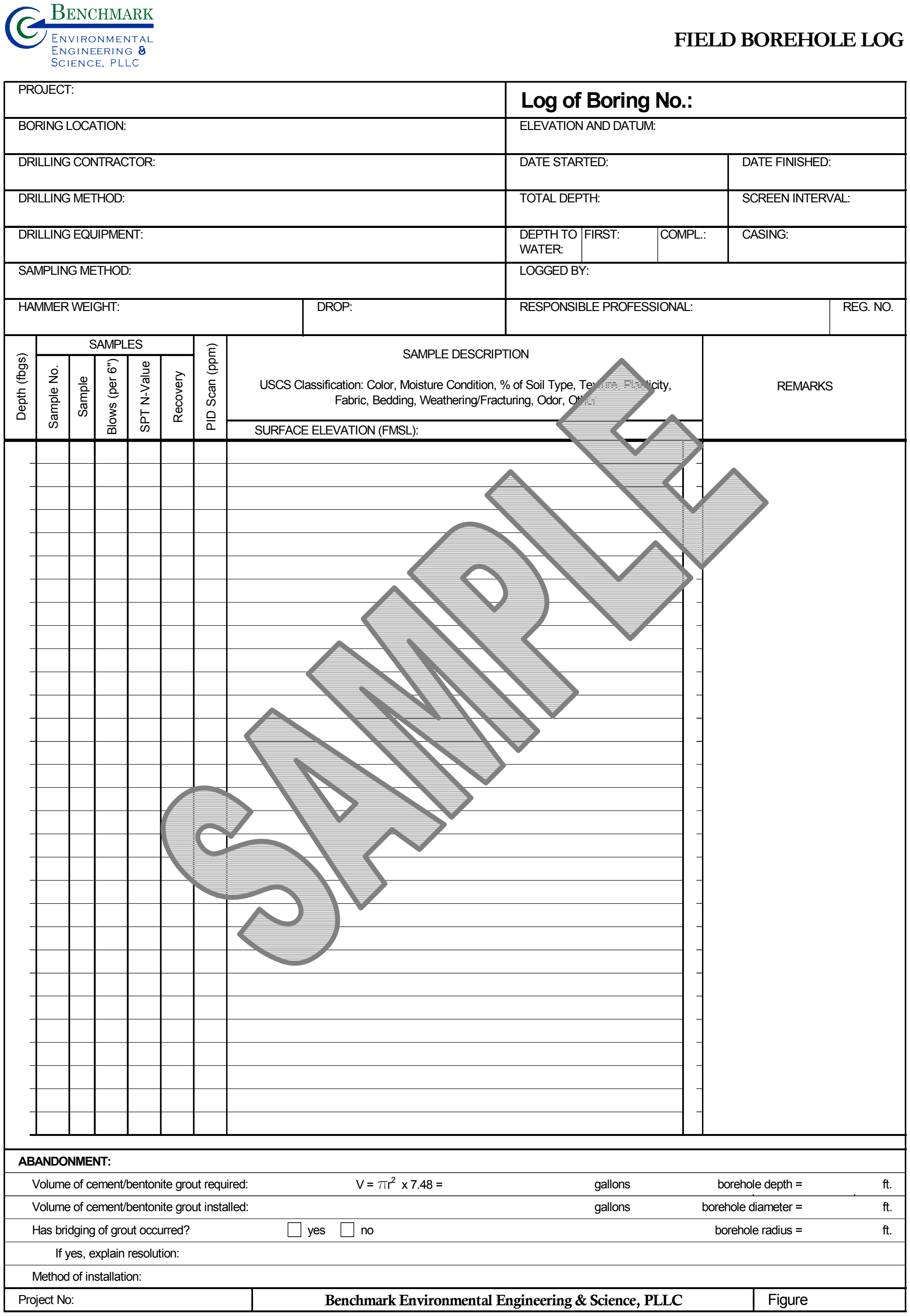
FIELD ACTIVITY DAILY LOG

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)



Benchmark Environmental Engineering & Science, PLLC

FIELD BOREHOLE LOG

PROJECT:	**Log of Boring No.:**	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:	LOGGED BY:	
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS

ABANDONMENT:

Volume of cement/bentonite grout required: V = πr^2 x 7.48 = gallons borehole depth = ft.

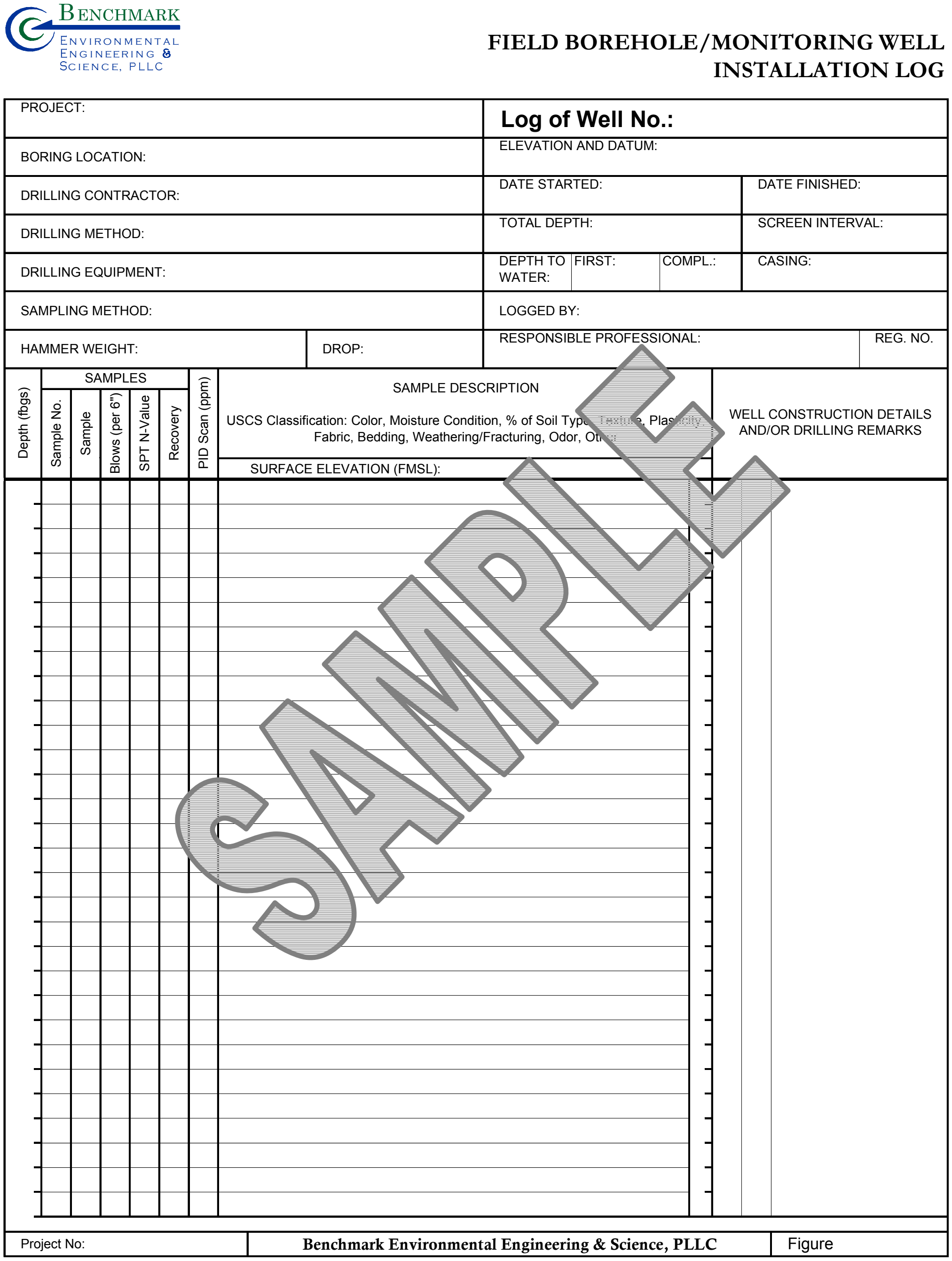
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

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



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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.

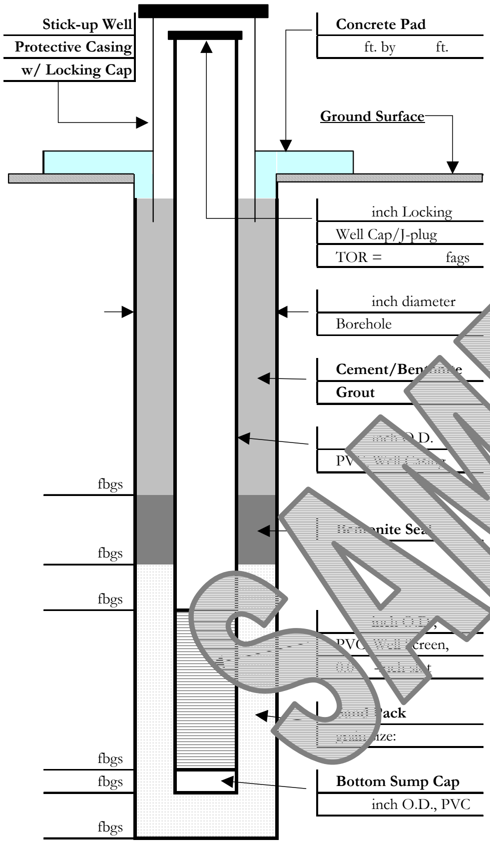
Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other: SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

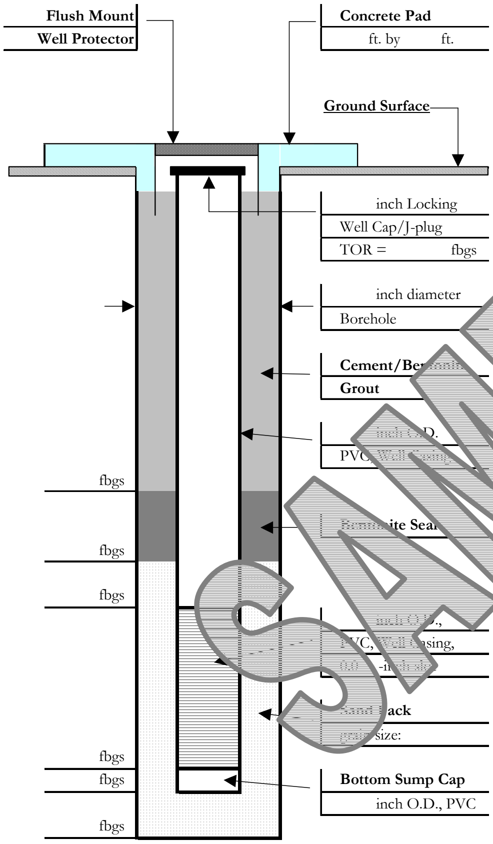
Comments:

PREPARED BY: DATE:

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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

