

# Remedial Investigation Work Plan

*Southside Plaza Site No. C907043  
Jamestown, New York*

November 2019  
Revised April 2020

B0505-019-001

Prepared For:

Kazmarek Mowrey Cloud Laseter LLP



Prepared By:



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**SOUTHSIDE PLAZA SITE  
BCP SITE NO. C907043  
JAMESTOWN, NEW YORK**

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0505-019-001

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## RI WORK PLAN

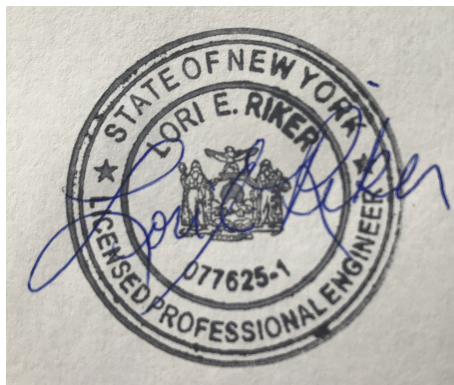
Southside Plaza Site  
Jamestown, New York

### Certification

I, Lori E. Riker, certify that I am currently a NYS registered professional engineer and that this April 2020 Remedial Investigation Work Plan for the Southside Plaza 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).

04/10/2020

Date



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## 1.0 INTRODUCTION

This document presents the proposed scope of work and implementation procedures for completion of a Remedial Investigation (RI) at the Southside Plaza Site (Site), located at 704-744 Foote Avenue, Jamestown, New York (see Figures 1 and 2).

The Applicant, LB-UBS 2007-C6 – Southside Station LLC (Southside), acting as a Participant, 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. Following investigation and remediation, the Site will remain a commercial retail plaza with a restaurant outbuilding and associated asphalt parking. The RI will be completed by Benchmark Environmental Engineering & Science, PLLC (Benchmark), on behalf of the Applicant. The work will be completed in accordance with NYSDEC DER-10 guidance (Ref. 1).

### 1.1 Site Background

The 5-acre Site consists of one tax parcel designated as 704-744 Foote Avenue, SBL No. 404.07-8-3. The Site is developed with two structures including a retail strip mall (Building 1) and a separate restaurant tenant space north of the strip mall (Building 2). Building 1 is currently occupied by several commercial tenants including TOPS Friendly Markets (TOPS), KeyBank, Cellular One, Dollar Tree, Spa Nails, and The UPS Store. Building 2 is currently occupied by McDonald's. Figure 2 shows the location of the current building tenants. The Site also includes a paved parking lot east of the structures, a paved parking lot/access road west of the structures, and some vegetated areas.

The Site was improved with several residential properties from at least the 1890s to 1955. A strip mall (Building 1) and a former separate structure north of the strip mall (former Building 2) were built between 1955-1958 and 1960. Two historical dry cleaners were present from 1956 to at least 1975 in Building 1 tenant space historically addressed as 736 Foote Avenue (Triangle Cleaners and Anderson Cleaners). In addition, two historical dry cleaners occupied the Building 1 tenant space historically addressed at 750 Foote Avenue from approximately 1980 to at least 1994 (Anderson Cleaners and Whirley-Wash Dry Cleaners). The dry cleaners will be referenced herein as the former Anderson Cleaners location (736 Foote Avenue) and the former Whirley-Wash location (750 Foote Avenue).

The Applicant owns the Subject Site referred to as the Southside Plaza Site, while others own the south adjoining property referred to as South Foote Avenue Plaza (SFAP). There has been some debate amongst these two property owners whether the former Whirley-Wash was located on-site (i.e., on the Southside Plaza Site) or off-site (i.e., the south adjoining SFAP property). However, a letter dated August 29, 2019 from Mr. Karim Abdulla of Barclay Damon, LLP (representing the SFAP property) submitted to Kazmarek Mowrey Cloud Laseter LLP (KMCL) (representing the Southside Plaza Site) and NYSDEC provides documentation that contends that both dry cleaners were located on the Southside Plaza Site and not the SFAP property. The letter contends that Whirley-Wash was located in a historic tenant address of 750 Foote Avenue, which fell within the addresses of the Southside Plaza Site (i.e., 704-750 Foote Avenue) at that time; the south adjoining SFAP property was historically addressed 752-778 Foote Avenue at the time and therefore “off-site”. No other former or current Building 1 tenants present a potential concern.

The former Building 2 was historically occupied by two former gas stations from the mid-1950s to the late 1970s; Bish’s South Side Service Station is known to have been located at the Site in 1969 and Cuifolo’s Service Center is known to have been located at the Site in 1975. The former Building 2 was demolished between 1975 and 1980. The existing Building 2 was constructed in 1980 for use as a McDonald’s. There is no evidence of underground storage tank (UST) usage at the former dry cleaner locations; however, two 500-gallon oil tanks and four 3,000-gallon gasoline tanks are known to be on-site per the City of Jamestown Fire Department. No information is available regarding petroleum bulk storage (PBS) registration or tank closure.

Previous environmental studies completed at the Site indicate that the Site is underlain by soil/fill impacted by chlorinated volatile organic compounds (CVOCs) yielding concentrations above 6NYCRR Part 375 Unrestricted Use Soil Cleanup Objectives (USCOs, Ref. 2) and Residential Use Soil Cleanup Objectives (RSCOs) and groundwater impacted by CVOCs yielding concentrations above 1.1.1 TOGS Groundwater Quality Standards/Guidance Values (GWQS/GV; Ref. 3). The highest concentrations of CVOCs in soil and groundwater were observed proximate the former Whirley-Wash location; elevated concentrations of CVOCs were also observed in sub-slab vapor samples collected from this area. A sub-slab depressurization system (SSDS) was installed in February 2013 at the location of the former Whirley-Wash, within the existing TOPS. No CVOCs have been

detected above detection limits in the TOPS indoor air since system installation, confirming that the SSDS is effectively mitigating CVOC concentrations in the sub-slab vapor of Building 1.

## 1.2 Project Objectives

For sites entering the BCP at the point of investigation, NYSDEC requires completion of an RI. The primary objectives of this RI are to:

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

As part of the RI, 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 photoionization detector (PID) measurements, groundwater elevation measurements, and field analyses (i.e., pH, temperature, turbidity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and specific conductivity). 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 4.0. Sampling and analytical acceptance and performance criteria such as precision, accuracy, representativeness, comparability, completeness, and sensitivity, are defined in the QAPP.

### **1.3 Project Organization and Responsibilities**

The Applicant, Southside, applied to the New York State BCP as a non-responsible party (Volunteer) per ECL§27-1405; however, the Department's BCP acceptance letter (March 20, 2020) determined the Applicant to be a Participant as defined in ECL 27-1405(1)(a). Benchmark will complete the RI fieldwork and manage the brownfield cleanup on behalf of the Applicant. The Region 9 NYSDEC Division of Environmental Remediation (DER), in consultation with the New York State Department of Health (NYSDOH), shall monitor the RI and remedial actions to be performed in accordance with the Brownfield Cleanup Agreement (BCA), the approved RI Work Plan (RIWP), and NYSDEC DER-10 guidance (Ref. 1).

Benchmark 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. Appendix A includes the résumé for Benchmark's Project Manager. The table below presents the planned project team.

<b>Company</b>	<b>Role</b>	<b>Name</b>	<b>Contact Information</b>
Southside Station LLC	Applicant Contact	Mark Miller	(305) 695-5600
Benchmark	Project Officer	Michael Lesakowski	(716) 856-0599 (716) 818-3954
Benchmark	Project Manager/ QA Officer	Lori Riker	(716) 856-0599 (716) 474-7510
Benchmark	Field Team Leader/ Site Safety and Health Officer	Tom Behrendt	(716) 856-0599 (716) 818-8358
Eurofins TestAmerica	Analytical Testing	Brian Fischer	(716) 504-9835
Earth Dimensions, Inc.	Drilling Services	Brian Bartron	(716) 491-1847
TREC Environmental, Inc.	Drilling Services	Keith Hambley	(585) 314-6189
Data Validation Services	Data Validation	Judy Harry	(518) 251-4429

## 2.0 SITE DESCRIPTION

### 2.1 General

The Site is located on Foote Avenue between Cole Avenue and Marion Street in a highly developed residential and commercial area in the City of Jamestown, Chautauqua County, New York. The Site is bordered by residential and commercial properties, and Cole Avenue to the north; residential and commercial properties, including the adjoining SFAP property to the south; residential properties and Ivy Street to the west; and residential and commercial properties and Foote Avenue to the east. The Site is currently developed with two commercial buildings including a retail strip mall (58,741 square feet) and a separate restaurant tenant space (4,214 square feet), asphalt parking areas, an asphalt access road, and some green space.

### 2.2 Site Topography and Drainage

The Site is generally flat lying with topographic relief sloping toward Foote Avenue. Exterior surfaces are primarily covered with asphalt, with few small areas covered with green space. Precipitation (i.e., rain or melting snow) primarily moves to storm drains in the parking lots and roadways via overland flow; minimal precipitation infiltrates the ground surfaces. Surface and shallow groundwater flow are 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 glaciated Allegheny Plateau. The Allegheny Plateau is an eroded plateau typified by sharp relief with highly varied elevations ranging from 4,000 feet in the unglaciated Allegheny Plateau, to less than 100 feet in the glaciated Allegheny Plateau. The surficial geology of the glaciated Allegheny Plateau has developed from glacial till. According to the United States Department of Agriculture (USDA) web soil survey (Ref. 4), Site soils are characterized primarily as Fremont silt loam (FmA) with a small portion of the Site soils characterized as Schuyler silt loam (ShC). Fremont silt loam is characterized as a somewhat poorly drained soil with 0 to 3 percent slopes. The Schuyler silt loam is characterized as a moderately well drained soil with 8 to 15 percent slopes.



Most of the Site is covered by asphalt paving or concrete structures, with vegetation covering some small areas. The underlying overburden geology is generally described as gray to brown sandy silt and clayey silt with some gravel. The overburden extends from ground surface to approximately 6 to 11 feet below ground surface (fbgs) at the southwestern end of the Site and 16 to 20+ fbgs at the northeastern end of the Site. The overburden overlies gray weathered shale. The RI will include further investigation of the overburden at the Site.

### ***2.3.2 Bedrock***

Based on the bedrock geologic map of Erie County (Ref. 5), the Site is situated over the Onondaga Formation of the Conneaut group. The Conneaut group is comprised of Upper Devonian-aged shale, sandstone, and siltstone and has a thickness of 250-600 feet. Shale was encountered between 6-16 fbgs during the previous investigations. According to a local drilling company who has conducted rock coring at a nearby location, depth to bedrock on-site is anticipated to be encountered at approximately 35 to 40 fbgs. The RI will include further investigation of bedrock at the Site.

### ***2.3.3 Hydrogeology***

The Site is located within the Allegheny River major drainage basin, which is typified by high topographic relief. In the Allegheny River Basin, the major areas of groundwater are within coarser overburden deposits and sandstone and shale bedrock. Regional groundwater is anticipated to flow east/southeast toward the Allegheny River. Groundwater was encountered in the Site overburden from approximately 2 fbgs at the southern end to 10 fbgs at the northern end. The groundwater was observed flowing northeast across the Site toward the Chadakoin River. Local groundwater flow may be influenced by subsurface features, such as excavations, utilities, and localized fill conditions. On-site groundwater flow will be further investigated during the RI.

## **2.4 Climate**

Western New York has a cold continental climate, with moisture from Lake Erie causing increased precipitation. Average annual precipitation is reportedly 45.22 inches for rainfall and 97 inches for snowfall. Average temperature is 46.4 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 Jamestown, encompassing 9.1 square miles, has a population of 31,160 (2010 US Census Bureau). The Site is currently zoned for commercial use.

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

## 2.6 Utilities and Groundwater Use

The Site has access to all major public and private utilities, including potable water (Jamestown Board of Public Utilities), sanitary and storm sewers (Jamestown Board of Public Utilities), electric (Jamestown Board of Public Utilities), and natural gas (National Fuel).

Groundwater at the Site is assigned Class “GA” by 6NYCRR Part 701.15. Regionally, groundwater in the area is pumped from two local aquifers, the Cassadaga Aquifer and the Conewango Aquifer, and is used for industrial, agricultural, and public supply purposes. Municipal potable water service is provided on-site and in areas surrounding the Site.

## 2.7 Wetlands and Floodplains

There are state wetlands located within 0.5 miles of the Site and federal wetlands located within 1 mile of the site, including freshwater emergent and freshwater forested/shrub wetlands. The Site is not located within a flood zone.

## 2.8 Previous Investigations

A summary of the investigations that have occurred at the Site are presented below. Previous investigations described below are provided in Appendix B. Figure 3 illustrates previous investigation locations and areas of concern.

### *2.8.1 April 2007 – Phase I Environmental Site Assessment*

EMG Corporation (EMG) completed a Phase I Environmental Site Assessment (ESA) for Lehman Brothers Bank, FSB in April 2007. EMG identified the following recognized environmental condition (REC):

- The Site was historically occupied by a dry cleaner (Anderson Cleaners/Triangle Cleaners), which was formerly located in the southern portion of the Site, from 1956 until at least 1976.

### ***2.8.2 November 2008 – Limited Site Investigation Report***

Apex Companies, LLC (Apex) completed site investigation activities for Phillips Edison & Company Limited (PECO) in August 2008 and submitted a report summarizing the results in November 2008. The investigation consisted of sub-slab vapor sampling at two locations (SS-01 & SS-02) inside the existing TOPS and shallow soil gas sampling at two exterior locations (SV-01 & SV-02). Additionally, four soil borings were advanced to approximately 16 fbgs (SB-01 through SB-04). Three soil borings were converted into temporary groundwater wells (SB-01 through SB-03). Findings are detailed below:

- Mitigation recommended for tetrachloroethene (PCE) at SV-01. Monitoring recommended for PCE and 1,1,1-trichloroethane (1,1,1-TCA) at SS-01, PCE at SS-02, and trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) at SV-01.
- Only PCE (62 ug/L) was detected above 1.1.1 TOGS Groundwater Quality Standards/Guidance Values (GWQS/GV) at SB-01; total lead was detected above GWQS/GV at all three temporary well locations, dissolved lead was less than the method detection limit (MDL).
- No volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) were detected in the soil above MDLs.
- A discolored layer of soil at 1-2 fbgs was observed at SB-02. Lead was detected in the soil at SB-02 above 6NYCRR Part 375 Unrestricted Soil Cleanup Objectives (USCOs) with a concentration of 125 mg/kg. Total lead was also detected in the groundwater from a temporary well point installed in soil boring SB-02 at a concentration (0.093 mg/L), which is above the GWQS/GV (0.025 mg/L). Analysis for dissolved lead was conducted on the temporary well point samples filtered in the laboratory; none of the three samples contained dissolved lead concentrations above the method detection limit indicating the lead is associated with the suspended solids.

### ***2.8.3 March-May 2010 – Additional Site Investigation***

Apex completed additional site investigation activities in March 2010 and submitted a report summarizing the results to PECO in May 2010. The investigation consisted of one interior sub-slab vapor investigation within the existing UPS store (SS-UPS) paired with one indoor air sample. Five soil borings were advanced and converted into temporary monitoring wells (SB-4/GW-4 through SB-9/GW-9). Findings are detailed below:

- No monitoring or mitigation recommended within the UPS store.
- Groundwater above GWQS/GV for PCE in all temporary wells except GW-7.

- Soil detected below MDLs except methylene chloride (MC), which was detected at all borings below USCOs. PCE detected at SB-8 below USCOs.

As a result of the groundwater contamination indicated in the November 2008 and May 2010 investigation reports submitted to PECO, Apex recommended the installation of five permanent monitoring wells to characterize groundwater contamination across the Site.

#### ***2.8.4 May-July 2010 – June 2010 Site Investigation***

Apex completed site investigation activities between May and June 2010 and submitted a report summarizing the results to PECO in July 2010. The investigation consisted of five soil borings/permanent monitoring wells (MW-1 through MW-5). Findings are detailed below:

- Groundwater flows northeast across the Site.
- Groundwater was detected above GWQS/GV for PCE at all wells except MW-4 and for TCE at all wells except MW-3 and MW-4. MC and vinyl chloride (VC) were also detected above GWQS/GV at MW-1. Maximum concentrations were observed in MW-2 (PCE at 2,300 ug/L and TCE at 39 ug/L). MW-2 is screened at 5.5-16 fbgs and water was observed at 6 fbgs. MW-2 is located downgradient of the former Anderson Cleaners.
- Soil detected below MDLs except MC, which was detected at all borings below USCOs and PCE and TCE at MW-3 (8-10 fbgs); PCE was detected below USCOs at 37 parts per billion (ppb) and TCE was detected below USCOs at 4 ppb. No elevated photoionization detector (PID) or visual/olfactory evidence of contamination observed.

#### ***2.8.5 February-May 2011 – April 2011 Site Investigation***

Apex completed site investigation activities between February and April 2011 and submitted a report summarizing the results to PECO in May 2011. The investigation consisted of two additional permanent monitoring wells, MW-6 and MW-7 along the southern and western borders. Findings are detailed below:

- Groundwater was detected above GWQS/GV for cis-1,2-DCE, MC, PCE, TCE, and VC at MW-6.
- The highest concentrations of PCE (2,300 ug/L) and TCE (39 ug/L) were detected at MW-2, located cross/downgradient of the former Anderson Cleaners.

- The second highest concentrations of PCE (1,200 ug/L) and TCE (28 ug/L) were detected at MW-6, located cross/downgradient of the former Whirley-Wash along the southern boundary of the Site.
- Soil was detected below MDLs except MC, which was detected at both borings below USCOs and PCE at MW-7 (12-14 fbgs) detected at 110 ppb below USCOs.