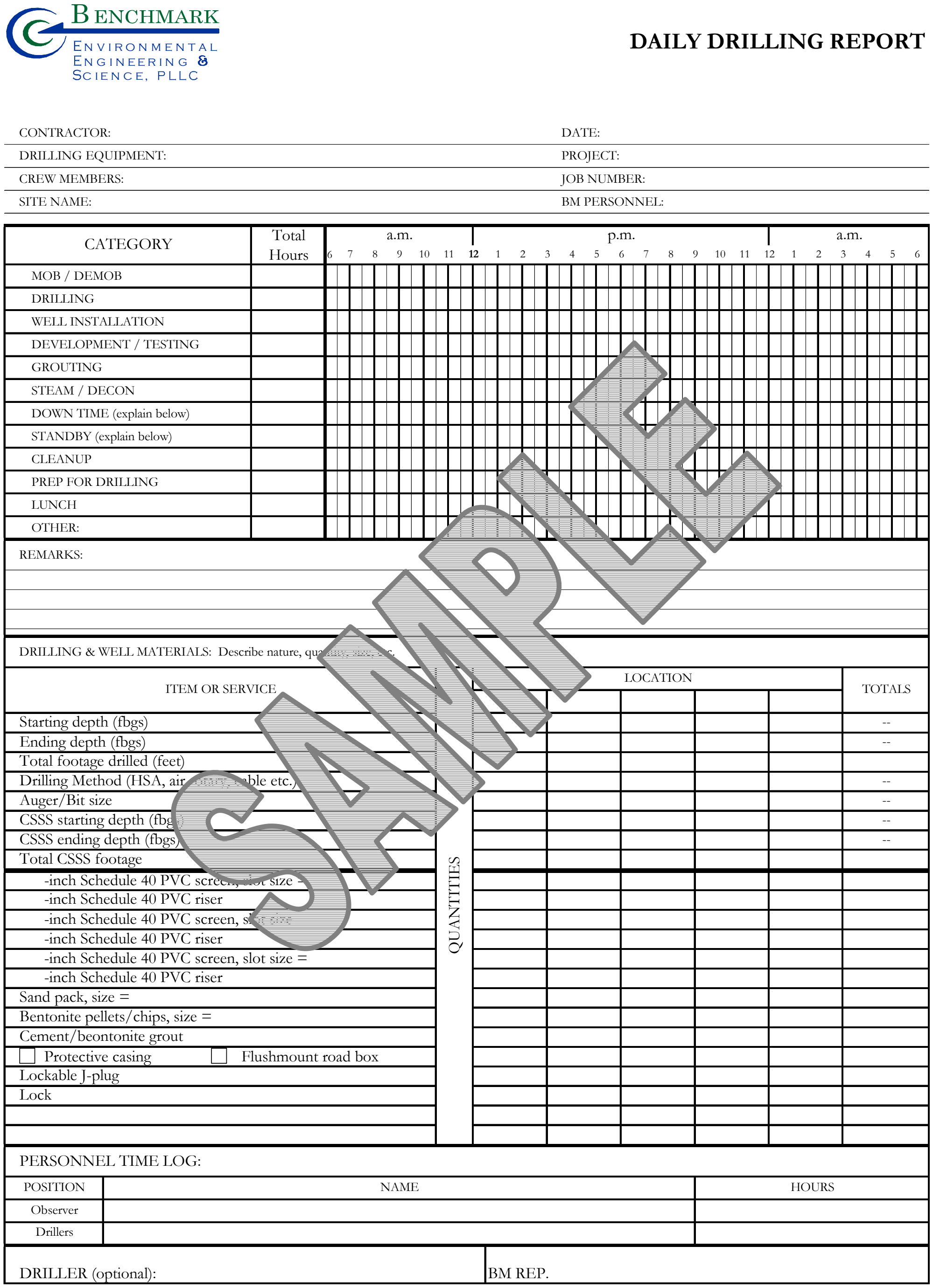
Casing:
Screen:
Sump:
Sand Pack:
Annular Seal:

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:



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

$$V = 0.0408[(B)^2 \times \{(A) - (C)\}]$$

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:

- <u>Bailer</u> – 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.

- <u>Well Wizard Purge Pump (or similar)</u> – 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.

- <u>Submersible Pump (12 or 24 volt, or similar)</u> – 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.

- <u>Waterra™ Pump</u> – 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*

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

GROUNDWATER WELL INSPECTION FORM

Project:	**WELL I.D.:**
Client:	
Job No.:	
Date:	
Time:	

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

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	^{o}C or ^{o}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).

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

Benchmark FOPs:

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*

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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*

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
“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: _______________

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

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. 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.*

Benchmark FOPs:

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*

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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):

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

Project Name:
Project Number:

Container I.D.:
Contents/Matrix:
Estimated Quantity:
Date of Generation:
Date of Sample Collection:

Contact Name:
Contact Phone Number:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

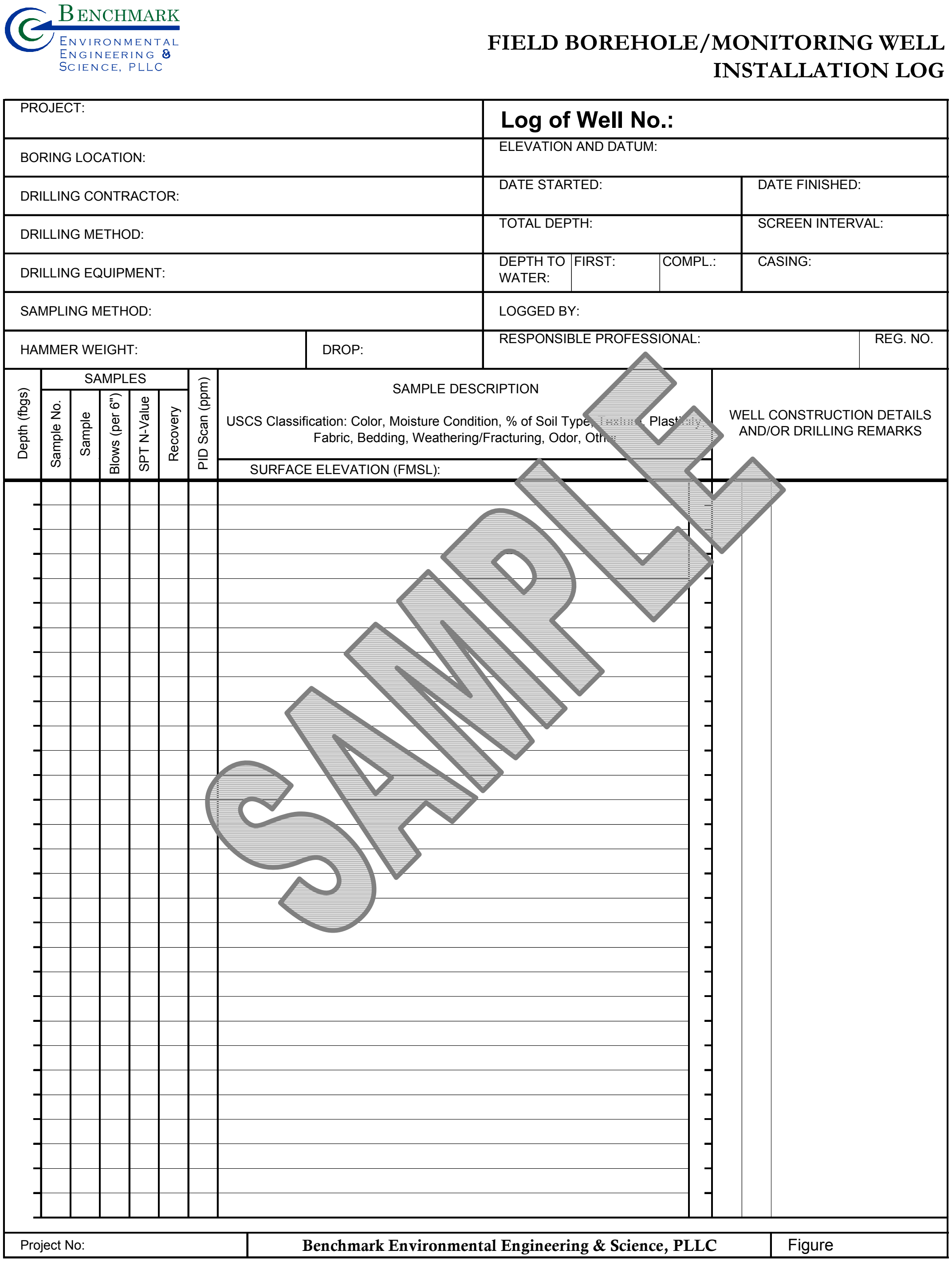
ATTACHMENTS

Field Borehole/Monitoring Well Installation Log (sample)
Typical Monitoring Well Detail (Figure 1)

REFERENCES

Benchmark FOPs:

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*



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

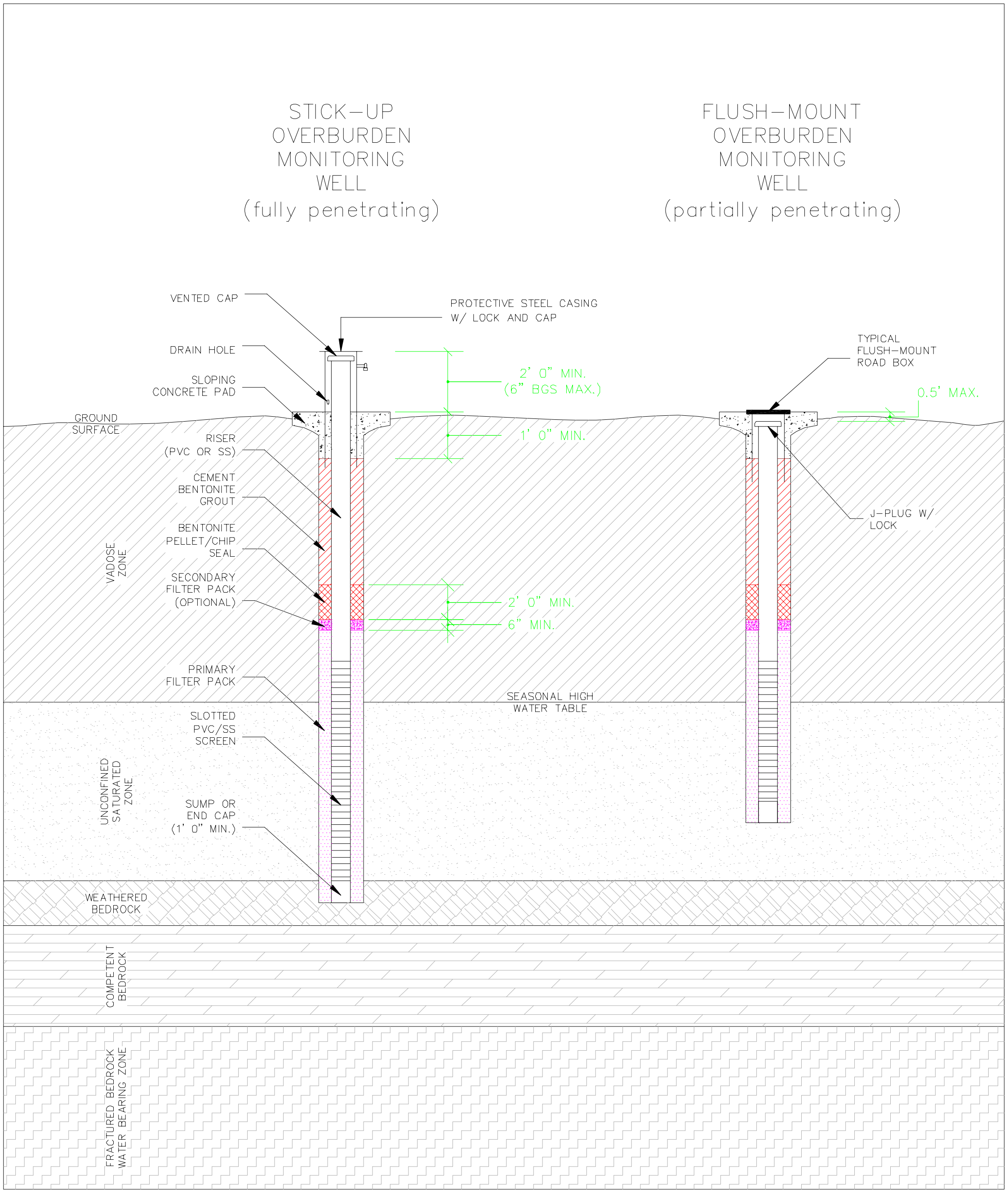
FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

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	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	
							SURFACE ELEVATION (FMSL):	

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
2' 0" MIN.
(6" BGS MAX.)
1' 0" MIN.
TYPICAL
FLUSH–MOUNT
ROAD BOX
0.5' MAX.
RISER
(PVC OR SS)
CEMENT
BENTONITE
GROUT
BENTONITE
PELLET/CHIP
SEAL
J–PLUG W/
LOCK
VADOSE
ZONE
SECONDARY
FILTER PACK
(OPTIONAL)
2' 0" MIN.
6" MIN.
PRIMARY
FILTER PACK
SEASONAL HIGH
WATER TABLE
SLOTTED
PVC/SS
SCREEN
UNCONFINED
SATURATED
ZONE
SUMP OR
END CAP
(1' 0" MIN.)
WEATHERED
BEDROCK
COMPETENT
BEDROCK
FRACTURED BEDROCK
WATER BEARING ZONE

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

Benchmark FOPs:
040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*

Benchmark
Environmental
Engineering &
Science, PLLC

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): $V = 0.0408 [(B)^2 \times \{ (A) - (C) \}]$	

*Use the table to the right to calculate one well volume.