#### ***2.8.6 December 2011-January 2012 – Off-Site Site Investigation***

Apex completed off-site investigation activities on the adjoining SFAP property, located south adjacent to the Site in December 2011 and submitted a report summarizing the results to the NYSDEC and Southside Station, Inc. in January 2012. The investigation consisted of four additional wells, MW-8, MW-9, MW-10A, and MW-11. Findings are detailed below:

- PCE concentrations at the off-site wells were lower than PCE concentrations observed in on-site downgradient concentrations. Groundwater was detected above GWQS/GV for PCE at MW-8 and MW-11.
- Soil was detected below MDLs except MC, which was detected at all borings below USCOs and PCE at MW-8 (10-12 fbgs), detected at 9.7 ppb below USCOs.

#### ***2.8.7 March-April 2012 – Sub-Slab Vapor Assessment***

Apex completed a sub-slab vapor assessment in March 2012 and submitted a letter report to the NYSDEC and Southside Station, Inc. in April 2012. The assessment consisted of five sub-slab vapor investigation locations inside TOPS (SS-1 through SS-5). The owners of the SFAP denied access to the property for proposed off-site sub-slab vapor sampling. Findings are detailed below:

- Mitigation recommended for 1,2-DCE at SS-5, PCE at SS-4 and SS-5, and TCE at SS-5. Monitoring recommended for TCE at SS-4.

#### ***2.8.8 July 2012 – Off-Site Sub-Slab Vapor Assessment at Southside Foote Avenue Plaza***

Apex completed a sub-slab vapor assessment at the adjoining SFAP property and submitted a report summarizing the results to the NYSDEC and Southside Station, Inc. in July 2012. The assessment consisted of four sub-slab vapor sample locations, two in the Salon 1 tenant space (SS-6 and SS-7) and two in the US Postal Service tenant space (SS-8 and SS-9). Findings are detailed below:

- Mitigation recommended for PCE and TCE at SS-6, and PCE at SS-7. Monitoring recommended for PCE at SS-9.

#### ***2.8.9 December 2012 – Phase I Environmental Site Assessment***

EBI Consulting (EBI) completed a Phase I ESA for Five Mile Capital Partners, LLC (FMCP) dated December 2012. EBI identified the following RECs:

- The Site was historically occupied by a gas station, which was formerly located in the northern portion of the Site (at the location of the existing McDonald's restaurant).
- The Site was historically occupied by a dry cleaner, which was formerly located in the southern portion of the Site.
- The Site is listed as a Brownfield site. Groundwater at the Site is contaminated with PCE, TCE, and breakdown products. Several monitoring wells have been installed to characterize the extent of contamination.
- The Site is a Resource Conservation and Recovery Act (RCRA) non-generator, former RCRA-Large Quantity Generator (LQG), of halogenated solvents (including PCE and TCE).
- Six 55-gallon drums were observed along the rear wall of the strip mall.

#### ***2.8.10 May 2013 – Sub-Slab Depressurization System Installation Report***

Apex submitted an Interim Remedial Measures (IRM) Work Plan to Southside Station, Inc. for the design, installation, and monitoring of a SSDS within TOPS in February 2013. The SSDS was installed on February 26 and 27, 2013 in conformance with the October 2006 NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (Ref. 6). The system was constructed with three suction points along the southern property boundary (SP-1, SP-2, and SP-3). A U-tube style manometer installed at SP-3 indicated a vacuum of 1.3 inches water column. Apex noted that action should be taken if this measurement dropped significantly below its initial value. Initial performance testing was also conducted at test points and indoor air sample locations surrounding the SSDS to verify the system's effectiveness. Apex concluded these results indicated the SSDS was providing adequate vacuum to mitigate potential vapor intrusion of dry-cleaning solvent vapors at the Site and on the adjoining SFAP property. An email to Apex from Anthony Lopes of the NYSDEC transmitting indoor and outdoor air sample results on May 7, 2013 confirms this conclusion. The SSDS Installation Report was submitted to Southside Station, Inc. c/o PECO on May 1, 2013.



***2.8.11 August 2013 – Addendum to Phase I Environmental Site Assessment and NYSDEC Regulatory File Review***

EBI completed an addendum to their December 2012 Phase I ESA for Kasowitz, Benson, Torres & Friedman LLP in August 2013. EBI updated their report by summarizing the activities completed at the Site by Apex (as discussed above) to date. No further conclusions or recommendations were made.

***2.8.12 August 2013 – Environmental Review and Comments***

Bell Oldow completed a review of EBI's "Addendum to Phase I Environmental Site Assessment and New York State Department of Environmental Conservation Regulatory File Review" for FMCP in August 2013. The purpose of the review was to summarize environmental conditions at the Site for any potential new owners.

***2.8.13 October 2014 – Phase I Environmental Site Assessment***

AEI Consultants (AEI) completed a Phase I ESA for Kazmarek Mowrey Cloud Laseter LLP (KMCL) and LNR Partners, LLC (LNR) dated October 2014. AEI did not identify any on-site RECs at the Site. AEI identified the following controlled REC (CRECs):

- The Site was formerly occupied by a dry cleaner located at 736 Foote Avenue (Triangle/Anderson Cleaners) from the 1960s to the late 1970s. A second dry cleaner was located at 750 Foote Avenue (Whirley-Wash, formerly Anderson Cleaners, which apparently moved from 736 Foote Avenue to 750 Foote Avenue).
- PCE and TCE were observed at high concentrations in the sub-slab soil vapor. An SSDS was installed May 2013 in TOPS to mitigate PCE and TCE concentrations. Operation and Maintenance (O&M) requirements for the SSDS include periodic inspections and testing.
- PCE, TCE, cis-1,2-DCE, and VC were detected at concentrations exceeding GWQS/GV. The highest concentrations of TCE and PCE were observed directly downgradient of the former Whirley-Wash. At least seven wells were installed to characterize TCE and PCE contamination across the Site.
- The Site entered the NYS BCP, Site No. C907043.
- The gas station formerly located at the northern portion of the Site in the location of the existing McDonald's was identified as a historical REC (HREC). The gas station was identified as Bish's South Side Service Station and Cuifolo's Service Center gas station. The former gas station was identified as a HREC as no petroleum constituents were observed in the soil/groundwater.

#### ***2.8.14 May 2015 – Potential Source Area Investigation***

Apex submitted a Source Area Investigation Work Plan and a Groundwater Delineation Work Plan to the Southside Station, Inc. in November 2013 and February 2014, respectively. Apex completed source area investigation activities in April 2015 and submitted an investigation report to KMCL in May 2015. The investigation consisted of five soil borings (SB-9, SB-10, SB-12, SB-13, and SB-14). Three soil borings were converted into monitoring wells (MW-12, MW-13, and MW-14). Findings are detailed below:

- Groundwater was detected above GWQS/GV for PCE at all three locations, TCE at MW-12 and MW-13, and 1,1-Dichloroethene (1,1-DCE), 1,1,1-TCA, cis-1,2-DCE, and trans-1,2-Dichloroethene (trans-1,2-DCE) at MW-13.
- The highest concentration of PCE in groundwater was observed in on-site well MW-13 (32,000 ug/L).
- Soil was detected above USCOs for PCE at SB-12 (4-8 fbgs) and above RSCOs for PCE at SB-13 (6-10 fbgs).
- The highest concentrations of PCE were observed in the soil on the former Whirley Wash subparcel; 1,300 ug/kg (SB-12; 4-8 ft interval) and 14,000 ug/kg (further downgradient SB-13; 6-10 ft interval).

#### ***2.8.15 July 2019 – Groundwater Sampling Results & Evaluation of Sub-Slab Depressurization System***

ATC Engineering, LLP (ATC) submitted a Groundwater Investigation Work Plan to the NYSDEC on January 18, 2019 and January 30, 2019. ATC completed investigation activities in April 2019 and submitted an investigation report to LNR c/o KMCL in July 2019. ATC collected groundwater samples from previously installed MW-1, MW-2, MW-4, MW-6, MW-7, MW-9, MW-10A, MW-12, MW-13, and MW-14 and analyzed them for VOCs and emerging contaminants including 1,4-dioxane, and perfluoroalkyl substances (PFASs). The investigation also included an inspection of the SSDS and installation of three sub-slab monitoring points (SV-01 through SV-03) proximate to the three previously installed suction points (SP-1 through SP-3), and one indoor air sample (IA-01) within TOPS. Findings are detailed below:

- The depth to groundwater ranged between 2.91 to 6.87 fbgs.
- Groundwater flow direction was observed toward the northeast, consistent with previous investigations.



- CVOCs including cis-1,2-DCE, trans-1,2-DCE, PCE, and TCE were measured in groundwater samples retrieved from wells MW-1, MW-2, MW-6, MW-7, MW-12 and MW-13 at concentrations above the GWQS/GV of 5 µg/L.
- Former Whirley Wash Location: PCE concentrations at 621 ug/L (MW-12) and 27,100 ug/L (MW-13). Cross/downgradient well: PCE at 1,620 ug/L (MW-6).
- Former Anderson Cleaners Location: PCE concentration at 1,420 ug/L in cross/downgradient well (MW-2), and at 3,050 ug/L in further downgradient well (MW-1).
- 1,4-Dioxane was detected at one location and PFAS were detected at three locations at concentrations below the NYSDOH recommended maximum contaminant levels (MCLs).
- An adequate vacuum measurement was observed at SV-01 and SV-02; however, a vacuum measurement of 0.0 inches water column was observed at SV-03. Despite the potentially insufficient vacuum in the area of SV-03, the SSDS was observed to be operating within normal range, with the U-tube style manometer at SP-3 reading at 1.7 inches water column. No visual observations were observed suggesting there were any problems associated with the SSDS and no CVOCs were detected in the indoor air, confirming that the SSDS was sufficiently reducing sub-slab vapor concentrations to a level protective of public health.

## 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:** CVOCs, lead
- **Groundwater:** CVOCs

### 3.0 REMEDIAL INVESTIGATION SCOPE OF WORK

The RI scope of work is focused on defining the nature and extent of on-site contamination 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 an alternatives analysis.

Field team personnel will collect environmental samples in accordance with the rationale and protocols described in the QAPP in Section 4.0. United States Environmental Protection Agency (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 NYSDOH and NYSDEC. Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

#### 3.1 Preparation Activities

##### *3.1.1 Pre-Investigation Assessment*

Benchmark will contact the City of Jamestown to obtain sanitary and storm sewer utility maps. If available, these maps will be used during the Site walkthrough to locate sanitary sewer manholes and building floor drains and adjust planned sampling locations (if necessary) to evaluate potential preferential pathways. Benchmark contacted the City of Jamestown Department of Public Works and will obtain a Work in the Right of Way Permit for installation of temporary wells and soil vapor points along Foote and Cole Avenues.

On March 27, 2020, a Benchmark scientist (Tom Behrendt) inspected the SSDS to ensure the system was working as designed prior to RI activities. The U-tube style

manometer installed at SP-3 read 1.7 inches of water column, verifying the SSDS is providing adequate vacuum to mitigate CVOC concentrations in the sub-slab vapor of Building 1. Apex indicated that action should be taken if the manometer vacuum measurement drops significantly below 1.3 inches water column. Benchmark will periodically check the system during RI field activities. If insufficient vacuum is observed in the area of SV-03 or if the manometer vacuum at SP-3 is below 1.0 inches water column, Benchmark will contact Mitigation Tech, the company that installed the system, to discuss potential corrective actions.

ATC could not locate groundwater monitoring wells MW-3, MW-5, MW-8 and MW-11 during the April 2019 investigation. On March 27, Benchmark used a metal detector in the vicinity of these wells to locate the flush mount cover as they may have been covered by asphalt. The metal detector registered a hit in the general vicinity of each location. The property manager (Mr. Gary Davis), who has been involved with the property for about 20 years, indicated approximately 4 to 6 inches of asphalt have been laid since the wells were last accessed. Well MW-6 has also been covered by asphalt. Well MW-3 was visible; however, the road box is damaged and filled with asphalt. Since wells MW-8 and MW-11 are off-site, approval from the property owner to uncover the wells (if located) will be required. If the wells cannot be found, Benchmark and the Department will determine if new wells will be installed at or near these locations.

Benchmark will also request access to the interior of Salon 1, the off-site tenant space located directly south of the Site, to determine the feasibility of advancing planned soil borings and installing monitoring wells.

### ***3.1.2 Utility Clearance***

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

## **3.2 RI Soil/Fill Investigation**

A soil/fill investigation will be completed across the Site to further assess whether additional impacts exist beyond the limits, and to assess the extent, of known historical

contamination. The soil/fill investigation will include the completion of surface soil samples, near surface soil samples, and subsurface soil borings to allow for characterization of soil/fill material and sample collection. Figure 4 presents the planned RI sample locations. Table 1 identified the planned sampling and analytical program.

### ***3.2.1 Soil Investigation***

#### ***3.2.1.1 Surface/Near-Surface Soil/Fill Investigation***

Two surface soil samples and two near surface soil samples (S-1/NS-1 and S-2/NS-2) will be collected from the non-hardscape area in the southwest corner of the Site. The surface soil samples will be collected from 0 to 2 inches below vegetative cover and the near surface soil samples will be collected from 2 to 12 inches below ground surface to allow for assessment of human exposure via incidental soil ingestion, inhalation of soil, or dermal contact with soil. As summarized on Table 1, the surface/near surface soil samples will be analyzed for Target Compound List (TCL) SVOCs plus tentatively identified compounds (TICs), Target Analyte List (TAL) metals, polychlorinated biphenyls (PCBs), herbicides, pesticides, 1,4-dioxane and PFAS. If elevated PID readings are noted during field screening, VOC samples may be collected in consultation with the Department. Soil samples to be analyzed for 1,4-dioxane and PFAS will be collected and analyzed in accordance with the Department's current sampling protocols (see Tables 1 and 2 for analytical methods). The soil/fill samples will be analyzed in accordance with USEPA SW 846 methodology with equivalent Category B deliverables to allow for independent third-party data usability assessment.

#### ***3.2.1.2 Subsurface Soil/Fill Investigation***

Sixteen soil borings (SBs), identified as SB-15 through SB-30, will be advanced to collect soil samples. Borings SB-27 and SB-28 will be advanced inside TOPS, SB-15 through SB-26 will be exterior soil borings surrounding the on-site buildings, and SB-29 and SB-30 will be off-site interior soil borings within the adjacent SFAP. Exterior borings will be advanced using a traditional hollow stem auger (HSA) drill rig to a maximum depth of 15 feet, at least five feet into the upper water bearing zone, or until equipment refusal, whichever is shallower. Interior borings will be completed with a mobile direct-push rig due to interior access limitations. Interior soil boring locations are subject to change based on building accessibility, in consultation with the Department. If field evidence of impact is

observed during advancement of soil borings, Benchmark intends to add boring locations to delineate the horizontal and vertical extent of impacts.

All soil samples will be field screened for the presence of volatile organics using a calibrated PID with a 11.7 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 and sample intervals will be determined.

#### ***3.2.1.3 Soil/Fill Sample Collection and Analysis***

Soil/fill samples will be collected to further delineate the horizontal and/or vertical extent of the known contamination and determine if other impacts requiring remediation are present at the Site. The sample interval identified as the most impacted (i.e., greatest PID scan result and/or evidence of visual/olfactory impacts) at investigation locations will be selected for laboratory analysis. If either the impacts are ubiquitous from grade to final depth or no impacts are identified, the soil/fill from the bottom interval of the boring or immediately above a confining layer will be selected for analysis. The sample interval will be selected based on the professional discretion of the field personnel and in consultation with the NYSDEC. If differentiable impacts are noted within a given sample location during the investigation, additional samples will be collected to characterize the different material.

Samples will be collected and analyzed for TCL plus CP-51 List VOCs plus TICs, TCL SVOCs plus TICs, and TAL metals for all 14 soil boring samples and 8 locations to be completed as monitoring wells. PCBs, pesticides, herbicides, 1,4-dioxane and PFAS will also be analyzed in 8 of 22. Soil samples to be analyzed for 1,4-dioxane and PFAS will be collected and analyzed in accordance with the Department's current sampling protocols (see Tables 1 and 2 for analytical methods). En Core® samplers will be used to collect RI VOC soil samples. Remaining samples will be collected and placed into pre-cleaned laboratory provided sample bottles, cooled to 4°C in the field, and transported under chain-of-custody (COC) command to a NYSDOH Environmental Laboratory Approval Program (ELAP) certified analytical laboratory.

### **3.3 Groundwater Investigation**

Seven shallow overburden wells (MW-15 through MW-21), three deep overburden wells (MW-1D, MW-6D, and MW-18D) and three temporary shallow overburden wells

(TW-1 to TW-3) will be installed. MW-1D and MW-6D will be paired with existing monitoring wells MW-1 and MW-6, and MW-18D will be paired with planned monitoring well MW-18. Two shallow overburden monitoring wells (MW-20 and MW-21) will be installed off-site within the adjacent SFAP. The remaining shallow overburden wells (MW-15 through MW-19) and all three deep wells will be on-site exterior wells. The well locations were chosen to supplement the layout of the existing wells to better understand groundwater flow and CVOC contamination across the Site.

The three temporary wells will be installed off-site to assess whether the groundwater plume has migrated off-site; one north of Cole Avenue downgradient of the former gasoline filling station (TW-1) and two east of Foote Avenue downgradient of the on-site groundwater plume (TW-2 and TW-3). Following review of analytical data from the temporary off-site wells, Benchmark and the Department will decide which locations, if any, should be converted into permanent monitoring wells and whether additional off-site wells are warranted to delineate groundwater impacts.

Overburden wells will be drilled using an HSA drill rig to monitor the same groundwater interval as previously monitored in the existing overburden wells. The shallow overburden wells will be drilled to approximately 15 fbgs with a target minimum of five feet below the first encountered groundwater. Interior wells will be drilled with a mobile direct-push rig due to interior access limitations. Deep wells will be drilled to the top of competent bedrock, estimated at 35-40 fbgs, using an HSA drill rig.

Benchmark's driller will use a jack hammer or saw cut where the covered existing wells are assumed to be. Once uncovered, the integrity of the well will be established. If useable, the driller will install a riser (if needed) and new surface completion. Wells MW-5, MW-6, MW-8 and MW-11 need to be uncovered, evaluated and repaired, and well MW-3 road box needs to be repaired.

### ***3.3.1 Monitoring Well Installation***

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 exterior shallow and deep well will be constructed with two-inch diameter Schedule (SCH) 40 PVC with a minimum 10-foot flush joint SCH 40 PVC 0.010-inch machine-slotted well screen. Interior monitoring wells (MW-20 and MW-21) will be installed as one-inch diameter wells due to space and drilling equipment requirements. Temporary

wells (TW-1 to TW-3) will be installed as one-inch diameter wells. 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 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 redeposited on-site unless gross contamination (i.e., visible product) is encountered or there are excess cuttings, in which case they will be placed in sealed New York State Department of Transportation (NYSDOT)-approved drums and labeled for subsequent characterization and disposal.

### ***3.3.2 Well Development***

After installation, but not within 24 hours, newly installed (and existing) monitoring wells will be developed in accordance with Benchmark 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, DO, ORP, and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they 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 well volumes will be evacuated from each monitoring well. If impacts are noted during development including odors, sheen, light non-aqueous phase liquid (LNAPL) or 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, Benchmark and the Department will determine if the containerized development water is acceptable for surface discharge following pretreatment with activated carbon or requires off-site disposal. Development water will be handled in accordance with DER-10 Section 3.3.(e)5.

### ***3.3.3 Groundwater Sample Collection***

Groundwater sampling will occur one week following well development to allow natural groundwater conditions to become reestablished. Sampling will be performed as



soon as practical after purging provided the well has recovered sufficiently to sample or within 24 hours after evacuation if the well recharges slowly. Prior to sample collection, static water levels will be measured and recorded from all new and previously installed 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. Upon stabilization of field parameters, groundwater samples will be collected and analyzed as discussed below.

Groundwater sampling methods will conform with protocol acceptable for the collection of the PFAS in accordance with the Department's recent emerging contaminant initiative. Sampling personnel will wear nitrile gloves while handling empty sample containers, filling sample containers, sealing sample containers, and placement into sample coolers. Clean nitrile gloves be worn while handling sample containers, during the groundwater sampling, and sealing/placement of samples into the laboratory supplied cooler. Sample collection methods that will be implemented during the RI include:

- **Submersible Pump with Dedicated Pump Tubing**

Monitoring wells will be purged and sampled using a non-dedicated plastic submersible pump and dedicated HDPE or PVC tubing following low-flow (minimal drawdown) purge and sample collection procedures, as described above. Non-dedicated pumps will require decontamination prior to use at each well location and the collection of an equipment blank.



▪ **Disposable Bailer**

If low flow is not feasible (e.g., due to depth to groundwater), wells of any depth (up to 100 fbs) may be purged and sampled using a disposable HDPE or PVC bailer via direct grab. In general, a bottom filling dedicated 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, temperature, turbidity, DO, ORP, specific conductance, 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 COC command to a NYSDOH ELAP-approved laboratory for analysis.

***3.3.4 Groundwater Sample Analyses***

The seven shallow overburden wells, three temporary wells, and three deep wells installed during the RI and the 10 permanent monitoring wells that were installed during the previous investigations<sup>1</sup> will be sampled and analyzed for TCL plus CP-51 List VOCs plus TICs. Samples will also be analyzed for TCL SVOCs plus TICs, TAL metals, PCBs, pesticides, herbicides, 1,4-dioxane and PFAS at 9 of the 17 shallow overburden monitoring wells and 2 (i.e., one up-gradient, one down-gradient) of the 3 deep monitoring wells. Groundwater samples will be collected and analyzed in accordance with USEPA SW 846 methodology with equivalent NYSDEC Category B deliverables to allow for independent third-party data usability assessment. Samples collected for 1,4-dioxane will be analyzed via EPA Method 8270 Selective Ion Monitoring (SIM) mode and samples collected for PFAS

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<sup>1</sup> The number of previously installed monitoring wells Benchmark will sample is subject to change. ATC could only find 10 of the 14 previously installed permanent monitoring wells, including MW-1, MW-2, MW-4, MW-6, MW-7, MW-9, MW-10A, MW-12, MW-13 and MW-14. Benchmark will attempt to locate, develop, and sample all wells located on-site and on the SFAP property.

analysis will be analyzed via a modified EPA Method 537 to achieve reporting limits of 2 nanograms per liter (ng/L) (see Table 2).

### 3.4 Soil Vapor Investigation

Seven on-site soil vapor samples will be collected along the west, north and east property boundaries to complete a qualitative off-site exposure assessment. As shown on Figure 4, three samples will be collected along Foote Ave. to the east, one sample will be collected along Cole Ave. to the north, and three samples will be collected along the western property boundary. In addition, three off-site soil vapor samples will be collected on the east side of Foote Ave. Soil vapor sampling probes will be installed in general conformance with the NYSDOH Soil Vapor Intrusion Guidance (Ref. 9).

Each soil vapor sampling probe will be manually installed using specialized stainless-steel soil probe rods. Sampling equipment includes 6-inch long sampling screens, 1/4-inch inside diameter inert sample tubing and dedicated 6-liter Summa canisters. Soil boreholes will be advanced to a depth up to 5 fbs (depending on depth to groundwater observed during advancement of soil borings) using 3/4-inch inside diameter steel rods. The steel rod will be equipped with an anchor point at the driving end of the rod. The anchor point will be connected to the sampling screen and tubing on the inside of the steel rod. Once the steel rod is advanced to the target depth, the steel rod will be retracted, leaving the anchor point, sampling screen and sampling tubing within the borehole annulus. Glass beads will be poured around the sampling screen in a manner to cover the entire length of the sampling screen (e.g., 1-2 feet depth range). Bentonite or bentonite/soil mixture will be placed above the glass beads to the ground surface to create a seal to prohibit infiltration of ambient air into the sampling area.

Once the sample probes are installed, the probe and tubing will be purged (three volumes) using a calibrated syringe as required by NYSDOH guidance (Ref. 6) and helium tracer gas will be used during the purging phase (in the same manner as recommended for soil vapor probes) to ensure that the probes are well sealed. Samples will be collected over an approximate 4-hour period. All soil vapor samples will be collected and analyzed by EPA Method TO-15. This method employs a 6-liter, passivated (inert), stainless-steel, evacuated sampling sphere for collecting the air samples. The canister is received from the laboratory,

certified clean, evacuated, and prepared for sampling. The pressure in the canister is approximately 50 millitorr (compared to 760 torr of pressure in the atmosphere at sea level).

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

Samples will be shipped to the laboratory within two days of sampling so that no sample will exceed the 30-day holding time (since receipt from the lab) required by Method TO-15. Full chain of custody will be maintained for all canisters from time of shipping from the laboratory to time of analysis by the laboratory.

An outdoor air sample will also be collected concurrent with the six soil vapor samples. The outdoor field-located air sample will be collected from ground level at an upwind location, as determined on the day of soil vapor sampling activities. The outdoor air sample canister will also be equipped with a 4-hour regulator to allow the sample to be collected over the same approximate 4-hour period, as the soil vapor samples.

### **3.5 Analytical Testing for Evaluation of Remedial Alternatives**

Benchmark will also collect soil and groundwater samples for analysis of geochemical and microbiological parameters and dissolved gases in order to evaluate up to three in-situ remedial alternatives possibly including chemical oxidation (e.g., PersulfOx®), enhanced anaerobic bioremediation (e.g., Hydrogen Release Compound; HRC®) and sorption/biodegradation (e.g., PlumeStop®) or a combination of technologies. Bench-scale treatability studies and/or design verification activities/injections may also be performed.

### **3.6 Field Specific Quality Assurance/Quality Control Sampling**

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

### 3.7 Decontamination and Investigation-Derived Waste Management

Every attempt will be made to use dedicated sampling equipment during the RI; however, if non-dedicated equipment is required and/or used, the equipment will be decontaminated, at a minimum, with a non-phosphate detergent (i.e., Alconox®) and potable water mixture, rinsed with distilled water, and air-dried before each use in accordance with Benchmark's field operating procedure (FOP) presented in Appendix C (see Table 3). 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, elevated PID, etc.) will be returned to the borehole from which it was removed (soil/fill) or discharged to the ground surface (groundwater/rinse water following pretreatment with activated carbon) if it can infiltrate the ground in the vicinity from which it was generated. IDW 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 its 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 will be used to determine if spoils can be returned to the ground surface or used on-site, or if the spoils 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 off-site disposal arrangements.

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

### 3.8 Site Mapping

A Site map showing sampling locations and relevant Site features will be developed during the field investigation. Benchmark will employ a handheld GPS unit to identify the sample locations relative to State planar grid coordinates. Monitoring well elevations will be

measured by Benchmark's surveyor. An isopotential map showing the general direction of groundwater flow will be prepared based on water level measurements relative to United States Geological Survey (USGS) vertical datum.

### 3.9 Documentation

RI field activities will be documented in a project field book, field activities daily log (FADL) and/or handheld Rugged Reader® personal digital assistant (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 the date and time of all entries; names of personnel on-site; weather conditions (temperature, precipitation, etc.); and location and description of activity. 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 (included in Appendix D):

- COC 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
- Problem Identification Report (if necessary)
- Corrective Measures Report

Monthly progress reports summarizing RI activities will be submitted to the Department.

## 4.0 QUALITY ASSURANCE PROJECT PLAN

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

The QAPP will assure the accuracy and precision of data collection during the Site characterization and data interpretation periods. The QAPP identifies procedures for sample collection to mitigate the potential for cross-contamination, as well as analytical requirements necessary to allow for independent data validation. The QAPP has been prepared in accordance with USEPA's Requirements for QAPPs for Environmental Data Operations (Ref. 7); the EPA Region II CERCLA Quality Assurance Manual (Ref. 8), and NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (Ref. 1).

### 4.1 Scope of the QAPP

This QAPP was prepared to provide quality assurance guidelines to be implemented during RI activities and may be modified for subsequent phases of investigative work. 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 and QA Officer to assess if the activities planned are being implemented and their importance for accomplishing the goal of quality data.
- A means 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 (QA/QC) aspects of the procedures involved in the collection, preservation, packaging, and transportation of samples; field testing; record keeping; data management; COC 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.

## **4.2 QAPP Organization and Responsibility**

The principal organizations involved in verifying achievement of data collection goals for the Southside Plaza Site include the NYSDEC, NYSDOH, Southside (Participant), Benchmark Environmental Engineering & Science, PLLC (Participant's Consultant), the test pit and 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. Appendix A includes select resumes.

### ***4.2.1 Participant***

Southside ("Participant") 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 Applicant will also have the authority to select Remedial Action Contractor(s) to assist 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.

### ***4.2.2 Environmental Consultant***

Benchmark Environmental Engineering & Science, PLLC is the prime engineering and scientific consultant on this project and is responsible for the implementation of the RI



Work Plan including, but not limited to, field operations, laboratory testing, data management, data analysis, and reporting. Any one member of Benchmark's staff may fill more than one of the identified project positions (e.g., field team leader and site safety and health officer). The various quality assurances, field, laboratory, and management responsibilities of key project personnel are defined below.

■ Project Officer (PO):

*Michael Lesakowski*

The PO has the responsibility for ensuring conformance with the BCP program requirements. The PO will:

- o Report directly to the Applicant and the NYSDEC/ NYSDOH Project Coordinators.
- o Be responsible for project oversight.
- o Define project objectives and develop a detailed work plan schedule.
- o Acquire and apply technical and corporate resources as needed to assure performance within budget and schedule constraints.
- o Review the work performed on the project to assure its quality, responsiveness, and timeliness.
- o Certify deliverables before their submission to NYSDEC.

■ Project Manager (PM):

*Lori Riker*

The PM has the responsibility for ensuring that the project meets the Work Plan objectives. The PM will:

- o Report directly to the Applicant Project Coordinator and the NYSDEC/ NYSDOH Project Coordinators.
- o Be responsible for technical and project oversight.
- o Define project objectives and develop a detailed work plan schedule.
- o Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
- o Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- o Review the work performed on each task to assure its quality, responsiveness, and timeliness.
- o Review and analyze overall task performance with respect to planned requirements and authorizations.
- o Review all deliverables before their submission to NYSDEC.



- o Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
- o Ultimately be responsible for the preparation and quality of interim and final reports.
- o Represent the project team at meetings.

▪ FTL/SSHO:

*Tom Behrendt*

The Field Team Leader (FTL) has the responsibility for implementation of specific project tasks identified at the Site and reports directly to the Project Manager. The FTL will:

- o Be responsible for the supervision of project field personnel, subconsultants, and subcontractors.
- o Define daily work activities.
- o Orient field staff concerning the project's special considerations.
- o Monitor and direct subcontractor personnel.
- o Review the work performed on each task to ensure its quality, responsiveness, and timeliness.
- o 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) and, as such, be 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.

### 4.3 Quality Assurance (QA) Responsibilities

The QA Officer will have direct access to corporate executive staff as necessary, to resolve any QA dispute, and is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations and Benchmark policies, and NYSDEC requirements. The QA Officer has the authority to stop work on the investigation as deemed necessary in the event of serious QA issues.

▪ Project QA Officer:

*Lori Riker*

Specific function and duties of the QA Officer include:

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

#### **4.4 Field Responsibilities**

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

#### **4.5 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.
- COC procedures.
- Precision, accuracy, completeness, representativeness, decision rules, comparability and level of QC effort conformance for sample analysis and data management by laboratory under EPA analytical methods.

#### 4.6 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. The following QC samples will be provided:

- 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.
- Matrix spike/matrix spike duplicate (MS/MSD) samples provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD should be collected for every 20 or fewer investigative samples to be analyzed for organic and inorganic chemicals of a given matrix (see Table 1).

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 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.

#### 4.7 Sampling and Analysis Plan

Methods and protocol to be used to collect environmental samples (i.e., soil/fill, soil vapor, and groundwater) for this investigation are described in the Benchmark FOPs, which are summarized on Table 3 and presented electronically in Appendix C.

Table 1 summarizes the number and types of environmental samples to be collected. Table 2 summarizes the sample parameter lists, holding times and sample container requirements. 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 based on meeting data objectives. Such alternatives will be approved by NYSDEC before implementation and subsequently documented for inclusion in the project file.

#### ***4.7.1 Custody Procedures***

Sample custody is controlled and maintained through COC procedures. COC is the means by which the possession and handling of samples is tracked from the source (field) to the final disposition (i.e., the laboratory). A sample is considered to be in a person's custody if it is in the person's possession or 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 FOP for Sampling, Labeling, Storage, and Shipment, located in Appendix C, describes procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory.

#### ***4.7.2 Sample Storage***

Samples are stored in secure limited-access areas. Walk-in coolers or refrigerators are maintained at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ , 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.

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

#### ***4.7.4 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).

#### ***4.7.5 Split Sampling***

During the RI, the Department may split any soil, groundwater, or collect additional air samples at the Department's expense. Benchmark personnel will cooperate with the Department to facilitate split sampling, as requested.

### **4.8 Calibration Procedures and Frequency**

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

#### ***4.8.1 Field Instrument Calibration***

Quantitative field data to be obtained during groundwater sampling includes 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 C 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.

### **4.9 Analytical Procedures**

Samples collected during RI field activities will be analyzed by a NYSDOH ELAP-approved laboratory.

#### ***4.9.1 Field Analytical Procedures***

Field procedures for collecting and preserving groundwater and soil samples are described in the FOPs (see Appendix C and Table 3).

#### 4.10 Data Usability Evaluation

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

##### *4.10.1 Procedures Used to Evaluate Field Data Usability*

Procedures to validate field data for this project will be facilitated by adherence to the FOPs (see Appendix C). 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 logbooks is the responsibility of the FTL.

##### *4.10.2 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. 9), and Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review (Ref. 10). The data review guidance will be used only to the extent that it is applicable to the SW-846 methods; SW-846 methodologies will be followed primarily and given preference over CLP when differences occur. Also, results of blanks, surrogate spikes, MS/MSDs, and laboratory control samples will be reviewed/evaluated by the data validator. 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.



## 5.0 INVESTIGATION SUPPORT DOCUMENTS

### 5.1 Health and Safety Protocols

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

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

The HASP also includes a contingency plan that addresses potential site-specific emergencies, and a Community Air Monitoring Plan (CAMP) 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. A member of the field team will be designated to serve as the on-site SSHO 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.

#### ***5.1.1 Community Air Monitoring***

Real-time community air monitoring will be performed during the RI activities at the Site. A CAMP is included within Benchmark's HASP (see HASP Appendix E). Particulate and VOC monitoring will be performed along the upwind and downwind perimeter of the work area continuously during intrusive activities (e.g., installation of soil borings and monitoring wells) in accordance with this plan. CAMP data summary tables will be submitted to NYSDEC and NYSDOH weekly and exceedances of CAMP action levels and

corrective measures will be reported to NYSDEC and NYSDOH within 24 hours and included in daily reports.

The buildings are currently occupied. Although the heating, ventilations and air conditioning (HVAC) system will remain operational, interior air monitoring will be performed during interior work activities as described in Section 8.1.3 of the HASP. The CAMP is consistent with the requirements for community air monitoring at remediation sites as established by the NYSDOH and NYSDEC. Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 Appendix 1A (NYSDOH's Generic Community Air Monitoring Plan) and Appendix 1B (Fugitive Dust and Particulate Monitoring).