Field Personnel:

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

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (μS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor

REMARKS:

PREPARED BY:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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).

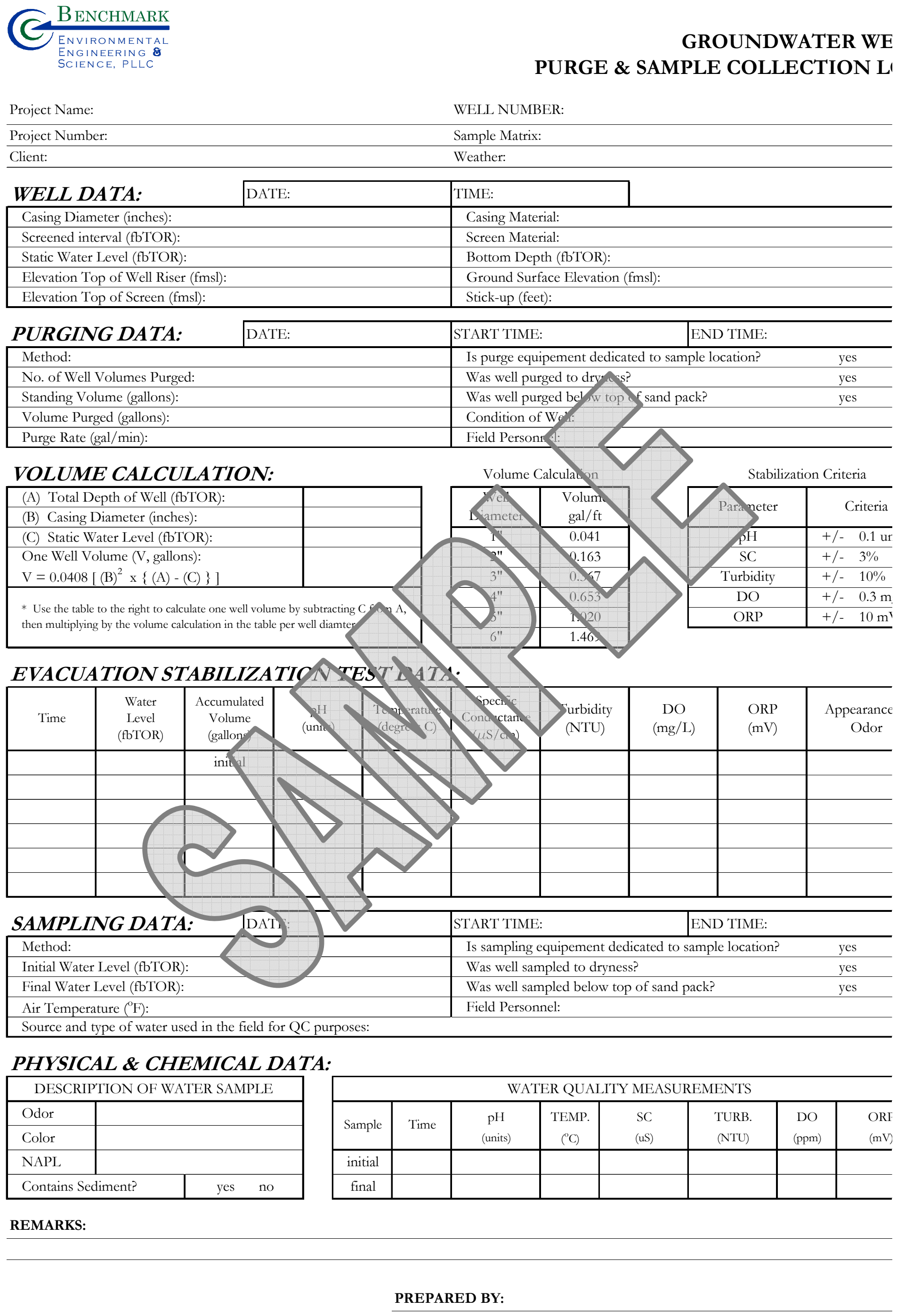
ATTACHMENTS

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*



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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 u
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 (^{o}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. (^{o}C)	SC (uS)	TURB. (NTU)	DO (ppm)	OR (mV)
initial							
final							

REMARKS:

PREPARED BY:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

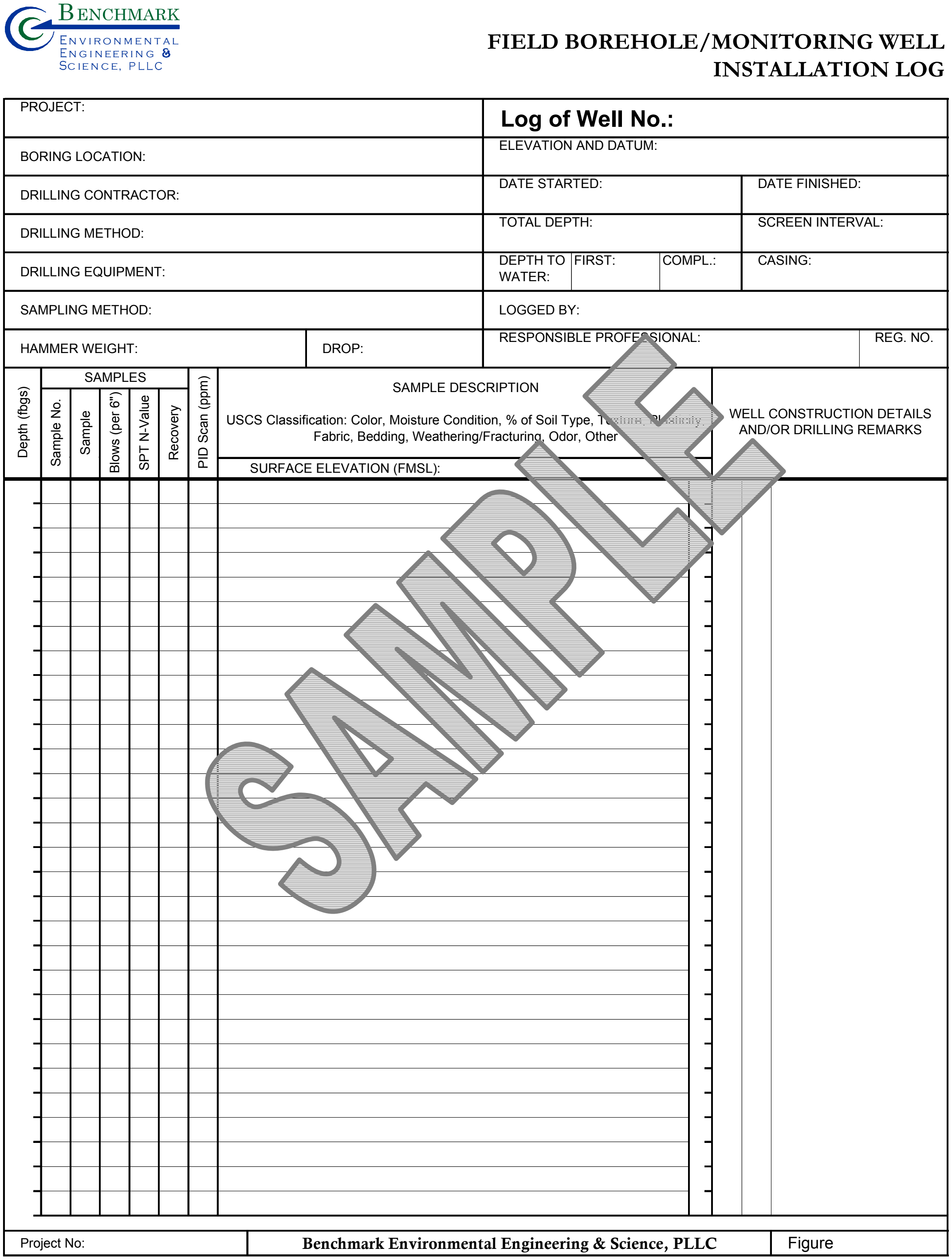
Field Borehole/Monitoring Well Installation Log (sample)
Pipe Leakage Testing Log (sample)

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



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

SAMPLE

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

PIPE LEAKAGE TESTING LOG

Project: Location:

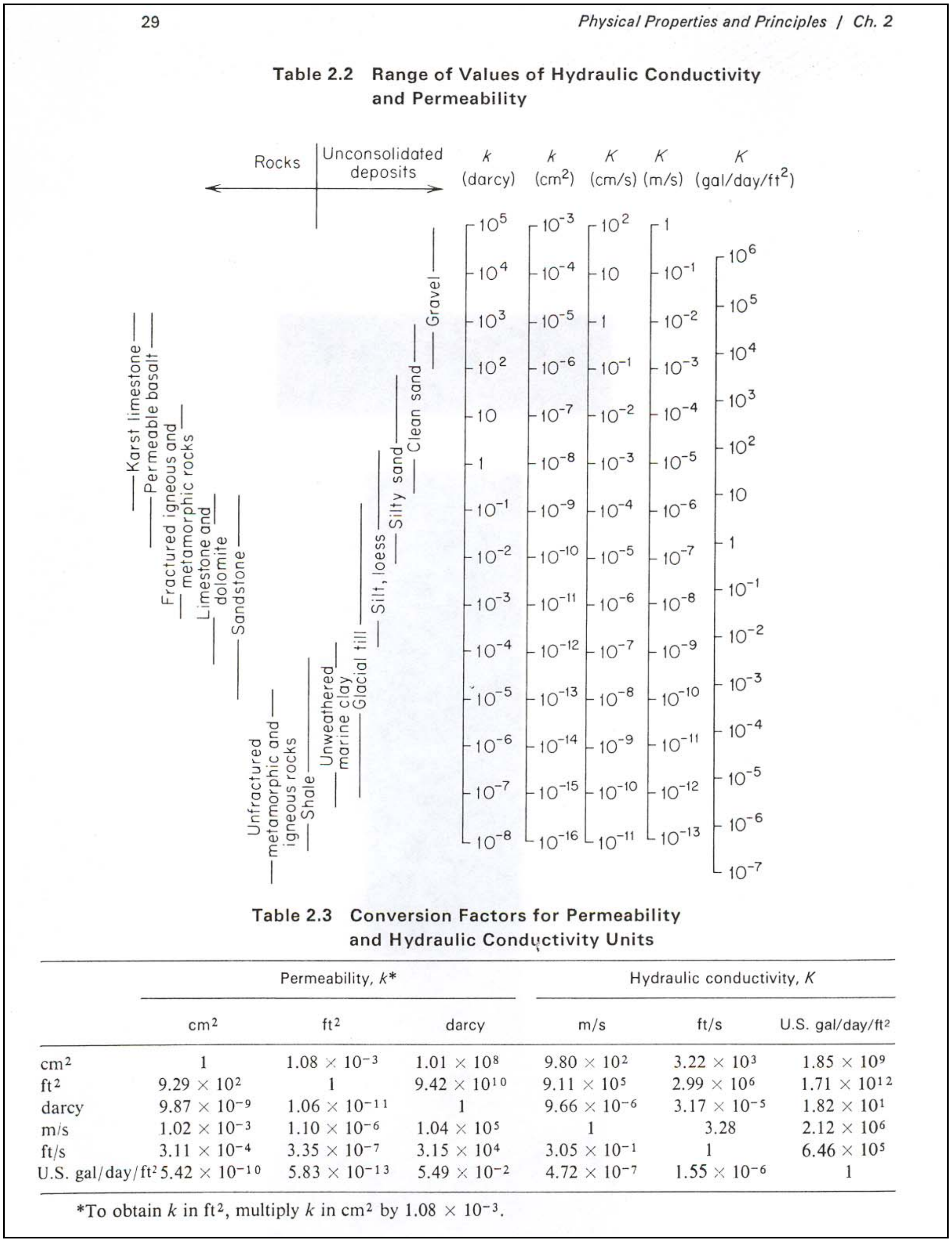
Client: Date:

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.)