## **5.2 Citizen Participation Activities**

NYSDEC will coordinate and lead community relations throughout the course of the project. Benchmark will support NYSDEC's community relations activities, as necessary. A Citizen Participation (CP) Plan will be prepared by Benchmark and submitted to NYSDEC under separate cover. The CP Plan will follow NYSDEC's CP Plans template for sites entering the BCP at the point of site investigation.

## 6.0 REPORTING AND SCHEDULE

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

### 6.1 Remedial Investigation Reporting

The RI section of the Report will include the following information and documentation, consistent with the NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (Ref. 1):

- 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, 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 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 (SCOs) and other pertinent regulatory standards or criteria.
- A discussion of contaminant fate and transport. This will provide a description of the hydrologic parameters of the Site and an evaluation of the lateral and vertical movement of groundwater.
- Conclusions regarding the extent and character of environmental impact in the media being investigated.
- The conclusions of the on-site and off-site qualitative human health and environmental exposure assessment completed in accordance with DER-10.
- Supporting materials for RI data including boring logs, monitoring well construction diagrams, laboratory analytical reports, and similar information.

- Data generated for the Site will be reported to NYSDEC electronically via EQuIS software where it will be stored in NYSDEC's Environmental Management System (EIMS).

In addition, Benchmark 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/AA Report.

## 6.2 Alternatives Analysis Report

The AA Report is developed in accordance with DER-10 to provide a forum for evaluating and selecting a recommended remedial approach. The results of the RI will be used to establish remedial goals and remedial action objectives (RAOs). A list of RAOs will be developed based on findings of the RI and the requirement for the selected remedial measures to be protective of public health and the environment under the proposed future use scenario. Proposed SCOs for the property will also be presented based on the proposed future use of the Site. SCOs will be based on published standards, criteria, and guidance (SCGs) and other NYSDEC and NYSDOH-accepted values.

Based on the RAOs and SCOs, volumes and areas of media potentially requiring additional remediation will be calculated. General response actions (GRAs) will then be delineated to address each of the Site problem areas. These GRAs 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 public health and the environment
- Compliance with SCGs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility or volume of contamination through treatment
- Short-term impacts and effectiveness
- Implementability
- Cost-effectiveness
- Community acceptance
- Land use

The criteria of community acceptance will be considered based on public comments on the RI/AA Report and proposed remedial action. The results of the additional analytical testing, bench-scale treatability studies, and design verification activities/injections will be used to evaluate up to three in-situ remedial alternatives, possibly including chemical oxidation (e.g., PersulfOx®), enhanced anaerobic bioremediation (e.g., Hydrogen Release Compound; HRC®) and sorption/biodegradation (e.g., PlumeStop®) or a combination thereof.

Following the screening of alternatives, a comparative analysis will be performed against the above criteria. The comparative analysis will allow for better understanding of the relative advantages and disadvantages of each of the alternatives and will facilitate identification of a recommended remedial approach.

## 7.0 PROJECT SCHEDULE

Figure 5 presents a tentative project schedule for the major tasks to be performed in support of the RI/AA.

## 8.0 REFERENCES

1. New York State Department of Environmental Conservation. *DER-10; Technical Guidance for Site Investigation and Remediation*. May 2010.
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4. United States Department of Agriculture (USDA), Soil Conservation Service. *Soil Survey of Erie County, New York*. December 1986.
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7. U.S. Environmental Protection Agency. *Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5)*. October 1998.
8. U.S. Environmental Protection Agency, Region II. *CERCLA Quality Assurance Manual, Revision I*. October 1989.
9. U.S. Environmental Protection Agency. *National Functional Guidelines for Organic Superfund Methods Data Review*. January 2017.
10. U.S. Environmental Protection Agency. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. January 2017.



## TABLES

**TABLE 1  
SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM**

**SOUTHSIDE PLAZA SITE  
JAMESTOWN, NEW YORK**

Location	Number of Planned Locations	Matrix	Parameter <sup>1</sup>						
			TCL + CP-51 VOCs (+TICs)	TCL SVOCs (+TICs)	TAL Metals <sup>2</sup>	PCBs	Herbicides	Pesticides	1,4-dioxane and PFAS <sup>5</sup>
RI Soil/Fill									
Surface Soil (0-2")	2	Soil/Fill	-	2	2	2	2	2	2
Near Surface Soil (2-12") <sup>7</sup>	2	Soil/Fill	2	2	2	2	2	2	2
Soil Borings	16	Soil/Fill	16	16	16	5	5	5	5
Monitoring Wells	8	Soil/Fill	8	8	8	3	3	3	3
<i>Blind Duplicate</i> <sup>3</sup>	-	Soil/Fill	2	2	2	1	1	1	1
<i>MS</i> <sup>3</sup>	-	Soil/Fill	2	2	2	1	1	1	1
<i>MSD</i> <sup>3</sup>	-	Soil/Fill	2	2	2	1	1	1	1
Soil Subtotal			32	34	34	15	15	15	15
RI Groundwater									
Existing Monitoring Wells <sup>8</sup>	14	Groundwater	14	14	14	7	7	7	7
Shallow Monitoring Wells	7	Groundwater	7	7	7	4	4	4	4
Temporary Monitoring Wells	3	Groundwater	3	-	-	-	-	-	-
Deep Monitoring Wells	3	Groundwater	3	3	3	2	2	2	2
<i>Blind Duplicate</i> <sup>3</sup>	-	Groundwater	2	2	2	1	1	1	1
<i>MS</i> <sup>3</sup>	-	Groundwater	2	2	2	1	1	1	1
<i>MSD</i> <sup>3</sup>	-	Groundwater	2	2	2	1	1	1	1
<i>Trip Blank</i> <sup>4</sup>	-	Water	2	-	-	-	-	-	-
<i>Field Blank</i>	-	Water	2	-	-	-	-	-	1
Groundwater Subtotal			37	30	30	16	16	16	17
RI Soil Vapor									
Soil Vapor <sup>6</sup>	10	Soil Vapor	10	-	-	-	-	-	-
Soil Vapor Subtotal			10	0	0	0	0	0	0
Sampling Totals			79	64	64	31	31	31	32

**Notes:**

- Analyses will be performed via USEPA SW-846 methodology with equivalent Category B deliverables package.
- Groundwater samples will be filtered in the laboratory for dissolved metals analysis.
- Blind duplicate and MS/MSD samples will be collected at a frequency of 1 per 20 samples/media collected.
- Trip blanks will be submitted to the laboratory each day aqueous volatile organic samples are collected.
- GW analysis will include 1,4-dioxane via Method 8270 SIM and per- and poly-fluoroalkyl substances (PFAS) via Method 537.
- Soil vapor will be analyzed for TCL VOCs using USEPA Method TO-15.
- Near surface soil samples will only be analyzed for VOCs if elevated PID readings are noted during field screening.
- ATC could only locate wells MW-1, MW-2, MW-4, MW-6, MW-7, MW-9, MW-10A, MW-12, MW-13 & MW-14. Benchmark will attempt to locate, develop, & sample all wells on-site and on the SFAP property.

**TABLE 2**  
**SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS**

**SOUTHSIDE PLAZA SITE**  
**JAMESTOWN, NEW YORK**

Matrix	Parameter <sup>1</sup>	Method <sup>1</sup>	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 <sup>2</sup>	6010	WMG	4 oz.	Cool to 2-4 °C	6 months/Hg 28 days
	Pesticides	8081	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	Herbicides	8151	WMG	8oz	Cool to 2-4 °C	14 days extrac./40 days
	PCBs	8082	WMG	4 oz.	Cool to 2-4 °C	14 days extrac./40 days
	PFAS	modified 537	HDPE/Polypropylene	4-8 oz.	Cool to 2-4 °C	14 days extrac./40 days
Groundwater	TCL + CP-51 VOCs	8260B	glass vial	3 - 4 oz.	HCl to pH<2, Zero Headspace, Cool to 2-4 °C	14 days
	TCL SVOCs	8270C	amber glass	1000 ml	Cool to 2-4 °C	7 days extrac./40 days
	TAL Metals <sup>2</sup>	6010	plastic	600 ml	HNO <sub>3</sub> to pH<2, Cool to 2-4 °C	6 months/Hg 28 days
	Pesticides	8081B	amber glass	1000 ml	Cool to 2-4 °C	14 days extrac./40 days
	Herbicides	8151A	amber glass	1000 ml	Cool to 2-4 °C	14 days extrac./40 days
	PCBs	8082	amber glass	1000 ml	Cool to 2-4 °C	7 days extrac./40 days
	PFAS	modified 537	HDPE/Polypropylene	2 - 500 mL	Trizma, Cool to 2-4 °C	14 days
	1,4-dioxane	8270 SIM mode	amber glass	2 - 500 mL	Cool to 2-4 °C	7 days extrac./40 days
Soil Vapor	TCL VOCs	TO-15	Summa Cannister	6 liters	None	Analyze within 14 days of sample date of collection

**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
2. Mercury sampling in soil/groundwater via EPA methods 7471/7470 respectively.

**Acronyms:**

VOCs = Volatile Organic Compounds  
PFAS = Per- and Polyfluoroalkyl Substances  
SVOCs = Semi-Volatile Organic Compounds

TCL = Target Compound List  
TAL = Target Analyte List  
WMG = Wide Mouth Glass  
PCBs = Polychlorinated Biphenyls

**TABLE 3  
SUMMARY OF FIELD OPERATING PROCEDURES**

**SOUTHSIDE PLAZA SITE  
JAMESTOWN, NEW YORK**

FOP Number	Description	No. of Attachments	Total Pages	FOPs Referenced
001.1	Abandonment of Borehole Procedures	1	4	--
002.0	Abandonment of Monitoring Wells Procedure	1	5	018, 032
003.0	Air Rotary Drilling Procedure	0	2	026, 041, 042, 043
004.6	Soil Vapor Sample Collection Procedure	8	44	--
006.0	Calibration and Maintenance of Combustible Gas/Oxygen Meter	1	11	--
007.0	Calibration and Maintenance of Portable Dissolved Oxygen Meter	1	3	--
008.0	Calibration and Maintenance of Portable Field pH/Eh Meter	1	4	--
009.0	Calibration and Maintenance of Portable Field Turbidity Meter	1	7	--
010.0	Calibration and Maintenance of Portable Flame Ionization Detector	1	4	--
011.1	Calibration and Maintenance of Portable Photoionization Detector	3	31	--
012.0	Calibration and Maintenance of Portable Specific Conductance Meter	1	5	--
013.0	Composite Sample Collection Procedure for Non-Volatile Organic Analysis	1	3	040, 046
015.0	Documentation Requirements for Drilling and Well Installation	6	11	--
017.0	Drill Site Selection Procedure	0	1	--
018.0	Drilling and Excavation Equipment Decontamination Procedures	0	2	--
021.0	Establishing Horizontal and Vertical Control	0	2	--
022.0	Groundwater Level Measurement	1	3	040
023.1	Groundwater Purging Procedures Prior to Sample Collection	2	8	011, 022, 024, 040
024.1	Groundwater Sample Collection Procedures	1	10	007, 008, 009, 011, 012, 022, 023, 031, 040, 046
025.0	Hand Augering Procedure	1	3	013, 017, 040, 046, 054, 057
026.1	Hollow Stem Auger (HSA) Drilling Procedures	2	6	001, 010, 011, 017, 018, 058
031.2	Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedure	1	7	007, 008, 009, 011, 012, 022, 024, 040, 046
032.1	Management of Investigation-Derived Waste (IDW)	2	5	--
033.0	Monitoring Well Construction for Hollow Stem Auger Boreholes	2	6	015, 026, 032, 036
035.0	Monitoring Well Construction in Bedrock	2	9	003, 015, 017, 026, 032, 036, 041, 042, 043, 070
036.0	Monitoring Well Development Procedures	1	3	015, 040
039.1	NAPL Detection and Sample Collection Procedure	1	7	011, 040, 046
040.1	Non-Disposable and Non-Dedicated Sampling Equipment Decontamination	0	4	032
041.0	Overburden Casing Installation Procedure	3	7	018
042.0	Pressure Packer Test Procedure	1	6	--
043.0	Rock Core Classification Procedure	7	20	041, 044
044.0	Rock Quality Designation (RQD) Procedure	0	4	--
046.0	Sample Labeling, Storage and Shipment Procedures	5	9	--
047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities	2	4	010, 011, 015, 058
054.2	Soil Description Procedures Using The Visual-Manual Method	5	22	010, 011, 015, 025, 032, 046, 047, 058, 065
057.0	Soil Sample Collection for VOC Analysis - EnCore Sampling	1	6	046
058.0	Split-Spoon Sampling Procedures	0	3	015, 046, 047, 054
063.2	Surface and Subsurface Soil Sampling Procedures	3	7	006, 010, 011, 040, 046, 073
070.0	Well/Piezometer Construction Materials and Design	0	2	--
073.2	Real-Time Air Monitoring During Intrusive Activities	1	12	006, 010, 011, 084
076.0	"Before Going Into the Field" Procedure	0	4	--
077.0	Temporary Well (Piezometer) Construction Procedures	3	8	015, 032, 065, 078
078.0	Geoprobe Drilling Procedures	2	6	001, 017, 018, 054, 077
079.0	Stockpile Sampling Procedures for Chemical Analysis	0	3	046
080.0	Stockpile-Borrow Source Sampling Procedures for Physical Analysis	1	5	--
082.0	Waste Sampling Procedures	1	15	011, 046
083.0	Active Subslab Depressurization Pre-Design Testing Procedure	0	4	011, 046
084.0	Calibration and Maintenance of Portable Particulate Meter	0	8	--
085.0	Field Quality Control Procedures	0	3	040
090.0	Outdoor Ambient Air VOC Sample Collection Procedure	1	6	--

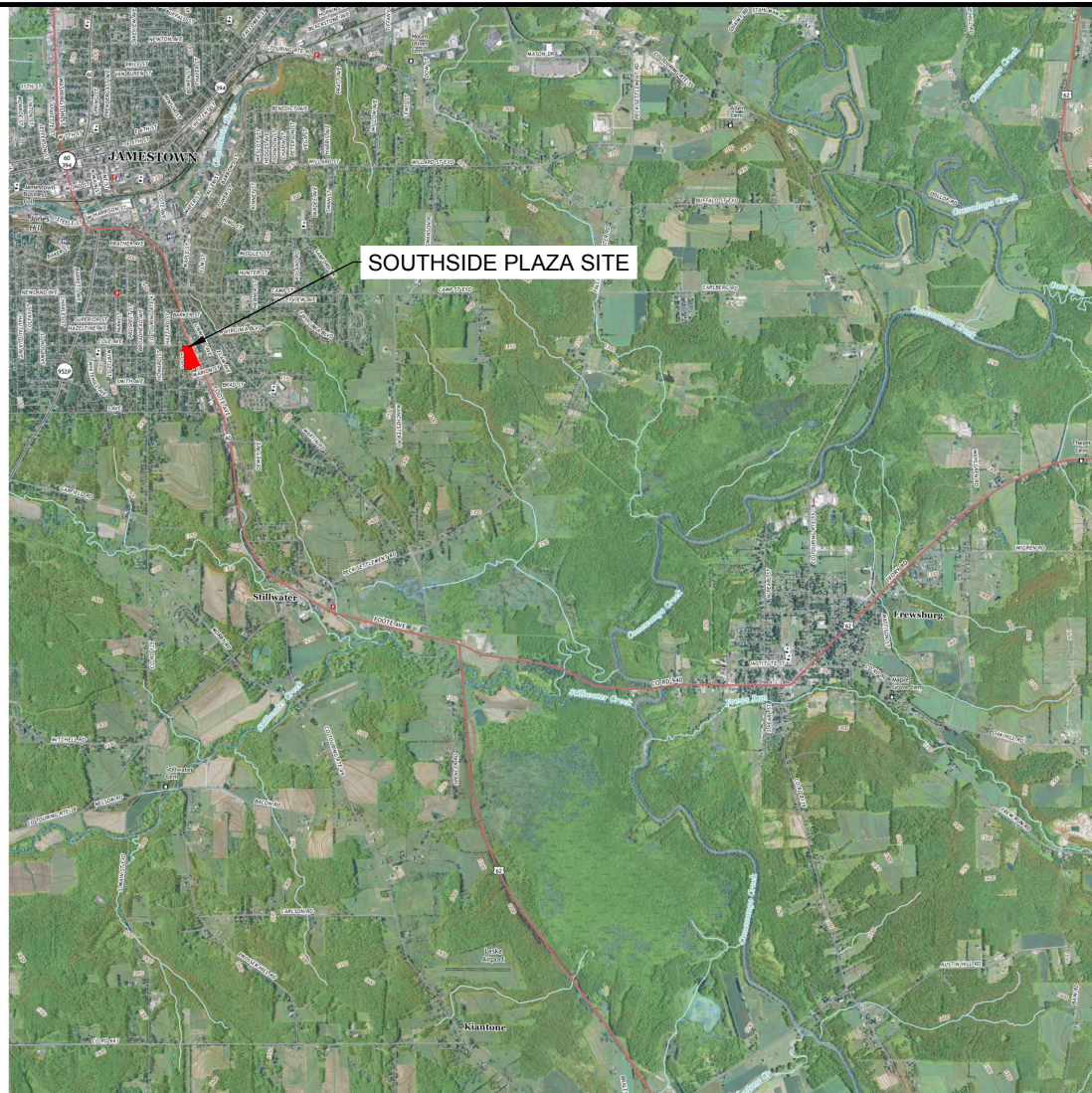
**Notes:**

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

## FIGURES



**FIGURE 1**



BASEMAP: USGS JAMESTOWN 2016 QUADRANGLE



SCALE: 1 INCH = 6000 FEET  
SCALE IN FEET  
(approximate)



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

PROJECT NO.: 0505-019-001

DATE: NOVEMBER 2019

DRAFTED BY: RFL

## SITE LOCATION & VICINITY MAP

REMEDIAL INVESTIGATION WORK PLAN

SOUTHSIDE PLAZA SITE  
704-744 FOOTE AVENUE  
JAMESTOWN, NEW YORK

PREPARED FOR

KAZMAREK MOWREY CLOUD LASETER LLP

**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.



DATE: NOVEMBER 2019  
DRAFTED BY: RFL



- BUILDING 1:
- 1. UPS STORE
  - 2. SPA NAILS
  - 3. DOLLAR TREE
  - 4. CELLULAR ONE
  - 5. KEY BANK
  - 6. TOPS
- BUILDING 2:
- 7. MCDONALDS



SCALE: 1 INCH = 100 FEET  
SCALE IN FEET  
(approximate)



LEGEND:

----- PROPERTY BOUNDARY

SITE PLAN (AERIAL)

REMEDIAL INVESTIGATION WORK PLAN  
SOUTHSIDE PLAZA SITE  
704-744 FOOTE AVENUE  
JAMESTOWN, NEW YORK  
PREPARED FOR  
KAZMAREK MOWREY CLOUD LASETER LLP

**BENCHMARK**  
ENVIRONMENTAL  
ENGINEERING &  
SCIENCE, PLLC

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

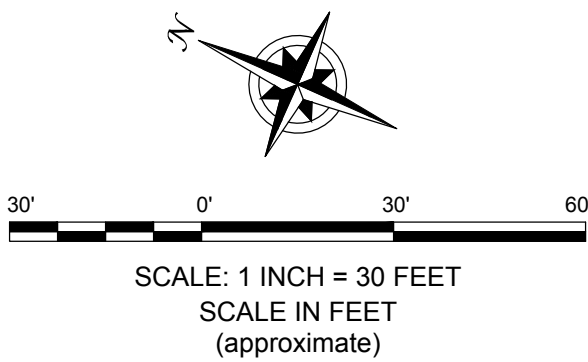
JOB NO.: 0505-019-001

FIGURE 2

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.



FIGURE 3: PREVIOUS INVESTIGATION LOCATIONS & AREAS OF CONCERN. PREPARED FOR KAZIMAREK MOWREY CLOUD LASETER LLP BY BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC. DATE: NOVEMBER 2019. SCALE: 1" = 30' (APPROXIMATE).



LEGEND:	
<span style="color: yellow;">---</span>	PROPERTY BOUNDARY
<span style="color: black;">●</span> SB-1	SOIL BORING (6)
<span style="color: black;">⊙</span> OA-1	OUTDOOR AIR SAMPLE (2)
<span style="color: black;">⊙</span> IA-QM1	INDOOR AIR SAMPLE (9)
<span style="color: blue;">●</span> SB-6	SOIL BORING WITH TEMPORARY MONITORING WELL (5)
<span style="color: blue;">●</span> GW-6	
<span style="color: cyan;">▼</span> SV-03	MAY 2019 SOIL VAPOR MONITORING POINT (3)
<span style="color: red;">⊙</span> SV-01	SOIL VAPOR (2)
<span style="color: red;">⊗</span> SS-1	SUBSLAB VAPOR (12)
<span style="color: blue;">⬇</span> MW-1	MONITORING WELL (14)
<span style="color: magenta;">---</span>	POTENTIAL FORMER CONTAMINANT SOURCE
<span style="color: black;">▲</span> SP-1	SUB-SLAB SUCTION PIT
<span style="color: black;">---</span>	SUB-SLAB PIPING LOCATION
<span style="color: black;">*</span>	SUB-SLAB FAN AND VENT LOCATION

NOTES:  
1. PROPERTY BOUNDARY ADAPTED FROM A SURVEY PREPARED BY LEHR LAND SURVEYORS DATED MAY 22, 2015.  
2. BASE MAP NYS STATE PLANAR PHOTOGRAPHY DATED APRIL 2016.  
3. INVESTIGATION LOCATIONS ADAPTED FROM SEVERAL PREVIOUS REPORTS. ALL LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. LOCATIONS TO BE SURVEYED DURING THE REMEDIAL INVESTIGATION (IF LOCATED AND ACCESSIBLE).

### PREVIOUS INVESTIGATION LOCATIONS & AREAS OF CONCERN

REMEDIAL INVESTIGATION WORK PLAN  
SOUTHSIDE PLAZA SITE  
704-744 FOOTE AVENUE  
JAMESTOWN, NEW YORK

PREPARED FOR  
KAZIMAREK MOWREY CLOUD LASETER LLP

### REVISIONS

NO.	BY	DATE	REMARKS

**BENCHMARK**  
ENVIRONMENTAL  
ENGINEERING &  
SCIENCE, PLLC

2558 HAMBURG TURNPIKE  
SUITE 100  
JAMESTOWN, NY 14218  
(716) 856-0589

JOB NO.: 0505-019-001

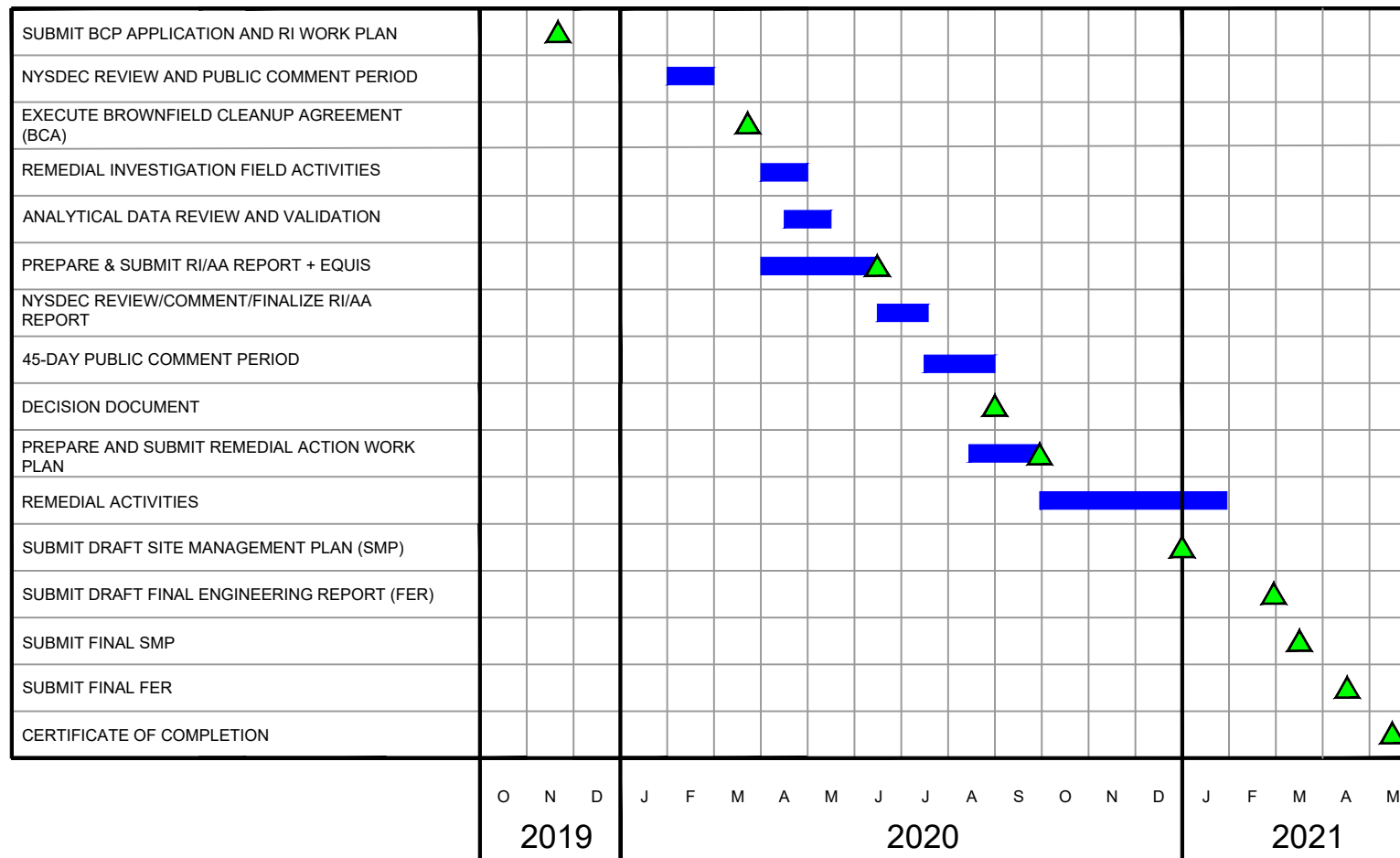
FIGURE 3







**PROJECT TASKS:**



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

PROJECT NO.: 0505-019-001

DATE: MARCH 2020

DRAFTED BY: CMC

## PRELIMINARY PROJECT SCHEDULE

REMEDIAL INVESTIGATION WORK PLAN

SOUTHSIDE PLAZA SITE  
704-744 PLAZA SITE  
JAMESTOWN, NEW YORK

PREPARED FOR  
KAZMAREK MOWREY CLOUD LASETER LLP

**FIGURE 5**

DISCLAIMER:  
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# APPENDIX A

## RESUMES



**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 20 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 (BCP) 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, smokestack 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.

## **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.



**LORI E. RIKER, P.E.**  
**SR. 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  
Visible Emissions Certification, Received April 1, 2015  
Air and Waste Management Association, Member

## **SUMMARY OF EXPERIENCE**

Ms. Riker has 24 years of environmental and civil engineering experience that has focused on industrial regulatory compliance assistance; Phase I environmental site assessments; remedial investigations and alternative analyses under various state and federal cleanup programs; detailed wastewater and industrial process design; and construction administration. Ms. Riker's regulatory compliance experience consists of 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; storm water permitting, reporting, Storm Water Pollution Prevention Plans (SWPPPs), and Best Management Practices (BMP) Plans; industrial wastewater design and pretreatment permitting; and hazardous waste auditing, annual reporting, and reduction plans.

## **REPRESENTATIVE PROJECT EXPERIENCE**

<b>May 2003 to Present</b>	<b>Benchmark Environmental Engineering &amp; Science, PLLC</b>
<b>Nov 1997 to May 2002</b>	<b>Malcolm Pirnie, Inc.</b>
<b>Feb 1995 to Oct 1997</b>	<b>ENVIRON Corporation</b>

- Currently serving as environmental consultant for two western NY pharmaceutical manufacturers. Providing on-going wastewater compliance assistance; and developed and updated Spill Prevention Control and Countermeasure (SPCC) Plans and air emissions permits. Presently assisting with wastewater treatment plant expansion, including sequencing batch reactors and UV disinfection, and NYSDEC State Pollutant Discharge Elimination System (SPDES) permit modifications for increased flow and new cooling tower water treatment chemicals.
- Currently serving as adjunct environmental compliance specialist for a company that designs and builds vacuum and heat transfer equipment. Environmental regulatory auditing, sampling, inspecting, reporting, and training services include: EPCRA Tier II and Form R; NYSDEC Multi-Sector General Permit (MSGP) for Storm Water Discharges Associated with Industrial Activity and the associated SWPPP; PBS and SPCC Plan; hazardous waste management; and air permitting.
- 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 MSGP for Storm Water Associated with Industrial Activity and 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.

- Assisted with permitting and design of facilities for storage and handling compressed gas in accordance with the NYS Fire Code, and prepared Emergency Action Plans, Fire Prevention Plans, and Hazardous Materials Management Plans required of NFPA 55.
- Currently serving as a third-party environmental consultant to Delta Sonic Car Wash Systems, Inc. for its NY, PA, and IL gasoline stations and lube oil shops. Performed environmental compliance audits focusing on NYSDEC PBS regulations, and prepared SPCC Plans and an overall BMP Plan.
- 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.
- Provided 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 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.
- 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.
- Assisted with environmental regulatory compliance audits at Gibraltar Steel's New York 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.
- 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.

## **RESENTATIONS/PUBLICATIONS**

- Riker, L.E., McManus, A.C., 2001. "*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.
- Riker, L.E., McManus, A.C., Sanders, L. A., 2001. "*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.
- Riker, L.E., McManus, K.R., Kreuz, D.E., Mistretta, M.V., 2001. "*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.

## APPENDIX B

### PREVIOUS INVESTIGATIONS

# APPENDIX C

## FIELD OPERATING PROCEDURES

# FIELD OPERATING PROCEDURES

## Abandonment of Borehole Procedures

**ABANDONMENT OF BOREHOLE PROCEDURE**

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**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.

**ABANDONMENT OF BOREHOLE PROCEDURE**

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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.



**ABANDONMENT OF BOREHOLE PROCEDURE**

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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.

**FOP 001.1**

**ABANDONMENT OF BOREHOLE PROCEDURE**



PREPARED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

# FIELD OPERATING PROCEDURES

## Abandonment of Monitoring Wells Procedure

**ABANDONMENT OF MONITORING WELLS PROCEDURE**

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**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.

**ABANDONMENT OF MONITORING WELLS PROCEDURE**

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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.

**ABANDONMENT OF MONITORING WELLS PROCEDURE**

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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

**ABANDONMENT OF MONITORING WELLS PROCEDURE**

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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.

[illegible]



# FIELD OPERATING PROCEDURES

## Air Rotary Drilling Procedure

**AIR ROTARY DRILLING PROCEDURE**

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**PURPOSE**

This guideline presents a standard method of subsurface drilling in bedrock or extremely resistant unconsolidated soils using air rotary drilling techniques.

**PROCEDURE**

1. Advance boring to top of competent bedrock as per Benchmark's FOP 026: Hollow Stem Auger (HSA) Drilling Procedures or FOP 041: Overburden Casing Installation Procedures, or approved other as per the project work plan.
2. Rock drilling is performed using air as the primary drilling fluid. Water present in the formation assists the drilling process. A large compressor supplies air that is piped through a dual filter system to a swivel hose connected to the top of the Kelly or drill pipe. The dual filters remove oil that may enter the air stream at the compressor. The secondary filter should be inspected periodically to determine if oil is passing the primary filter. If this occurs, the primary and secondary filters should be replaced.
3. The cuttings and formation water are blown from the bottom of the borehole and are channeled by the dissipator (an enclosed hood located at the borehole surface) through flexible hosing to a covered 55-gallon D.O.T.-approved drum.
4. Advance the boring into consolidated materials by standard rock coring procedures using a triple wa core barrel of NX or HQ size. Log bedrock core in accordance with Benchmark's FOP 043: Rock Core Classification Procedure. Temporary casing may be used if circulation of drill water is desired.
5. Perform packer permeability testing at this stage if the project requires such testing as per Benchmark's FOP 042: Pressure Packer Test Procedure.

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## FOP 003.0

### AIR ROTARY DRILLING PROCEDURE

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6. Continue advancing boring alternating between air rotary drilling (3 7/8-inch roller bit or other size as required) and core sample collection (typically in 5-foot increments or as the formation allows).
7. Verify borehole depth using a weighted measuring tape.
8. Air monitoring is performed in accordance with the site Health and Safety Plan (HASP).
9. Record all information in the Project Field Book and on the appropriate project field forms.

#### ATTACHMENTS

none

#### REFERENCES

##### Benchmark FOPs:

- 026 *Hollow Stem Auger (HSA) Drilling Procedures*
- 041 *Overburden Casing Installation Procedures*
- 042 *Pressure Packer Test Procedure*
- 043 *Rock Core Classification Procedure*

# FIELD OPERATING PROCEDURES

## Soil Vapor Sample Collection Procedures

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**BACKGROUND**

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**PURPOSE**

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

**SURVEYS AND PRE-SAMPLING BUILDING PREPARATION (IF REQUIRED)**

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

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

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

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

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



**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

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

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

**PRODUCT INVENTORY (IF REQUIRED)**

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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time air is tested to provide an accurate assessment of the potential contribution of volatile chemicals. If available, chemical ingredients of interest (e.g., analyte list) should be recorded for each product. If the ingredients are not listed on the label, record the product's exact and full name, and the manufacturer's name, address and telephone number, if available. In some cases, Material Safety Data Sheets (MSDS) may be useful for identifying confounding sources of volatile chemicals in air. Adequately documented photographs of the products and their labeled ingredients can supplement the inventory and facilitate recording the information.

**SAMPLE LOCATIONS**

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

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

- Sub-slab vapor

Sub-slab vapor samples are collected to characterize the nature and extent of soil vapor contamination immediately beneath a building with a basement foundation and/or a slab-on-grade. Sub-slab vapor sampling results are used when evaluating the following:

- *Current* human exposures;
- The potential for *future* human exposures (e.g., if the structural integrity of the building changes or the use of the building changes); and
- Site-specific attenuation factors (i.e., the ratio of indoor air to sub-slab vapor concentrations).

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

- Indoor air

Indoor air samples are collected to characterize exposures to air within a building, including those with earthen floors and crawlspaces. Indoor air sampling results are used when evaluating the following:

- *Current* human exposures;
- The potential for *future* exposures (e.g., if a currently vacant building should become occupied); and
- Site-specific attenuation factors (e.g., the ratio of indoor air to sub-slab vapor concentrations).

Indoor air samples are collected after subsurface vapor characterization and other environmental sampling (e.g., soil and groundwater characterization) indicate a need. When indoor air samples are collected, concurrent sub-slab vapor and

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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outdoor air samples are collected to evaluate the indoor air results appropriately. However, indoor air and outdoor air samples, without sub-slab vapor samples, may be collected when confirming the effectiveness of a mitigation system.