29 *Physical Properties and Principles / Ch. 2*

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}.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

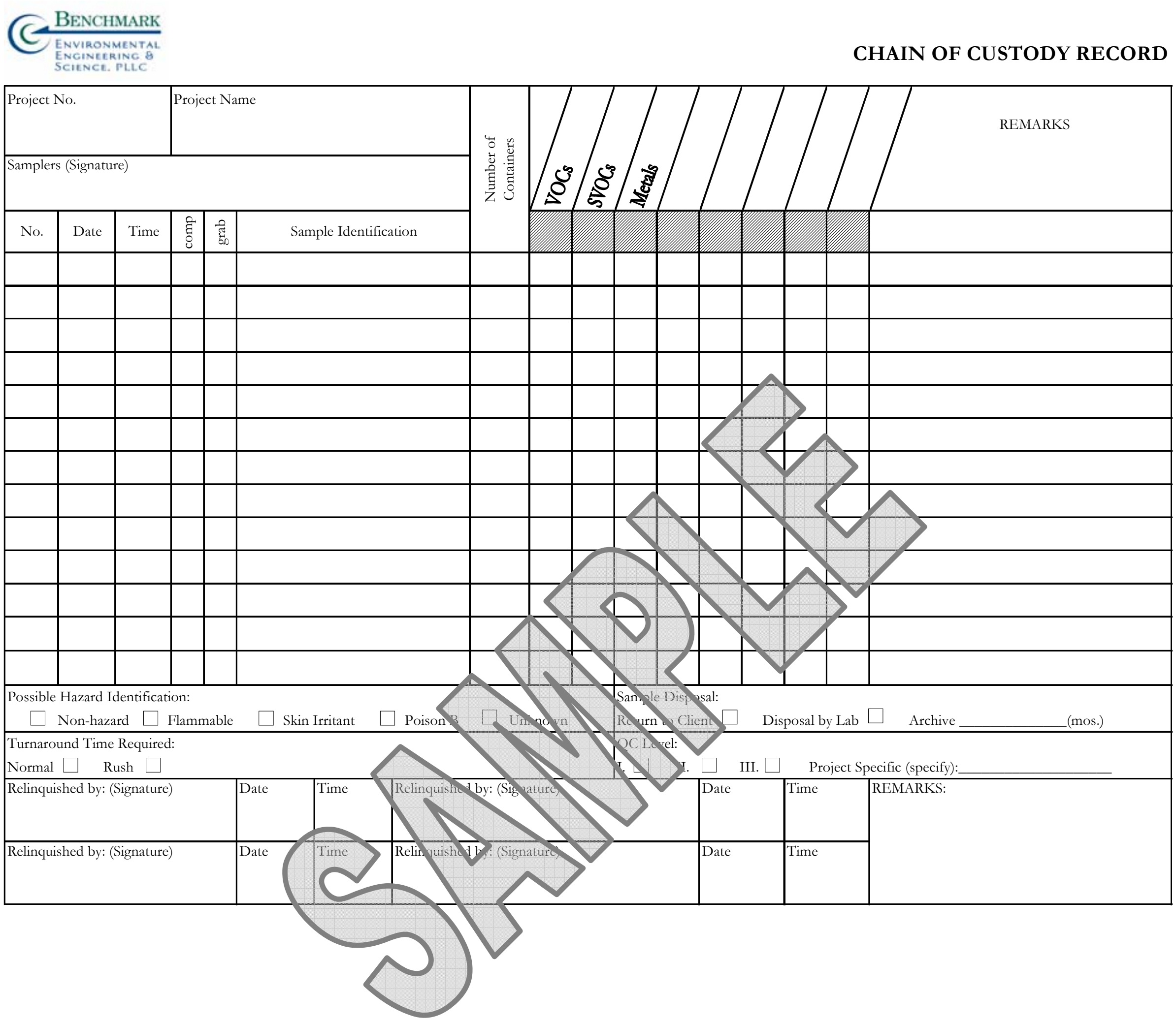
BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.



Benchmark Environmental Engineering & Science, PLLC

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	

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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 gloves (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

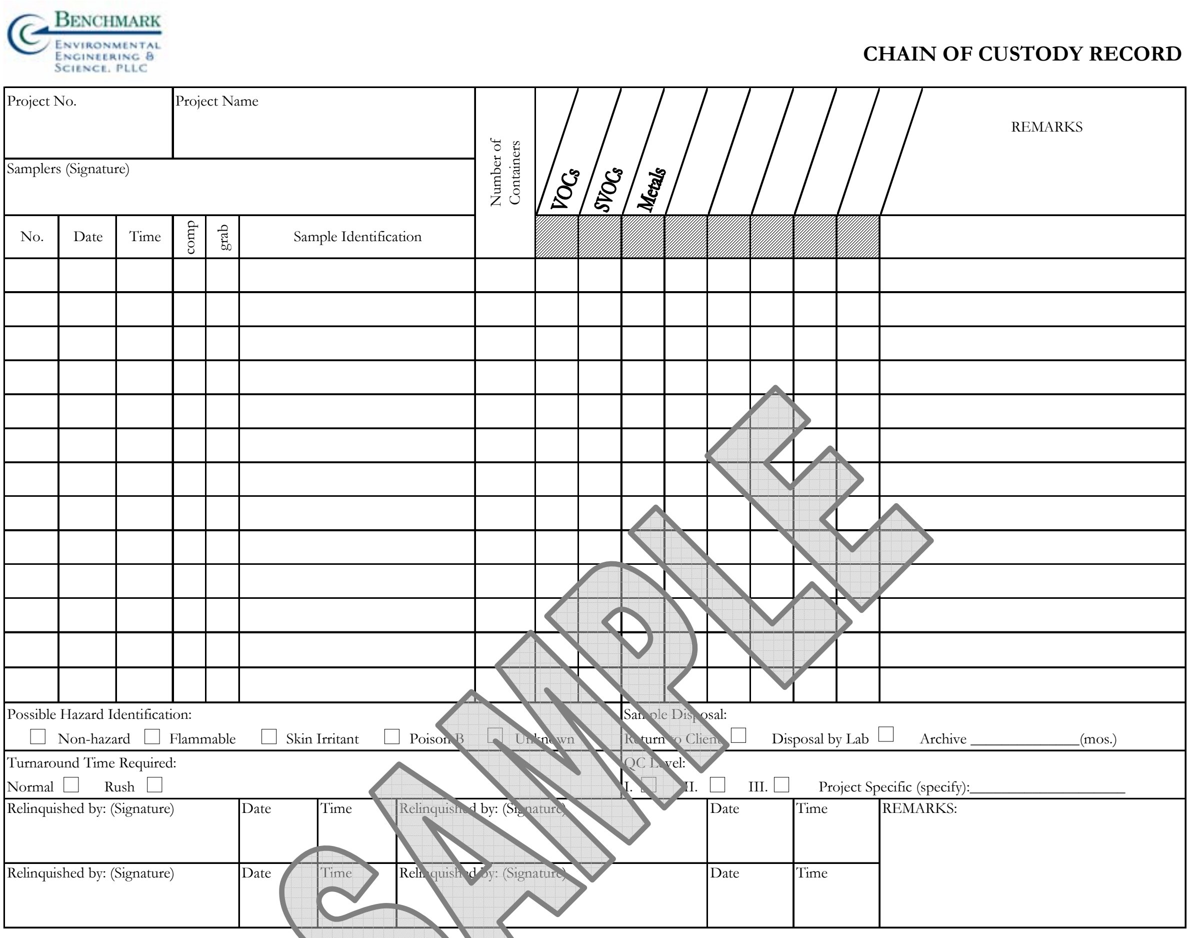
BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

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	

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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*

BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

PROJECT:	**Log of Boring No.:**		
BORING LOCATION:	ELEVATION AND DATUM:		
DRILLING CONTRACTOR:	DATE STARTED:		DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:		SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST:	COMPL.:	CASING:
SAMPLING METHOD:	LOGGED BY:		
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL:		REG. NO.

Depth (fbgs)	SAMPLES Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS

ABANDONMENT:

Volume of cement/bentonite grout required: V = πr^2 x 7.48 = gallons borehole depth = ft.

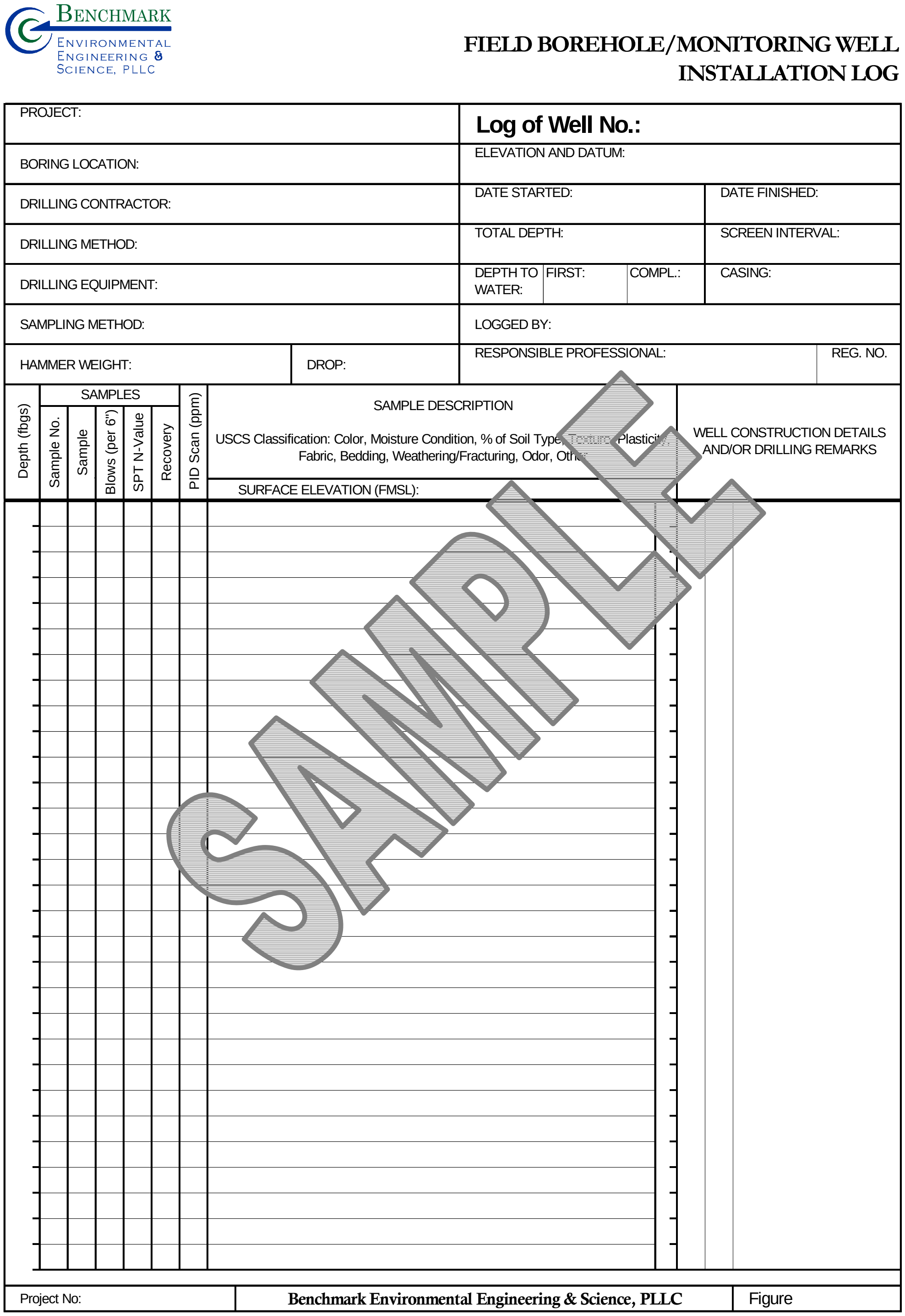
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

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



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

TurnKey
Environmental
Restoration, LLC

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 TurnKey'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 TurnKey'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 TurnKey'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^{o} 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 TurnKey's FOP: Surface and Subsurface Soil Sampling Procedures.