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

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

■ Outdoor air

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**SOIL VAPOR SAMPLE COLLECTION PROCEDURES**

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

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

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

- At least 24 hours after the installation of permanent probes and shortly after the installation of temporary probes, one to three implant volumes (i.e., the volume of

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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the sample probe and tube) must be purged prior to collecting the samples to ensure samples collected are representative;

- Flow rates for both purging and collecting must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling;
- The target final field vacuum after 24 hours will be approximately -5 inches of mercury. Samples with a final field vacuum of greater than -10 inches of mercury, or equal to zero, will be flagged (usability of data will depend on sample volume and reporting limits that can be achieved).
- Samples must be collected, using conventional sampling methods, in an appropriate container — one which meets the objectives of the sampling (e.g., investigation of areas where low or high concentrations of volatile chemicals are expected; to minimize losses of volatile chemicals that are susceptible to photodegradation), meets the requirements of the sampling and analytical methods (e.g., low flow rate; Summa® canisters if analyzing by using EPA Method TO-15), and is certified clean by the laboratory;
- Sample size depends upon the volume of sample required to achieve minimum reporting limit requirements; and
- A tracer gas (e.g., helium, butane, or sulfur hexafluoride) must be used when collecting soil vapor samples to verify that adequate sampling techniques are being implemented (i.e., to verify infiltration of outdoor air is not occurring) (discussed later in this procedure). Once verified, continued use of the tracer gas may be reconsidered.

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

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



**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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- Outdoor plot sketches should be drawn that include the site, area streets, neighboring commercial or industrial facilities (with estimated distance to the site), outdoor ambient air sample locations (if applicable), and compass orientation (north);
- Weather conditions (e.g., precipitation, outdoor temperature, barometric pressure, wind speed and direction) should be noted for the past 24 to 48 hours; and
- Any pertinent observations should be recorded, such as odors and readings from field instrumentation.

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

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

**SUB-SLAB VAPOR SAMPLE COLLECTION PROCEDURES**

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

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

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

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

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

The following describes the subslab air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.
4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample (discussed in the next section). Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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

5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. See the Outdoor Ambient Air Sampling Procedure section in this procedure.
6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.
7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.
8. At each location, drill an approximately  $\frac{3}{4}$ -inch diameter hole through the concrete slab (typically 6-8 inches thick) using a hand-held hammer drill.
9. Measure and record the concrete thickness in the Project Field Book.
10. Insert polyethylene or Teflon® tubing of laboratory or food grade quality into the drilled hole and no further than 2 inches into the subslab material.
11. Seal the tubing with an appropriately sized volatile organic compound-free stopper (i.e., permagum grout, melted beeswax, putty, or other non-VOC-containing and non-shrinking product) into the concrete core hole and secure in-place making sure the fit is very snug. Supplement any visible gaps between the stopper and concrete slab with a VOC-free sealant, such as beeswax or bentonite slurry.

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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12. Run the tubing assembly through a shroud (plastic pail, cardboard box, or garbage bag) creating a tight seal with the surface making sure not to disturb the seal around the tubing penetration.
13. Enrich the atmosphere of the shroud with helium. Measure and record the helium concentration within the shroud.
14. Purge approximately 1 to 3 tubing volumes (i.e., the volume of the sample probe and tube) using a hand pump (or similar approved device) to ensure the collection of a representative sample.
15. Flow rates for both purging and sample collection must not exceed 0.2 liters per minute to minimize outdoor air infiltration during sampling.
16. Use a portable monitoring device to analyze a sample of soil vapor for the tracer **prior to and after** sampling for the compounds of concern. Note that the tracer gas samples can be collected via syringe, Tedlar bag etc. They need not be collected in Summa® canisters or minicans.
17. If concentrations greater than 10% of tracer gas are observed either prior to and/or after sampling, the probe seal should be enhanced to reduce the infiltration of outdoor air. Following enhancement of the seal, repeat steps 14 through 17 above until purged concentrations are less than 10% of the tracer gas within the shroud.
18. Following tubing purge and adequate seal integrity testing via helium tracer gas, immediately attach a 6-liter Summa Canister fitted with a 24-hour regulator (or approved other duration) to the opposite end of the tubing. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.
19. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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20. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.
21. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
22. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
23. Repair all concrete openings with a cement patch.
24. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

**INDOOR AIR SAMPLE COLLECTION PROCEDURES**

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

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

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



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COLLECTION PROCEDURE**

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represent average concentrations over longer periods, then longer duration sampling periods may be appropriate. Typically, 24 hour samples are collected from residential settings;

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

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

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### SOIL VAPOR SAMPLE COLLECTION PROCEDURE

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

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

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

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

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

The following describes the indoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan. Indoor air sampling typically requires the continuous collection of samples over a 24-hour period.
4. The sampling program will consist of concurrently collecting and analyzing one sub-slab vapor sample and one indoor ambient air sample. Sample locations should be selected based on the likelihood for potential continuous human occupancy during the workday (i.e., due to the size of the areas and available infrastructure), and to account for the possibility of varying foundation depths in different areas of the building. In addition, sample locations typically are based upon the results of a subsurface investigation (i.e., soil gas survey or boring advancement) conducted prior to air sample collection activities. Canisters are typically placed in areas where the highest concentrations of soil gas were observed. Indoor air sample locations preferably should be selected near the middle of the sampled room, well away from the edges where dilution is more likely to occur.
5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building

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

6. Field personnel should assure conservative sampling conditions prior to and throughout the sampling event. The building should be closed (windows and doors shut) and existing building ventilation systems should be turned off 12 to 24 hours before the air sampling is scheduled to begin as well as during sample collection. Any air-handling units that may induce large pressure gradients (i.e., exhaust fans, HVAC units etc.) should also be turned off.
7. Any activity being conducted by current building tenants involving volatile organic compounds, such as the use of lacquer thinner and cleaning solvents, prior to and/or during air sampling activities should be noted in the Project Field Book. These activities have the potential to bias the analytical results.
8. Concurrent with each subslab sample location, prepare an indoor ambient air sample by staging a second Summa Canister on a ladder (approximately 2 to 5-feet above the floor) adjacent to the sub-slab sample location.
9. All Summa Canister valves should remain closed until all subslab borings are complete and all of the canisters in their respective positions.
10. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.
11. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
12. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
13. Analytical results submitted by the laboratory should be reported as concentrations of each VOC at each location, typically in parts per billion by volume (ppbv).

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COLLECTION PROCEDURE**

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**OUTDOOR AIR SAMPLE COLLECTION PROCEDURES**

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

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

- Outdoor plot sketches should be drawn that include the building site, area streets, outdoor air sample locations (if applicable), the location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), footings that create separate foundation sections, and paved areas;
- Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) should be reported; and
- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

The following describes the outdoor air sampling procedure:

1. Canisters will be supplied by the laboratory that will be conducting the analysis.
2. Sampling will take place in accordance with the project work plan sufficiently spaced to allow locations to be modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.
4. Sample locations typically are collected upwind of the facility.

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5. Collect at least one outdoor ambient air sample from a location on the building roof or designated background area of the site positioned away from building ventilation system equipment on the highest portion of the building roof or site. Place canisters on the ground or step ladder, with a clear plastic sheet beneath to prevent contamination. Locate the sampling inlet approximately 18-inches above the ground surface.
6. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results.
7. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.
8. All Summa Canister valves should remain closed until all subslab borings are complete and all of the indoor and outdoor canisters in their respective positions.
9. Open the valves to all of the canisters for the required collection period (i.e., 24-hours). Record initial canister pressure on the Air Canister Field Record form.
10. Following sample collection and prior to closing canister valve, record final canister pressure on the Air Canister Field Record form. Close canister valve.
11. Collect all Summa Canisters and ship, under chain-of-custody command to an approved analytical laboratory for VOC analysis in accordance with USEPA Method TO-14 or TO-15.
12. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-14 or TO-15.

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

**TRACER GAS**

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

Depending on the nature of the contaminants of concern, a number of different compounds can be used as a tracer. Typically, sulfur hexafluoride (SF<sub>6</sub>) or helium are used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Butane and propane (or other gases) could also be used as a tracer in some situations. The protocol for using a tracer gas is straightforward: simply enrich the atmosphere in the immediate vicinity of the area where the probe intersects the ground surface with the tracer gas, and measure a vapor sample from the probe for the presence of high concentrations (> 10%) of the tracer. A cardboard box, a plastic pail, or even a garbage bag can serve to keep the tracer gas in contact with the probe during the testing.

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

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



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

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

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

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COLLECTION PROCEDURE**

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**QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)**

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

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

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

New York State Public Health Law requires laboratories analyzing environmental samples collected from within New York State to have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix

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combinations. If ELAP certification is not currently required for an analyte (e.g., trichloroethene), the analysis should be performed by a laboratory that has ELAP certification for similar compounds in air and uses analytical methods with detection limits similar to background (e.g., tetrachloroethene via EPA Method TO-15).

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

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

**DECISION MATRICES (FIGURES 1, 2, AND 3)**

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

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

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COLLECTION PROCEDURE**

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

- The matrices are generic. As such, it may be necessary to modify recommended actions to accommodate building-specific conditions (e.g., dirt floor in basement, crawl spaces, etc.) and/or site-specific conditions (e.g., proximity of building to identified subsurface contamination) for the protection of public health. Additionally, actions more conservative than those specified within the matrix may be implemented at any time. For example, the decision to implement more conservative actions may be based on a comparison of the costs associated with resampling or monitoring to the costs associated with installation and monitoring of a mitigation system.
- Indoor air concentrations detected in samples collected from the building's basement or, if the building has a slab-on-grade foundation, from the building's lowest occupied living space should be used.
- Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude the need to investigate possible sources of vapor contamination, nor does it preclude the need to remediate contaminated soil vapors or the source of soil vapor contamination.
- When current exposures are attributed to sources other than vapor intrusion, the agencies must be provided documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix and to support assessment and follow-up by the agencies.

**RECOMMENDED ACTIONS**

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

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- *No further action*  
When the volatile chemical is not detected in the indoor air sample and the concentration detected in the corresponding sub-slab vapor sample is not expected to substantially affect indoor air quality.
- *Identify source(s) and resample or mitigate*  
Reasonable and practical actions are recommended to identify the source(s) affecting indoor air quality and that actions be implemented to reduce indoor air concentrations to within background ranges. The concentration detected in the indoor air sample is likely due to indoor and/or outdoor sources rather than soil vapor intrusion given the concentration detected in the sub-slab vapor sample. Resampling may be required in the event indoor and/or outdoor sources are not readily identified or confirmed to demonstrate SVI mitigation actions are not needed. Steps should be taken to identify potential source(s) and to reduce exposures accordingly (e.g., by keeping containers tightly capped or by storing volatile chemical-containing products in places where people do not spend much time, such as a garage or shed). Mitigation may be required if soil vapor intrusion cannot be ruled out.
- *Monitor*  
Monitoring, including sub-slab vapor, basement air, lowest occupied living space air, and outdoor air sampling, is needed to determine whether concentrations in the indoor air or sub-slab vapor have changed. Monitoring may also be needed to determine whether existing building conditions (e.g., positive pressure HVAC systems) are maintaining the desired mitigation endpoint and to determine whether changes are needed. The type and frequency of monitoring is determined on a site-specific and building specific basis, taking into account applicable environmental data and building operating conditions.
- *Mitigate*  
Mitigation is needed to minimize current or potential exposures associated with soil vapor intrusion. Methods to mitigate exposures related to soil vapor intrusion are described in Section 4 of the Guidance.

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COLLECTION PROCEDURE**

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**TIME OF YEAR**

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

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

**SAMPLING ROUNDS**

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

- To characterize the nature and extent of subsurface vapor contamination (similar to the delineation of groundwater contamination) and to address corresponding exposure concerns;
- To evaluate fluctuations in concentrations due to
  - Different weather conditions (e.g., seasonal effects),
  - Changes in building conditions (e.g., various operating conditions of a building's HVAC system),
  - Changes in source strength, or
  - Vapor migration or contaminant biodegradation processes (particularly when degradation products may be more toxic than the parent compounds); or

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

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

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

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

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

**ATTACHMENTS**

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

Air Canister Field Record

Indoor Air Quality Questionnaire and Building Inventory



**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**REFERENCES**

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

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

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

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

- Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). Pp. 15-1 through 15-62.
- Method TO-17, Determination of Volatile Organic Compounds in Ambient Air using Active Sampling on Sorbent Tubes. Pp. 17-1 through 17-49.
- Compendium of Methods for the Determination of Air Pollutants in Indoor Air, EPA/600/4-90-010.

## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 1

### Soil Vapor/Indoor Air Matrix A

May 2017

**Analytes Assigned:**

Trichloroethene (TCE), *cis*-1,2-Dichloroethene (c12-DCE), 1,1-Dichloroethene (11-DCE), Carbon Tetrachloride

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

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

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

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

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

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

MATRIX A Page 1 of 2

SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE

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ADDITIONAL NOTES FOR MATRIX A

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

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.20 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 2

### Soil Vapor/Indoor Air Matrix B

May 2017

**Analytes Assigned:**

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

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

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

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

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

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

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

MATRIX B Page 1 of 2



**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**ADDITIONAL NOTES FOR MATRIX B**

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

- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 1 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.

## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 3

### Soil Vapor/Indoor Air Matrix C

May 2017

**Analytes Assigned:**  
Vinyl Chloride

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

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

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

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

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

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

MATRIX C Page 1 of 2

**SOIL VAPOR SAMPLE  
COLLECTION PROCEDURE**

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**ADDITIONAL NOTES FOR MATRIX C**

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

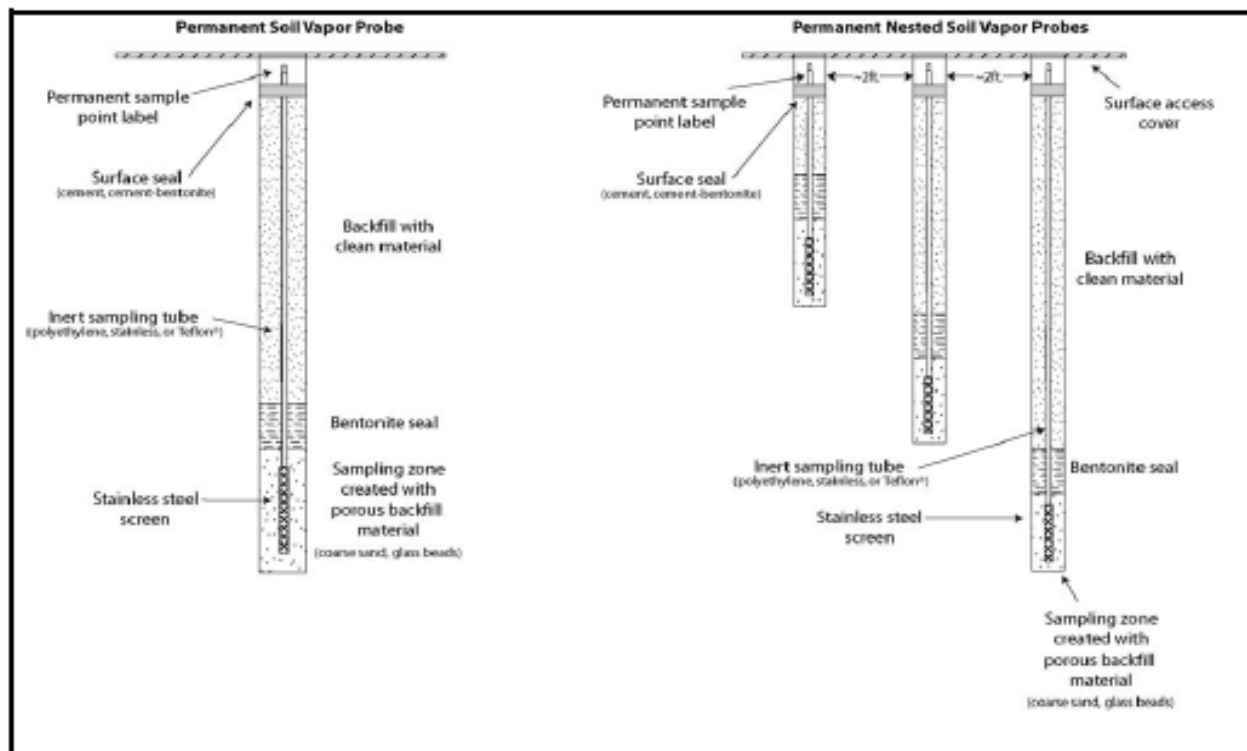
- [1] The matrix is generic. As such, it may be appropriate to modify a recommended action to accommodate analyte-specific, building-specific conditions (e.g., dirt floor in basement, crawl spaces, thick slabs, current occupancy, etc.), and/or factors provided in Section 3.2 of the guidance (e.g., current land use, environmental conditions, etc.). For example, collection of additional samples may be recommended when the matrix indicates "no further action" for a particular building, but the results of adjacent buildings (especially sub-slab vapor results) indicate a need to take actions to address exposures related to soil vapor intrusion. Mitigation might be recommended when the results of multiple contaminants indicate monitoring is recommended. Proactive actions may be proposed at any time. For example, the party implementing the actions may decide to install sub-slab depressurization systems on buildings where the matrix indicates "no further action" or "monitoring." Such an action might be undertaken for reasons other than public health (e.g., seeking community acceptance, reducing costs, etc.). However, actions implemented *in lieu* of sampling will typically be expected to be captured in the final engineering report and site management plan, and might not rule out the need for post-implementation sampling (e.g., to document effectiveness or to support terminating the action).
- [2] Actions provided in the matrix are specific to addressing human exposures. Implementation of these actions does not preclude investigating possible sources of soil vapor contamination, nor does it preclude remediating contaminated soil vapor or the source of soil vapor contamination.
- [3] Appropriate care should be taken during all aspects of sample collection to ensure that high quality data are obtained. Since the data are being used in the decision-making process, the laboratory analyzing the environmental samples must have current Environmental Laboratory Approval Program (ELAP) certification for the appropriate analyte and environmental matrix combinations. Furthermore, samples should be analyzed by methods that can achieve a minimum reporting limit of 0.20 microgram per cubic meter for indoor and outdoor air samples. For sub-slab vapor samples and dirt floor soil vapor samples, a minimum reporting limit of 1 microgram per cubic meter is recommended.
- [4] Sub-slab vapor and indoor air samples are typically collected when the likelihood of soil vapor intrusion is considered to be the greatest (i.e., worst-case conditions). If samples are collected at other times (typically, samples collected outside of the heating season), then resampling during worst-case conditions might be appropriate to verify that actions taken to address exposures related to soil vapor intrusion are protective of human health.
- [5] When current exposures are attributed to sources other than soil vapor intrusion, the agencies should be given documentation (e.g., applicable environmental data, completed indoor air sampling questionnaire, digital photographs, etc.) to support a proposed action other than that provided in the matrix box and to support agency assessment and follow-up.
- [6] The party responsible for implementing the recommended actions will differ depending upon several factors, including but not limited to the following: the identified source of the volatile chemicals, the environmental remediation program, and analyte-specific, site-specific and building-specific factors.



# SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 4

*Schematics of a permanent soil vapor probe and permanent nested soil vapor probes*

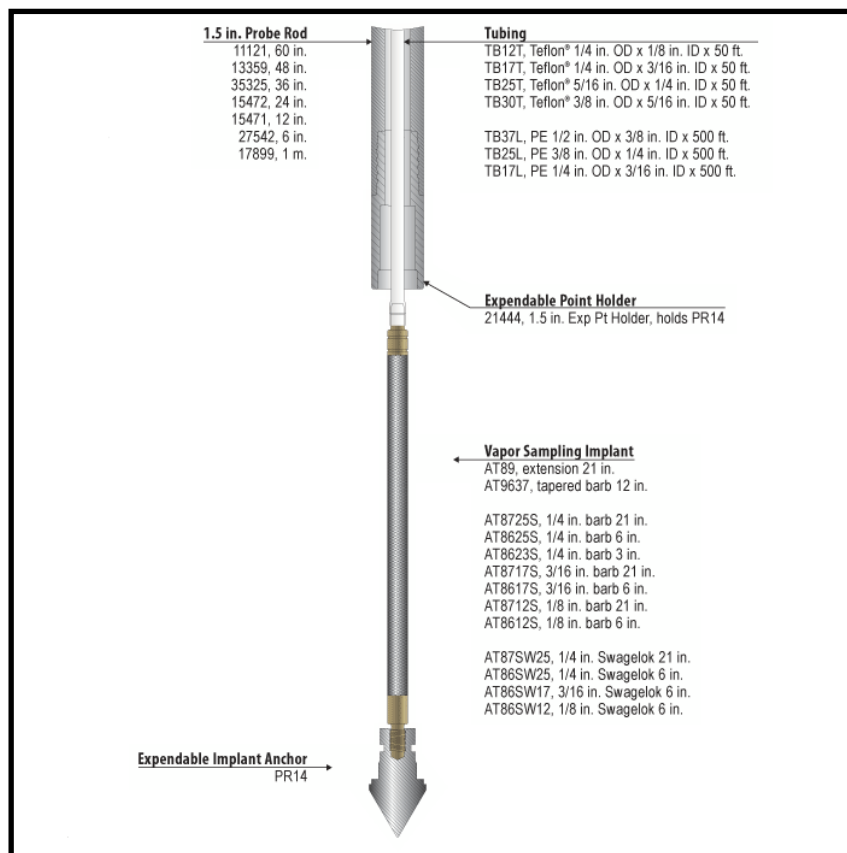
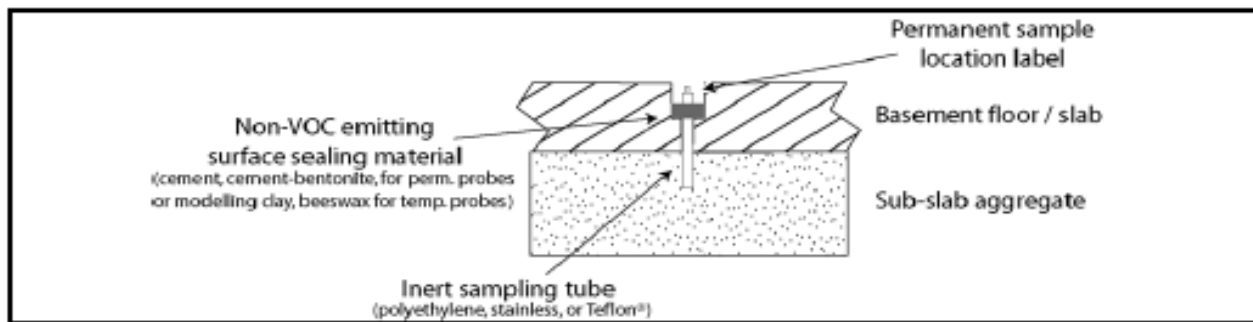


## FOP 004.6

### SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 5

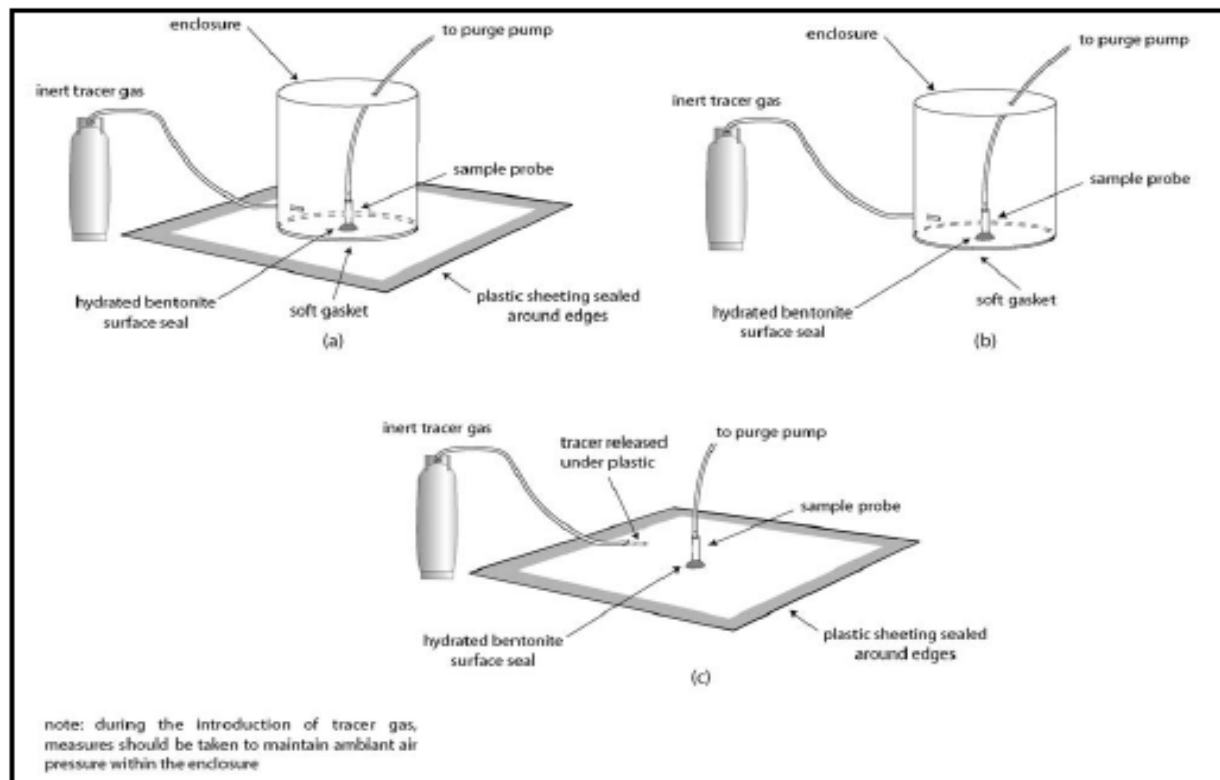
*Schematic of a sub-slab vapor probe*



## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

FIGURE 6

*Schematics of tracer gas applications*



## SOIL VAPOR SAMPLE COLLECTION PROCEDURE



### AIR CANISTER FIELD RECORD

**PROJECT INFORMATION:**

Project:	<b>SAMPLE I.D.:</b>
Job No:	
Location:	
Field Staff:	
Client:	

**WEATHER CONDITIONS:**

Ambient Air Temp. - A.M.:	Size of Canister:
Ambient Air Temp. - P.M.:	Canister Serial No.:
Wind Direction:	Flow Controller No.:
Wind Speed:	Sample Date(s):
Precipitation:	Shipping Date:
	Sample Type: <input type="checkbox"/> Indoor Air <input type="checkbox"/> Outdoor Air
	<input type="checkbox"/> Subslab, complete section below <input type="checkbox"/> Soil Gas
	Soil Gas Probe Depth:

**FIELD SAMPLING INFORMATION:**

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check <sup>1</sup>				
Initial Field Vacuum <sup>2</sup>				
Final Field Vacuum <sup>3</sup>				
Duration of Sample Collection				

**LABORATORY CANISTER PRESSURIZATION:**

Initial Vacuum (inches Hg and psia)	
Final Pressure (psia)	
Pressurization Gas	

**SUBSLAB SHROUD:**

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
Shroud Helium Concentration:	
Calculated tubing volume: $\times 3 =$	15 Min. 316 - 333
Purged Tubing Volume Concentration:	0.5 Hours 158 - 166.7
Is the purged volume concentration less than or equal to 10% in shroud?	1 79.2 - 83.3
<input type="checkbox"/> YES, continue sampling	2 39.6 - 41.7
<input type="checkbox"/> NO, improve surface seal and retest	4 19.8 - 20.8
	6 13.2 - 13.9
	8 9.9 - 10.4
	10 7.92 - 8.3
	12 6.6 - 6.9
	24 3.5 - 4.0

**NOTES:**

- 1 Vacuum measured using portable vacuum gauge (provided by Lab)
- 2 Vacuum measured by canister gauge upon opening valve
- 3 Vacuum measured by canister gauge prior to closing valve

Signed: \_\_\_\_\_

## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

**BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC**

### INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

Project Name: \_\_\_\_\_ Project No: \_\_\_\_\_  
 Project Location: \_\_\_\_\_ Client: \_\_\_\_\_  
 Preparer's Name: \_\_\_\_\_ Date/Time: \_\_\_\_\_  
 Preparer's Affiliation: \_\_\_\_\_ Phone No: \_\_\_\_\_

Purpose of Investigation: \_\_\_\_\_

**1. OCCUPANT:**  
 Interviewed: ☐ yes ☐ no  
 Last Name: \_\_\_\_\_ First Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 County: \_\_\_\_\_  
 Home Phone: \_\_\_\_\_ Office Phone: \_\_\_\_\_  
 Number of Occupants/persons at this location: \_\_\_\_\_ Age of Occupant(s): \_\_\_\_\_

**2. OWNER OR LANDLORD:** (check if same as occupant)  
 Interviewed: ☐ yes ☐ no  
 Last Name: \_\_\_\_\_ First Name: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 County: \_\_\_\_\_  
 Home Phone: \_\_\_\_\_ Office Phone: \_\_\_\_\_

**3. BUILDING CHARACTERISTICS:**  
 Type of Building (check appropriate box):  
☐ Residential ☐ Commercial/Multi-use  
☐ Industrial ☐ Other: \_\_\_\_\_  
 If the property is residential, type (check appropriate response):  
☐ Single Family ☐ 3-Family  
☐ Attached Single ☐ Split Level ☐ Colonial  
☐ Cape Cod ☐ Contemporary ☐ Mobile Home  
☐ Duplex ☐ Apartment House ☐ Townhouse/Condo  
☐ Modular ☐ Log Home ☐ Other: \_\_\_\_\_

If multiple units, how many? \_\_\_\_\_  
 If the property is commercial, type?  
 Business Type(s): \_\_\_\_\_  
 Does it include residences (i.e., multi-use)? ☐ yes ☐ no If yes, how many? \_\_\_\_\_

**Other Characteristics:**  
 Number of floors: \_\_\_\_\_ Building age: \_\_\_\_\_  
 Is the building insulated? ☐ yes ☐ no How air tight? ☐ tight ☐ average ☐ not tight

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**BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC**

### INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

**4. AIR FLOW**  
 Use air current tubes or tracer smoke to evaluate air flow patterns and qualitatively describe:

Airflow between floors: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 Airflow near source: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 Outdoor air infiltration: \_\_\_\_\_  
 \_\_\_\_\_  
 Infiltration into air ducts: \_\_\_\_\_  
 \_\_\_\_\_

**5. BASEMENT AND CONSTRUCTION DETAILS (check all that apply):**

a. Above grade foundation	<input type="checkbox"/> basement	<input type="checkbox"/> stone
b. Basement floor	<input type="checkbox"/> concrete	<input type="checkbox"/> slab
c. Basement wall	<input type="checkbox"/> dirt	<input type="checkbox"/> stone
d. Basement floor	<input type="checkbox"/> concrete	<input type="checkbox"/> covered
e. Concrete floor	<input type="checkbox"/> sealed	<input type="checkbox"/> sealed with
f. Foundation wall	<input type="checkbox"/> poured	<input type="checkbox"/> block
g. Foundation wall	<input type="checkbox"/> sealed	<input type="checkbox"/> sealed with
h. The basement is:	<input type="checkbox"/> wet	<input type="checkbox"/> damp
i. The basement is:	<input type="checkbox"/> finished	<input type="checkbox"/> unfinished
j. Sump present?	<input type="checkbox"/> yes	<input type="checkbox"/> no
k. Water in Sump?	<input type="checkbox"/> yes	<input type="checkbox"/> no

Basement/Lowest level depth below grade: \_\_\_\_\_  
 Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains):  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

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**BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC**

### INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

**6. HEATING, VENTING, AND AIR CONDITIONING** (check all that apply)  
 Type of heating system(s) used in this building: (check all that apply - note primary)  
☐ Hot air circulation ☐ Hot pump ☐ Hot water baseboard  
☐ Space Heaters ☐ Steam radiation ☐ Radiant floor  
☐ Electric baseboard ☐ Wood stove ☐ Outdoor wood boiler  
☐ Other: \_\_\_\_\_

The primary type of fuel used is:  
☐ Natural Gas ☐ Fuel oil ☐ Propane  
☐ Electric ☐ Pellets ☐ Coal  
☐ Wood ☐ Other: \_\_\_\_\_

Domestic hot water tank fueled by: \_\_\_\_\_  
 Boiler/furnace located in:  
☐ Basement ☐ Outdoor ☐ Other: \_\_\_\_\_  
 Air Conditioning:  
☐ Central Air ☐ Window units ☐ Other: \_\_\_\_\_

Are there air distribution ducts present? ☐ yes ☐ no

Describe the supply and return air registers, vents, and grilles where visible, including whether there is a cold air return and the tightness of the registers. Indicate the locations on the floor plan diagram.  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**7. OCCUPANCY**  
 Is basement/lowest level occupied? ☐ Full time ☐ Occasionally ☐ Seldom ☐ Almost Never  
 General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage):  
 Basement: \_\_\_\_\_  
 First Floor: \_\_\_\_\_  
 Second Floor: \_\_\_\_\_  
 Third Floor: \_\_\_\_\_  
 Fourth Floor: \_\_\_\_\_

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**BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC**

### INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

**8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY**

a. Is there an attached garage? ☐ yes ☐ no

b. Does the garage have a separate heating unit? ☐ yes ☐ no ☐ NA

c. Are petroleum-powered machines or vehicles stored in the garage? ☐ yes ☐ no ☐ NA  
 (e.g., lawnmowers, etc., no) If yes, please specify: \_\_\_\_\_

d. Has the building ever had a fire? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

e. Is a kerosene or vented gas space heater present? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

f. Is there a workshop or hobby/craft area? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

g. Is there smoking in the building? ☐ yes ☐ no

h. Have cleaning products been used recently? ☐ yes ☐ no

i. Have construction materials been used recently? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

j. Has painting been done in the last 6 months? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

k. Is there new carpet or vinyl flooring? ☐ yes ☐ no  
 If yes, when? \_\_\_\_\_

l. Have air fresheners been used recently? ☐ yes ☐ no  
 If yes, when & type? \_\_\_\_\_

m. Is there a kitchen exhaust fan? ☐ yes ☐ no  
 If yes, when used? \_\_\_\_\_

n. Is there a bathroom exhaust fan? ☐ yes ☐ no  
 If yes, when used? \_\_\_\_\_

Page 4 of 8

## SOIL VAPOR SAMPLE COLLECTION PROCEDURE

**G H ENCH MARK**  
SCIENTIFIC PLAG

# INDOOR AIR QUALY QUESTIONNAIRE & BUILDING INVENTORY

## 8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY (continued)

a. Is there a clothes dryer?

If yes, is it vented outside?      yes      no      ☐ yes      ☐ no

b. Has there been a pesticide application?

If yes, when & type?      yes      no      ☐ yes      ☐ no

c. Are there odors in the building?

If yes, please describe?      yes      no      ☐ yes      ☐ no

d. Do any of the building occupants use solvents at work?

(e.g., chemical manufacturing or laboratory, auto maintenance, painting, hand-dictery, home mechanic,  
pesticide application, cosmetology)

If yes, what types of solvents are used?

If yes, are their clothes washed at work?      yes      no      ☐ yes      ☐ no

e. Do any of the building occupants regularly clean their car at a car-cleaning service?

(check appropriate response)

<input type="checkbox"/> yes, use dry-cleaning solvent	<input type="checkbox"/> no
<input type="checkbox"/> yes, use cleaning agents (other than dry-cleaning solvent)	<input type="checkbox"/> unknown
<input type="checkbox"/> yes, wash at a car-wash facility	

f. Is there a swimming pool or hot tub in the building's structure?

☐ yes      ☐ no

Is system active or passive?