ATTACHMENTS

Impacted Soil Excavation Log (sample)

REFERENCES

<ins>TurnKey FOPs:</ins>

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*

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.)
	Width: (approx.)
End:	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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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° C (140° F). Soil containing natural dry lumps about ½ inch in diameter may be used in place of molded balls, however the dry strengths are usually lower. Test the strength by crushing the dry balls or lumps between your fingers using the descriptions below.

    - None – the dry specimen crumbles with the slightest pressure of handling
    - Low – the dry specimen crumbles with some finger pressure
    - Medium – the dry specimen breaks into pieces or crumbles with considerable finger pressure
    - High – the dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
    - Very High – the dry specimen cannot be broken between the thumb and a hard surface

  - **Dilatency** (ASTM D2488; Table 9)

    FTM (Dilatency): Place enough material in your hand to form a ball approximately ½ inch in diameter and moisten with water until it can be molded or shaped without sticking to your fingers (slightly below the sticky limit). Smooth the ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other several times. Note the reaction of water appearing on the surface of the soil. The soil is said to have given a reaction to this test if, when it is shaken, water comes to the surface of the sample producing a smooth, shiny appearance. Squeeze the sample between the thumb and forefinger and note the reaction as follows:

- None – no visible change in the specimen
- Slow – water slowly appears on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
- Rapid – water quickly appears on the surface of the specimen during shaking and disappears upon squeezing

- **Toughness** (ASTM D2488; Table 10)

  FTM (Toughness): Following the dilatency test above, shape the test specimen into an elongated pat and roll by hand on a smooth surface or between palms into a thread about 1/8 inch in diameter. Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch (e.g., near the plastic limit). Note the pressure required to roll the thread near the plastic limit as well as the strength of the thread. After the thread crumbles, lump the pieces together and knead the lump until it crumbles. Describe the toughness as follows:

  - Low – only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and very soft.
  - Medium – medium pressure is required to roll the thread to near the plastic limit. The thread and the lump are soft.
  - High – considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump are firm.

Using the results of the dry strength, dilatency, and toughness test described above, classify the soil according to the following:

Soil Symbol	Dry Strength	Dilatency	Toughness
Silt (ML)	None to low	Slow to rapid	Low or thread cannot be formed
Lean clay (CL)	Medium to high	None to slow	Medium
Elastic Silt (MH)	Low to medium	None to slow	Low to medium
Fat Clay (CH)	High to very high	None	Low to medium high

- **Plasticity** (ASTM D2488; Table 11)

  Two field test methods can be used to determine plasticity of fine-grained soils (material passing the No. 40 sieve): the roll or thread test and the ribbon test. Each test is described below.

  FTM (Roll or Thread Test): As with the toughness test above, mix a representative portion of the soil sample with water until it can be molded or shaped without sticking to your fingers (slightly below the sticky limit). Place an elongated cylindrical sample on a nonabsorbent rolling surface (e.g., glass or was paper on a flat surface) and attempt to roll it into a thread approximately 1/8 inch in diameter. The results of this test are defined below (non-plastic to high plasticity).

  FTM (Ribbon Test): Form a roll from a handful of moist soil (slightly below the sticky limit) about ½ to ¾ inches in diameter and about 3 to 5 inches long. Place the material in the palm of your hand and, starting at one end, flatten the roll between your thumb and forefinger to form the longest and thinnest ribbon possible that can be supported by the cohesive properties of the material before breaking. If the soil sample holds together for a length of 6 to 10 inches without breaking, the material is considered to be both highly plastic and highly compressive (Fat Clay, CH). If the soil cannot be ribboned, it is non-plastic (Silt, ML or MH). If it can be ribboned only with difficulty into short lengths, it has low plasticity (Lean Clay, CL). Use the following terms to describe the plasticity of soil:

  - Nonplastic (ML or MH) – a 3 mm (0.12 inches) thread cannot be rolled at any water content
  - Low Plasticity (CL, ML, or MH) – the thread can barely be rolled, and crumbles easily
  - Medium Plasticity (CL) – the thread is easy to roll and not much time is required to reach the plastic limit before crumbling
  - High Plasticity (CH) – it takes considerable time rolling and kneading to reach the plastic limit; the thread can be rolled several times before crumbling

Note: A soil with as little as 20% clay will behave as a clayey soil. A soil needs 45% to over 60% medium to coarse sand to behave as a sandy soil. In a soil with 20% clay and 80% sand, the soil will behave as a clayey soil.

- **Relative Density of Cohesionless (Granular) Soils**
  - Very loose – easily penetrated 30 cm (1.2 inches) with 13 mm (0.5 inch) rebar pushed by hand (SPT = 0 to 4)
  - Loose – easily penetrated several cm with 13 mm (0.5 inch) rebar pushed by hand (SPT = 4 to 10)
  - Medium dense – easily to moderately penetrated with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = 10 to 30)
  - Dense – penetrated 0.3 m (1 foot) with difficulty using 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = 30 to 50)
  - Very dense – penetrated only a few cm with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer (SPT = >50)
- **Color** (use Munsel® Color System, as necessary)
- **Particle Size** (see Figure 3)
  - Boulder – larger than a basketball
  - Cobble – grapefruit, orange, volleyball
  - Coarse Gravel – tennis ball, grape

  - Fine Gravel – pea
  - Coarse Sand – rock salt
  - Medium Sand – opening in window screen
  - Fine Sand – sugar, table salt
  - Fines (silt and clay) – cannot visually determine size (unaided)
- **Gradation**
  - Well Graded (GW, SW) – full range and even distribution of grain sizes present
  - Poorly-graded (GP, SP) – narrow range of grain sizes present
  - Uniformly-graded (GP, SP) – consists predominantly of one grain size
  - Gap-graded (GP-SP) – within the range of grain sizes present, one or more sizes are missing
- **Organic Material** – Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread of the toughness test will be spongy.
  - PEAT – 50 to 100 percent organics by volume, primary constituent
  - Organic (soil name) – 15 to 50 percent organics by volume, secondary organic constituent
  - (Soil name) with some organics – 5 to 15 percent organics by volume, additional organic constituents
- **Fill Materials** – All soils should be examined to see if they contain materials indicative of man-made fills. Man-made fill items should be listed in each of the soil descriptions. Common fill indicators include glass, brick, dimensioned lumber, concrete, pavement sections, asphalt, metal, plastics, plaster etc. Other items that could suggest fill include buried vegetation mats, tree limbs, stumps etc. The soil description for a fill material should be followed by the term "FILL", i.e., for a sandy silt with some brick fragments the description would be "SANDY

SILT (ML), with brick fragments (Fill)". The size and distribution of fill indicators should be noted. The limits (depth range) of fill material should be determined and identified at each exploration location.

- **Other Constituents/Characteristics**
  - Additional constituents and/or pertinent soil characteristics not included in the previous categories should be described depending on the scope and objectives of the project. Observations that may be discussed include:
    - Oxide staining
    - Odor
    - Origin
    - Presence of root cast
    - Presence of mica
    - Presence of gypsum
    - Presence of calcium carbonate
    - Percent by volume of cobbles & boulders with size description and appropriate rock classification
  - Other pertinent information from the exploratory program should be recorded, if it would be useful from a biddability/constructability perspective. The conditions that should be listed include caving or sloughing, difficulty in drilling and groundwater infiltration.

SOIL DESCRIPTIONS

Generally, soil descriptions collected during most investigations are not intended for civil engineering (construction) purposes, but rather for hydrogeologic and contaminant transport purposes. As such, the ASTM visual-manual assessments are somewhat limited in that they are only performed in order to indicate important information about potential hydraulic properties of a soil. Soil descriptions should be concise, stressing major constituents and characteristics, and should be given in a consistent order and format. The following order is recommended:

- Soil name. The basic name of the predominant grain size and a single-word modifier indicating the major subordinate grain size (i.e., mostly clay with some silt). The feel test can be used to determine the texture of the soil by rubbing some moist soil between your fingers; sand feels gritty, silt feels smooth, and clays feel sticky. The terms representing percentages of grain size to be used include:
    - Trace – particles are present, but estimated to be less than 5%
    - Few – 5 to 10%
    - Little – 15 to 25%
    - Some – 30 to 45%
    - Mostly – 50 to 100%
- Color (using Munsell® charts, as necessary). Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. It the sample contains layers or patches of varying colors (e.g., mottled), this shall be noted and all representative colors shall be described. The color shall be described for moist samples, however if the color represents a dry condition, it must be stated as such in the log. Generally, colors become darker as the moisture content increases and lighter as the soil dries. Examples include:
    - Some fine-grained soils (OL, OH) with dark drab shades of brown or gray, including almost black, contain organic colloidal matter.
    - In contrast, clean, bright looking shades of gray, olive green, brown, red, yellow, and white are associated with inorganic soils.
    - Gray-blue or gray- and yellow-mottled colors frequently result from poor drainage.
    - Red, yellow, and yellowish brown result from the presence of iron oxides.

  - White to pink may indicate considerable silica, calcium carbonate, or aluminum compounds.
- Field moisture condition as dry, moist, or wet;
- Gradation or Plasticity. Granular soils (i.e., sands or gravels) should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soils (i.e., silts and clays) should be described as non-plastic, low, medium, or high, depending on the results of the manual evaluation for dry strength, dilatency, toughness, and plasticity discussed previously.
- Consistency/Density. An estimate of consistency of a cohesive soil or density of a granular soil, usually based on the SPT results (see Descriptive Terms section of this FOP);
- Soil Structure or Mineralogy. Description of discontinuities, inclusions, and structures, including joints, fissures, and slickensides.
- Odor. Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum, chemical, etc.), it should be noted in the log.
- Other important geologic information such as consolidation, gravel size and shape, visible internal structure, root holes, mica, odors, etc.

The first step when describing soil is to determine if the sample is predominantly fine-grained or coarse-grained (see Figures 3 and 4). Coarse-grained soils are relatively easy to identify, however descriptions of fine-grained soils can be more difficult, requiring additional field tests to assist the field geologist arrive at the proper soils classification (see **FTMs** under Descriptive Terms above). These tests are explained in detail in the ASTM Standard D2488 and briefly herein. Generally, the differentiation between silt and clay is based on plasticity and "texture". However, tests for dry strength and dilatency, along with plasticity, can be very helpful and are recommended in the ASTM Standard. If additional tests are performed, in addition to plasticity, to classify the fines, record them with the soil description on the logs. Doing this will assist the reader (i.e., Project Manager) to follow the logic used to describe a soil (e.g., medium plasticity, <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:

<u>Coarse-grained Soil</u>

POORLY GRADED FINE SAND w/ SILT: Dark grey, wet, mostly fine sand with some non-plastic fines, some iron-stained mottling, laminated, medium dense

<u>Fine-grained Soil</u>

LEAN CLAY: Dark reddish/brown, moist, mostly fines, medium plasticity, firm, no dilatency, medium dry strength, root holes.

<u>Soil/Fill (option 1) – visual evidence of fill</u>

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).*

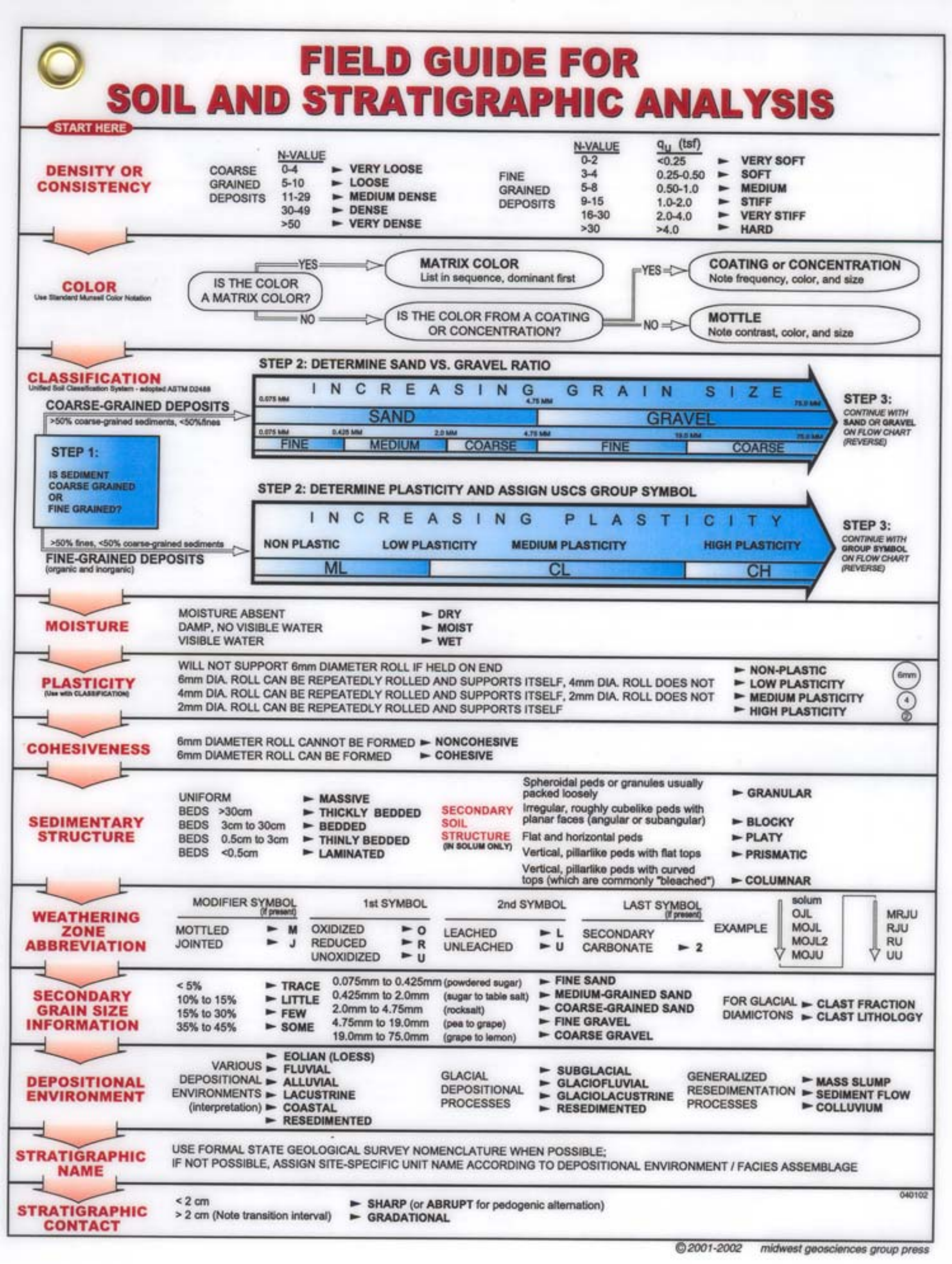
State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1996. *Soil & Rock Logging Classification Manual (Field Guide), by Joseph C. de Larios.*

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	
0-4	► VERY LOOSE
5-10	► LOOSE
11-29	► MEDIUM DENSE
30-49	► DENSE
>50	► VERY DENSE

FINE GRAINED DEPOSITS N-VALUE	q_u (tsf)	
0-2	<0.25	► VERY SOFT
3-4	0.25-0.50	► SOFT
5-8	0.50-1.0	► MEDIUM
9-15	1.0-2.0	► STIFF
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 · 4.75 MM · 75.0 MM
SAND | GRAVEL
0.075 MM · 0.425 MM · 2.0 MM · 4.75 MM · 19.0 MM · 75.0 MM
FINE | MEDIUM | COARSE | FINE | COARSE

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

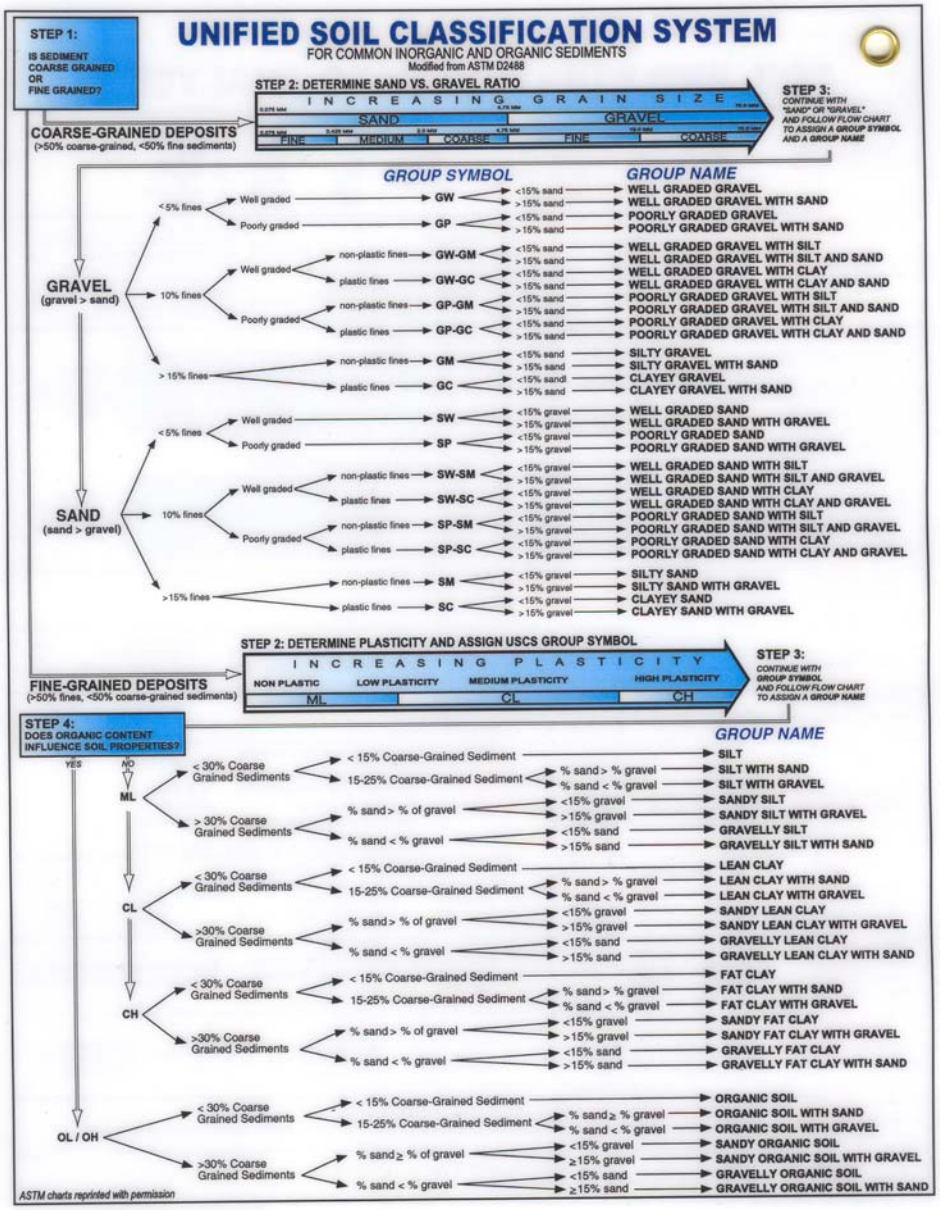
STRATIGRAPHIC CONTACT

< 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)



ASTM charts reprinted with permission

FIGURE 3

ILLUSTRATION OF PARTICLE SIZES

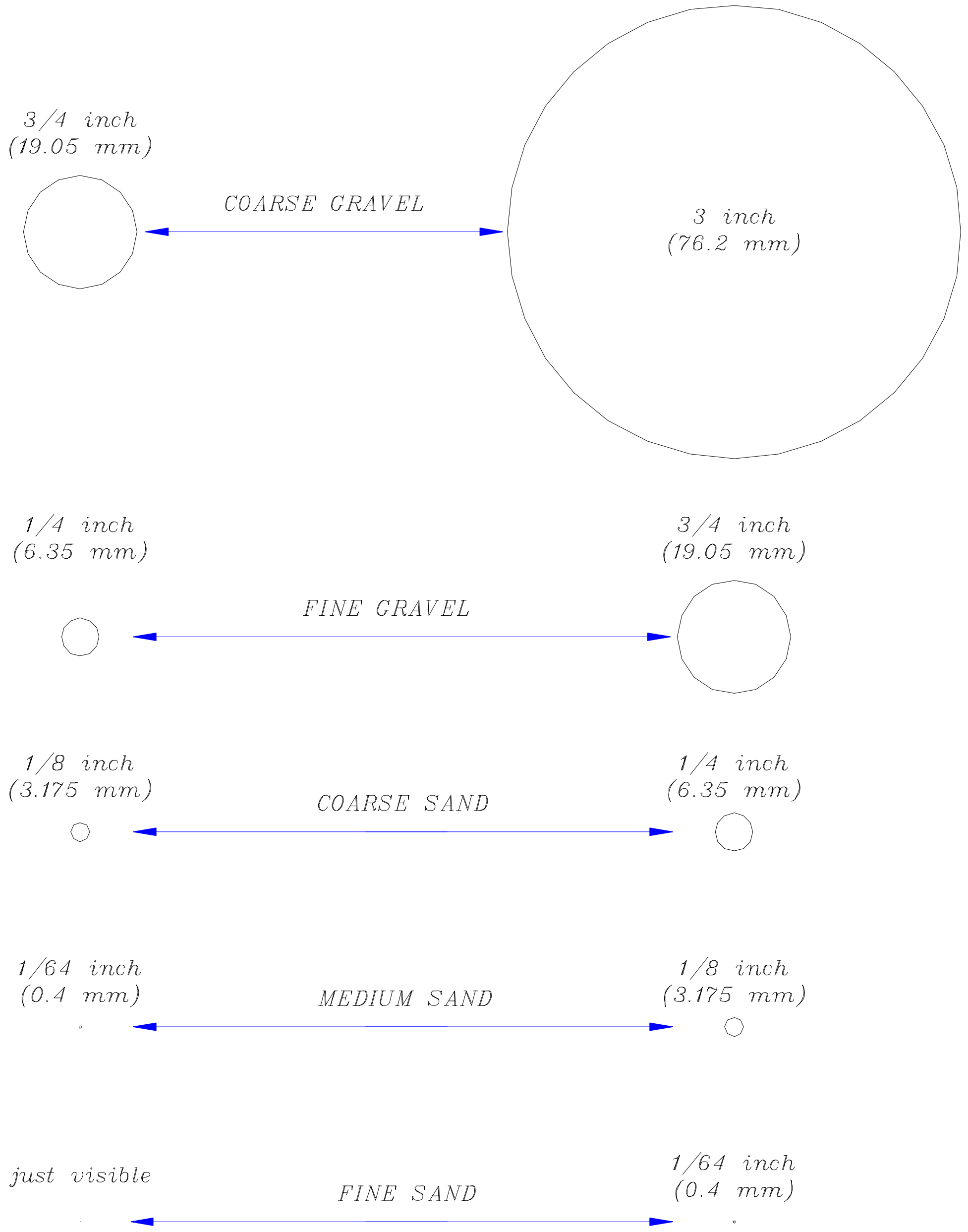


FIGURE 4

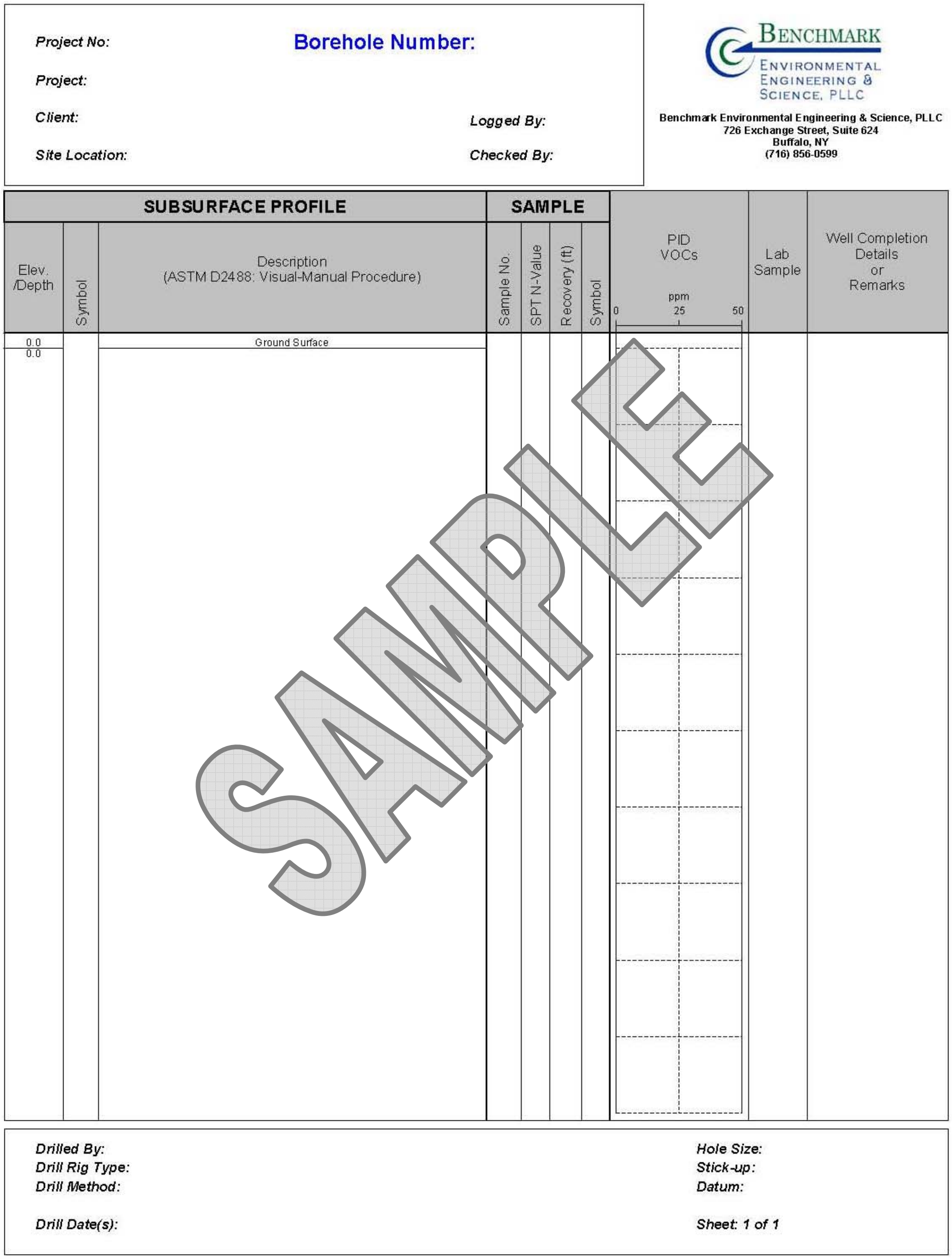
GRAIN-SIZE SCALE (MODIFIED WENTWORTH SCALE)

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).

SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD



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	Lab Sample	Well Completion Details or Remarks
Elev. /Depth	Symbol	Description (ASTM D2488: Visual-Manual Procedure)	Sample No.	SPT N-Value	Recovery (ft)	Symbol	ppm 0 25 50		
0.0		Ground Surface							
0.0									

Drilled By:
Drill Rig Type:
Drill Method:

Drill Date(s):

Hole Size:
Stick-up:
Datum:

Sheet: 1 of 1

TurnKey
Environmental
Restoration, LLC

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 (see Figure 1) 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 TurnKey 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 TurnKey's FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).

13. Record all information in accordance with TurnKey's FOP: Documentation Requirements for Drilling and Well Installation.

14. Collect a portion of the sample for field screening as described in the TurnKey's 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 TurnKey's FOP: Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

Figure 1; Split Spoon Sampler Schematic

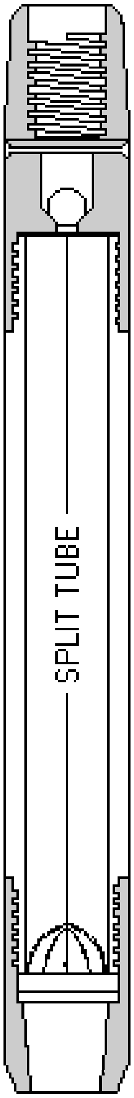
REFERENCES

<u>TurnKey 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)*

FIGURE 1

SPLIT SPOON SAMPLER SCHEMATIC



BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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 non-dedicated 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. <u>Volatile Organic Compound (VOCs)</u>: 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. <u>All Other Parameters</u>: 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*

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

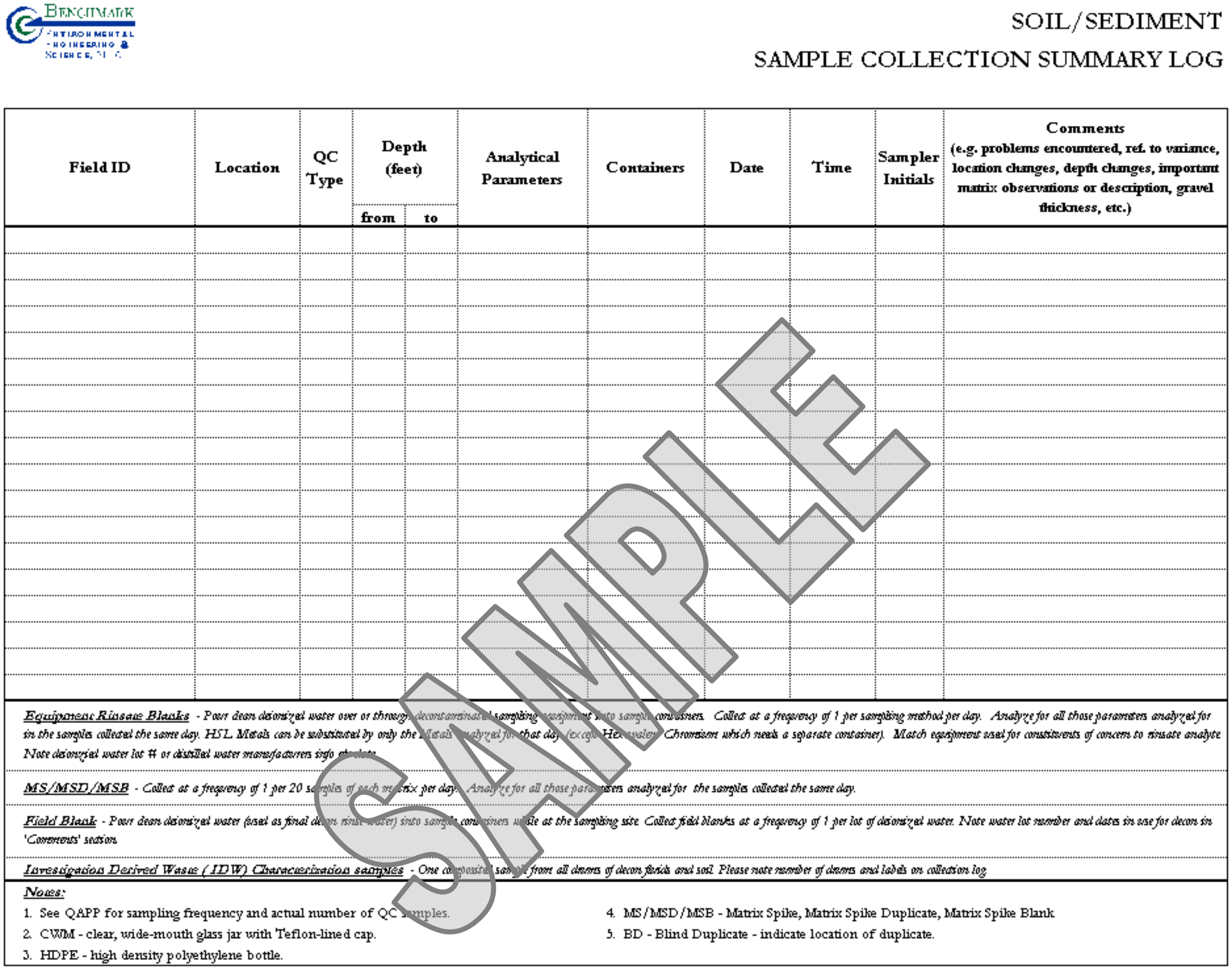
New Equipment:

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:



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 [illegible]

__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.

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:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

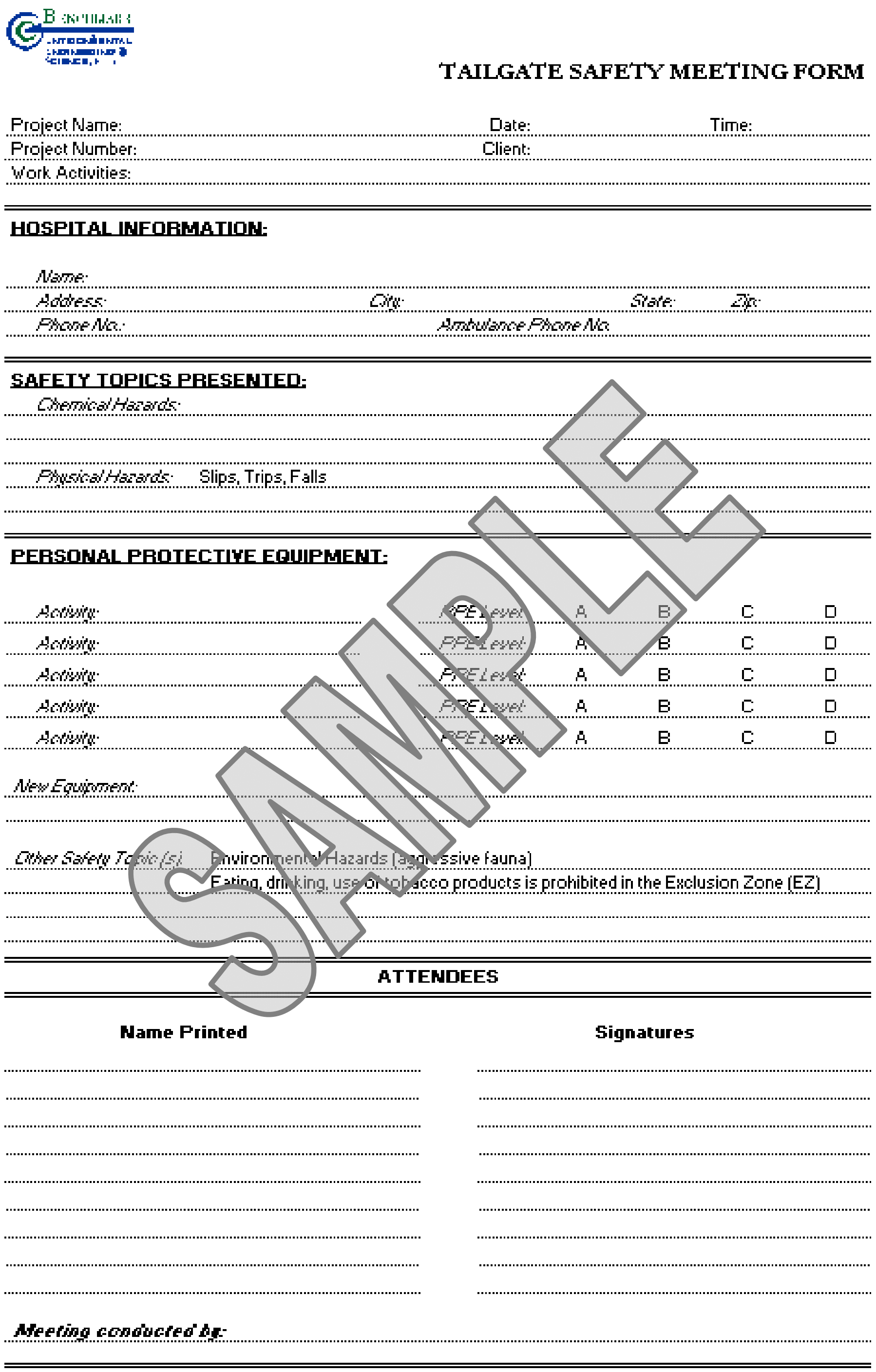
ATTACHMENTS

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*



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:

REAL TIME AIR MONITORING LOG

Date:

Project Name:

Project Number:

Project Location:

Client:

Purpose of Air Monitoring:

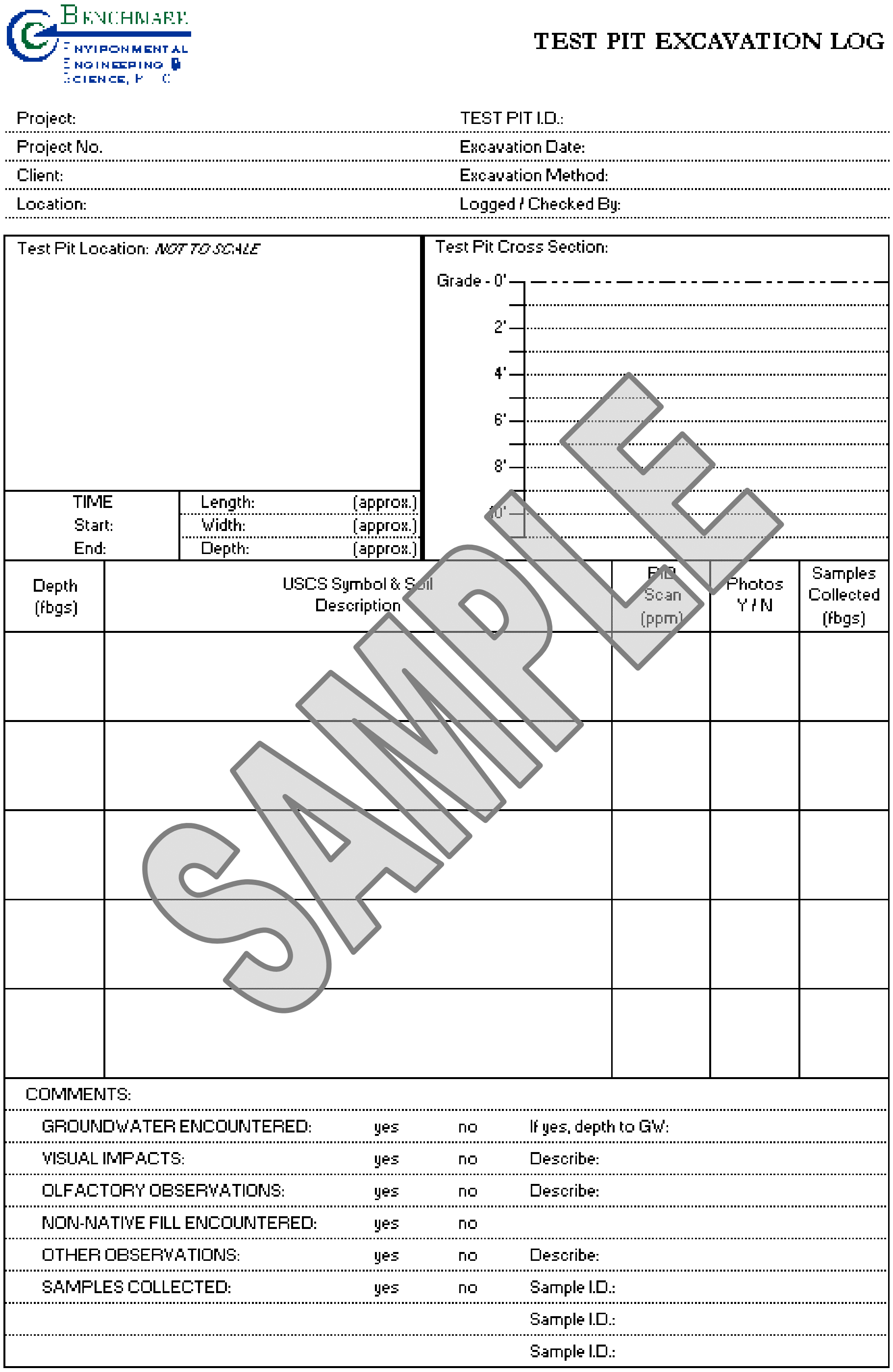
WEATHER CONDITIONS:

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

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:

Grade - 0'
2'
4'
6'
8'
10'

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.:

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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.

- **<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*

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:

TurnKey Environmental Restoration, LLC

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 TurnKey'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 TurnKey'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 TurnKey'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 TurnKey'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 TurnKey's Field Operating Procedure for Abandonment of Borehole. Boreholes to be used as temporary wells should be completed in accordance with TurnKey'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 TurnKey'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 TurnKey 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 TurnKey field supervisor.

ATTACHMENTS

Drilling Safety Checklist (sample)
Tailgate Safety Meeting Form (sample)

REFERENCES

<u>TurnKey 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*

TurnKey Environmental Restoration, LLC

DRILLING SAFETY CHECKLIST

Project: Date:
Project No.: Drilling Company:
Client: 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?		

TurnKey Environmental Restoration, LLC

DRILLING SAFETY CHECKLIST

Project: Date:

ITEMS TO CHECK	OK	ACTION NEEDED
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?		
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 **TurnKey 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:

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:

TurnKey
Environmental
Restoration, LLC

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

TurnKey
Environmental
Restoration, LLC

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

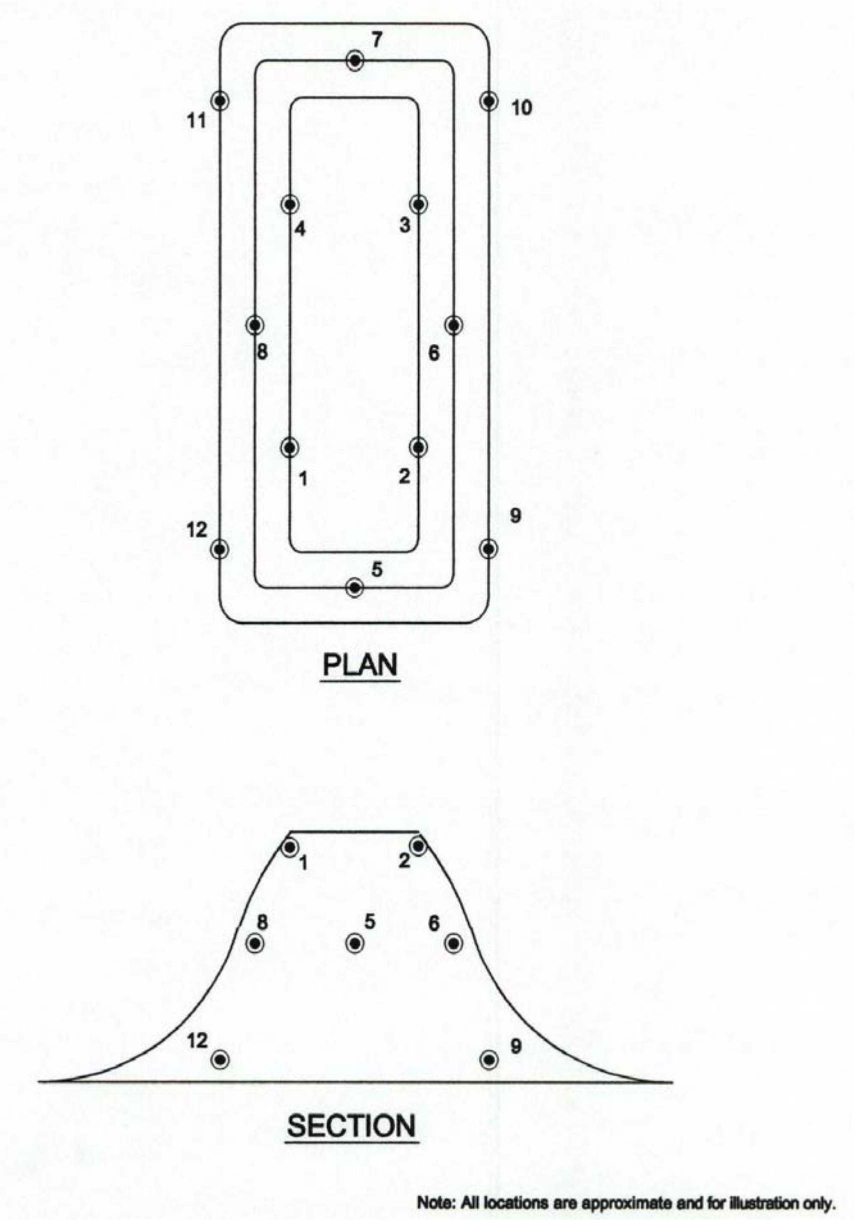
Figure 1; Stockpile Sampling Methodology

REFERENCES

None

FIGURE 4

1,000 CY STOCKPILE SAMPLING METHODOLOGY



TurnKey
Environmental
Restoration, LLC

FIELD OPERATING PROCEDURES

Waste Sampling Procedures

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.

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

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

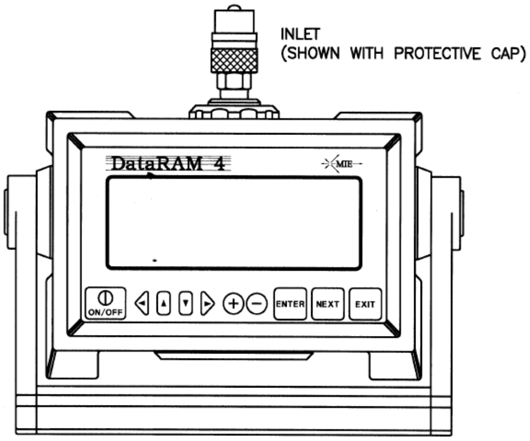


FIGURE 1. FRONT–PANEL VIEW OF DataRAM

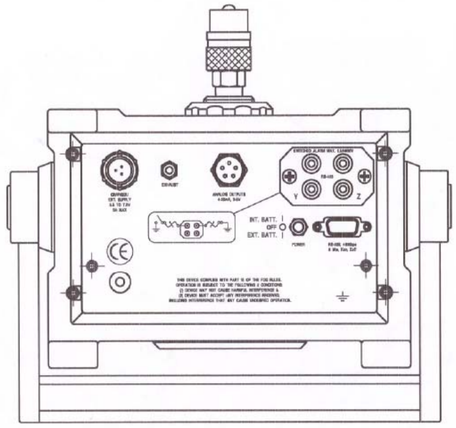


FIGURE 2. BACK–PANEL VIEW OF DataRAM

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).

<u>Instrument Storage</u>

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.

<u>Filter Replacement</u>

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.

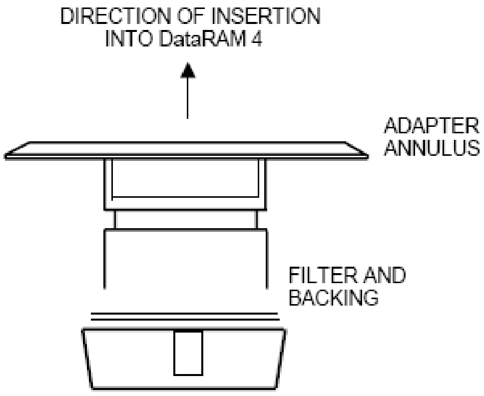
> *HEPA Filter Cartridge Replacement*
>
> The DataRAM 4 is shipped from the factory with the HEPA filter cartridge installed. This cartridge can be identified by its metallic cover. Remove this cartridge. Clean the internal black rubber gasket against which the cartridge is normally compressed. Install 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

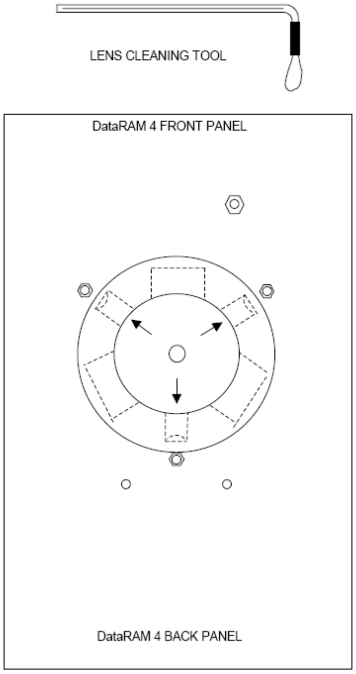
Although the DataRAM 4 incorporates filtered air shielding of the critical optical sensing surfaces, continued sampling of airborne particles at high concentrations may result in gradual build-up of contamination on those interior surfaces of the sensing chamber components. This may cause an excessively 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

TurnKey Environmental Restoration, LLC

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 TurnKey'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

TurnKey FOPs:
040 Non-disposable and Non-dedicated Sampling Equipment Decontamination