## 9. WATER AND WASTE

Water Supply:      ☐ Municipal Water      ☐ Drilled Well      ☐ Dugwell      ☐ Dog Well

Sewage Disposal:      ☐ Public Sewer      ☐ Septic Tank      ☐ Leach Field      ☐ Dry Well

## 10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended:


Resident choose to:      ☐ remain in home      ☐ relocate to friends/family      ☐ relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained?      yes      no      ☐ yes      ☐ no

d. Relocation package provided and explained to residents?      yes      no      ☐ yes      ☐ no

Indoor Air Quality Questionnaire and Building Inventory

Page 5 of 8



**IB BENCHMARK**  
 CHARTERED INSTITUTE  
 OF BUILDING &  
 SCIENCE, PLAS

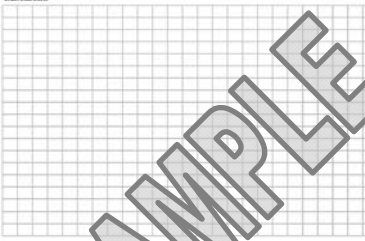
# INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY

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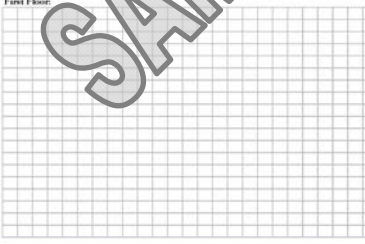
## II. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

**Basement**




**First Floor**



Indoor Air Quality Questionnaire and Building Inventory

Page 6 of 8



## INDOOR AIR QUALITY QUESTIONNAIRE & BUILDING INVENTORY


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**12. OUTDOOR PLOT**

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and spout system, if applicable, and a qualifying statement to help locate the site on a topographic map.

SAMPLE



Page 7 of 8

[illegible]



FIELD OPERATING PROCEDURES

Calibration and  
Maintenance of  
Combustible  
Gas/Oxygen Meter



**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

---

**PURPOSE**

This procedure presents a method for calibration of the GasTech GT402 four-gas meter. The GasTech GT402 is a portable instrument designed primarily for detection of combustible gases and of oxygen deficiency in ambient air and confined workspaces, such as natural gas or depleted oxygen in utility manholes. The GasTech GT402 monitors an environment for hydrocarbons (LEL/ppm), oxygen (O<sub>2</sub>), carbon monoxide (CO) and hydrogen sulfide (H<sub>2</sub>S). The meter detects gas by a sample-drawing method utilizing up to four internal sensors plugged into assigned molded flow block receptacles. During operation, the GasTech GT402 alerts the user with visual and audible alarms whenever a monitored gas reaches the preset alarm level. The GasTech GT402 has an internal pump that continually draws the atmosphere sample into the external probe and hose, then into the monitor to the sensor(s).

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 GasTech GT402. The actual equipment to be used in the field will be equivalent or similar. The unit selected for use in the field will be used to measure methane gas, hydrogen sulfide gas, Lower Explosive Limit (LEL), and percent oxygen. As always, consult the manufacturers operations manual prior to conducting this procedure to confirm accuracy.

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

---

**START-UP PROCEDURE**

Perform the following steps to start up the GasTech GT402 gas monitor and adjust internal circuits to “fresh air” readings (demand zero). Read this entire section before turning on the meter.

**WARNING**

Perform the following start-up procedure in a “fresh air” environment only (environment known to be free of toxic gases, combustible gases, and of normal oxygen content).

1. If you are using Ni-Cd batteries, make sure the batteries are fully charged before you continue this procedure.
2. Press the **ON/OFF** button once, then release the button. The display momentarily shows the software version of your monitor and the number of data logging hours that remain in memory. During the warm-up period, the gas readings stabilize for the installed sensors. You can hear the pump operating, and the words **WARMING UP** are displayed. The red LED flashes slowly during warm-up. Allow one minute for the display to stabilize and the LED to stop flashing. The GT sounds a periodic beep, and the display shows the words **WARMUP COMPLETE** when the meter completes initial warm-up.

**WARNING**

Do not perform the next step in the monitoring area. This can place you in potential danger if hazardous conditions exist.

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

---

3. Press and hold the **ADJUST/ENTER** button to adjust the monitor to “fresh air” readings. When the display reads “**DONE. THANK YOU**”, release the button.
4. Verify that the meter displays the correct fresh air reading for each of the meter’s channels. The table below lists the correct fresh air reading for **all** channels available for the meter.

Channel	Fresh Air Reading
% LEL	000
% Oxygen	20.9
Carbon Monoxide (ppm)	000
Hydrogen Sulfide (ppm)	000

5. Exhale over the inlet of the probe. The O<sub>2</sub> reading decreases.
6. Continue exhaling over the probe until the O<sub>2</sub> reading decreases to **19.5%** or below.
7. Verify that the alarm activates when the O<sub>2</sub> reading decreases to **19.5%**. The buzzer sounds, the O<sub>2</sub> reading flashes, and the display flashes “**ALRM**” when the alarm activates.
8. Verify that the O<sub>2</sub> reading returns to **20.9%**. The gas reading flashes until it increases above 19.5%.
9. To turn the GT Series gas monitor off, press the **ON/OFF** button and hold it down while the GT sounds five audible beeps. The monitor automatically shuts off. Release the button.

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

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10. If your GT uses rechargeable Ni-Cd batteries, the batteries must be fully charged before each use. When using alkaline batteries with your GT, for best possible operation you may choose to install fresh batteries before each use.

**CALIBRATION PROCEDURE**

Perform the following steps to calibrate the GasTech GT402 gas monitor and adjust internal circuits to “fresh air” readings (demand zero). Read this entire section before calibrating the meter.

**CAUTION**

**Calibrate the GasTech GT402 gas monitor in a “fresh air” environment (known to be of normal oxygen content and free of toxic or combustible gases). Do not begin calibration unless you can verify that you are in a “fresh air” environment.**

1. Verify that the calibrating area contains a level surface to set the meter and calibration kit accessories.
2. Turn on the meter in accordance with the Start-Up Procedure previously discussed. Enter the Function program and verify that the Battery Capacity screen displays at least three bars. Attach the probe to the inlet fitting on the meter.
3. Carefully screw the threaded end of the regulator into the gas cylinder.
4. Attach the sample tubing over the fitting on the regulator.
5. Press the **ADJUST/ENTER** button. The display shows the main screen.
6. Press the **RESET** and **BACK LITE/-** buttons simultaneously three times. The meter displays:

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

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Version N.NN

**Calibrate**

**Setting the Zero Readings**

NOTE: During a zeroing operation, an exclamation point (!) may appear at the beginning of the second line of the display reading when the reading is centered in the zero range. The “!” symbol represents the optimum reading.

1. Press the ADJUST/ENTER button. The GT displays:

**Zero Gas**

**NNN PPM H2S**

2. Use the FUNC./+ or BACK LITE/- buttons to adjust the display reading to 000 PPM H2S.
3. Press the ADJUST/ENTER button to save this zero setting. The GT displays:

**Zero Gas**

**NNNN PPM COMB**

4. Use the FUNC./+ or BACK LITE/- buttons to adjust the display reading to **0000 PPM COMB**.
5. Press the ADJUST/ENTER button to save this zero setting. The GT displays:

**Zero Gas**

**NNN PPM CO**

6. Use the FUNC./+ or BACK LITE/- buttons to adjust the display reading to **000 PPM CO**.

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

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7. Press the **ADJUST/ENTER** button to save this zero setting. The GT displays:

**Zero Gas**

**NN.N %VOL OXY**

8. Attach the tubing from the regulator to the probe tube. The GT will draw gas from the gas cylinder.
9. Allow at least one minute, then use the **FUNC./+** or **BACK LITE/-** buttons to adjust the display reading to match the O<sub>2</sub> value marked on the gas cylinder.
10. Press the **ADJUST/ENTER** button to save this setting. The GT displays:

**Span Gas**

**NNN PPM H<sub>2</sub>S**

**Setting the Span Readings**

1. Use the **FUNC./+** or **BACK LITE/-** buttons to adjust the display reading to match the H<sub>2</sub>S value marked on the gas cylinder.
2. Press the **ADJUST/ENTER** button to save this span setting. The GT displays:

**Span Gas**

**NNN %LEL COMB**

3. Use the **FUNC./+** or **BACK LITE/-** buttons to adjust the display reading to match the combustible gas value marked on the gas cylinder.
4. Press the **ADJUST/ENTER** button to save this span setting. The GT displays:

**Span Gas**

**NNN PPM CO**

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

---

5. Use the **FUNC./+** or **BACK LITE/-** buttons to adjust the display reading to match the CO value marked on the gas cylinder.

6. Press the **ADJUST/ENTER** button to save this span setting. The GT displays:

**Span Gas**

**NN.N %VOL OXY**

7. Disconnect the probe from the tubing leading to the regulator. The flow of gas will stop automatically.
8. Use the **FUNC./+** or **BACK LITE/-** buttons to adjust the display reading to 20.9 %VOL OXY.
9. Press the **ADJUST/ENTER** button to save this span setting.

Calibration is now complete. The GT displays:

**Exit**

**Press any Key...**

**Exiting Calibration Mode**

1. Press any button, except the **ON/OFF** to exit calibration mode.
2. Unscrew the regulator from the gas cylinder.
3. Store the components of the calibration kit in the storage case.
4. The GT is now ready for normal operation.
5. Record all calibration information in the Project Field Book as well as on an **Equipment Calibration Log** sheet (see attached sample).



**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

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**MAINTENANCE**

The following are daily, monthly, quarterly, and “as required” preventive maintenance suggestions to ensure the reliability of the GT monitor.

**Daily**

*BATTERIES*

The GT should always contain fully charged Ni-Cd batteries or sufficiently powered alkaline batteries before each day’s use. You can verify the capacity of the batteries using the Function program. To verify battery capacity:

1. Verify that the battery slide switch is at the proper **ALK** or **NI-CAD** setting for the type of batteries in the GT.
2. Press and hold the **FUNC./+** button, for four beeps, then release the button. If the display shows less than three bars, recharge the Ni-Cd batteries or replace the alkaline batteries as described later in this chapter.
3. Press the **FUNC./+** button to return to the main display.

*CALIBRATION*

For **optimum** efficiency of the monitor, calibrate the GT **before** and **after** each use. If multiple calibrations over a period of days indicate that only a minimum of adjustments are required, the frequency of calibration can be changed to weekly or monthly, depending on how often the monitor is used, and how demanding the monitoring environment is.

**CALIBRATION AND MAINTENANCE OF  
COMBUSTIBLE GAS/OXYGEN METER**

---

***NOTE***

At the very least, “challenge” the normal operation of the oxygen (O<sub>2</sub>) sensor (if applicable) before every use. Exhale over the inlet of the probe as you watch the display. The O<sub>2</sub> reading should **decrease**. When the O<sub>2</sub> reading decreases to **19.5%**, the alarm should activate confirming the normal operation of the O<sub>2</sub>

***SAMPLE-DRAW SUBCOMPONENTS***

Verify the proper operation of the flow alarm circuit by holding your finger over the inlet of the probe for a few seconds. The pump shuts off, the **PUMP OFF PRESS RESET** message appears on the display, and the audible alarm sounds if the flow alarm circuit is operating properly.

**Monthly/Quarterly**

***CALIBRATION***

Calibrate the sensors at least every one to three months. Calibration frequency depends on the frequency of use and also the environmental conditions in which you use the GT.

**As Required**

***ALARM CIRCUITS***

Periodically verify that all visual and audible alarms function properly.

**WARNING**

Verify alarm circuits in a “fresh air” environment only (environment known to be free of combustible and toxic gases and of normal oxygen content).

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## FOP 006.0

### CALIBRATION AND MAINTENANCE OF COMBUSTIBLE GAS/OXYGEN METER

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To verify the alarm circuits, use a concentration of the proper gas sample that is greater than the preset warn or alarm levels. Verify that **WARN** or **ALRM** displays and the buzzer sounds. Also, verify that the display reading in alarm flashes during the alarm sequence.

#### *SAMPLE-DRAW SUBCOMPONENTS*

Periodically check the probe, hoses, internal filter, and tubing for obstructions that can accumulate over time. *This is especially important if you use the GT in a dusty or dirty environment.* Replace the cotton and hydrophobic filter elements if they become contaminated or discolored.

#### ATTACHMENTS

Equipment Calibration Log (sample)

# FOP 006.0

## CALIBRATION AND MAINTENANCE OF COMBUSTIBLE GAS/OXYGEN METER



### 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re factor :
						ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/hr					background area		
<input type="checkbox"/>								

#### ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_



FIELD OPERATING PROCEDURES

Calibration and  
Maintenance of  
Portable Dissolved  
Oxygen Meter



**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  $\pm 1\%$  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.

**CALIBRATION AND MAINTENANCE OF PORTABLE  
DISSOLVED OXYGEN METER**

---

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)

# FOP 007.0

## CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER



### 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re factor :
						ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

#### ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_

FIELD OPERATING PROCEDURES

Calibration and  
Maintenance of  
Portable Field pH/Eh  
Meter

**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      $\pm 0.2$  pH unit, over the temperature range of  $\pm 0.2$  C.

Eh      $\pm 0.2$  millivolts (mV) over the range of  $\pm 399.9$  mV, otherwise  $\pm 2$  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.



**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD pH/Eh METER**

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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)

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## FOP 008.0

### CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

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- 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 meter 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)

# FOP 008.0

## CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER



### 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						ppm Iso. Gas		factor :
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

#### ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_



# FIELD OPERATING PROCEDURES

## Calibration and Maintenance of Portable Field Turbidity Meter

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

---

**PURPOSE**

This guideline describes the method for calibration of the HACH 2100P portable field turbidity meter. Turbidity is one water quality parameter measured during purging and development of wells. Turbidity is measured as a function of the samples ability to transmit light, expressed as Nephelometric Turbidity Units (NTUs). The turbidity meter is factory calibrated and must be checked daily prior to using the meter in the field. Calibration is performed to verify instrument accuracy and function. This procedure also documents critical maintenance activities for this meter.

**ACCURACY**

Accuracy shall be  $\pm 2\%$  of reading below 499 NTU or  $\pm 3\%$  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.



**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

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**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*)

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

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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 ( $\rightarrow$ ) 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  $\geq 0.5$  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

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

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**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

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

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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 11 of 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

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FIELD TURBIDITY METER**

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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)

## CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER



## 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						ppm Iso. Gas		factor :
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

## ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_



FIELD OPERATING PROCEDURES

Calibration and  
Maintenance of  
Portable Flame  
Ionization Detector  
(FID)

**CALIBRATION AND MAINTENANCE OF PORTABLE  
FLAME IONIZATION DETECTOR**

---

**PURPOSE**

This guideline presents a general description of the method for calibration and maintenance of a portable flame ionization detector (FID). The FID detects and initially quantifies a reading of the volatile organic compound (VOC) concentration in air. The FID is used as a field-screening tool for initial evaluation of soil samples and for ambient air monitoring. In order to ensure an accurate reading, the FID must be calibrated prior to use in the field.

Although 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 Sensidyne Portable Flame Ionization Detector. The actual equipment to be used in the field will be equivalent or similar.

The FID indicates total VOC concentration readings, which are normalized to a methane standard, so actual quantification of individual compounds is not provided. In addition, the FID response to compounds is highly variable, dependent on the structure of the compound and the presence or absence of other compounds. In the calibration mode, a methane standard of 200 parts per million by volume (ppmv) is used, and the desired accuracy at this concentration is  $\pm 50$  ppmv.

**PROCEDURE**

1. Zero the machine.
2. Calibrate all field test equipment at the beginning of each sampling day and check and recalibrate according to the manufacture's specifications.
3. Calibrate the FID meter using a compressed gas cylinder containing 200 ppmv methane in air, a 2 liter per minute flow regulator, and a tubing assembly.

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### CALIBRATION AND MAINTENANCE OF PORTABLE FLAME IONIZATION DETECTOR

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4. Assemble the calibration equipment and actuate the FID. Insert the probe into the calibration assembly and wait for a stable indication. Remove the cover over the calibration adjustment screw. Using a slotted screwdriver, turn the adjustment screw until the meter reads exactly 200 ppmv.
5. Replace the adjustment screw cover and deactivate the FID.
6. 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 instrument adjustments. 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 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

- The probe and handle of the FID should be checked before and after every use for cleanliness and worn or damaged parts. Drain the water trap in the handle as needed. Remove any other condensation with a clean cloth or

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## FOP 010.0

### CALIBRATION AND MAINTENANCE OF PORTABLE FLAME IONIZATION DETECTOR

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tissue. The dust filter and hydrophobic filters should be inspected and cleaned between use.

- The FID battery must be recharged when the battery level indicator is in the red sector. It is also recommended that the battery be recharged every month the instrument is not used frequently. Replace the instrument's hydrogen carrier gas as necessary.
- Store the FID in its carrying case when not in use. Additional maintenance details related to individual components of the FID 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

Equipment Calibration Log (sample)

# FOP 010.0

## CALIBRATION AND MAINTENANCE OF PORTABLE FLAME IONIZATION DETECTOR



### 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re factor :
						ppm Iso. Gas		
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

#### ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_

# FIELD OPERATING PROCEDURES

## Calibration and Maintenance of Portable Photoionization Detector (PID)



**CALIBRATION AND MAINTENANCE OF PORTABLE  
PHOTOIONIZATION DETECTOR**

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**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.

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## FOP 011.1

### CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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**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  $\pm 2$  ppm or 10% of the reading for concentrations ranging from 0-2,000 ppm and  $\pm 20\%$  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.

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PHOTOIONIZATION DETECTOR**

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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

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## FOP 011.1

### CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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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

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## FOP 011.1

### CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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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.

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## FOP 011.1

### CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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#### ATTACHMENTS

Table 1; Summary of Ionization Potentials  
Equipment Calibration Log (sample)  
Technical Note TN-106



## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

### SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
<b>A</b>		
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>B</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	

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
<b>C</b>		

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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
$\alpha$ -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	

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CALIBRATION AND MAINTENANCE OF PORTABLE  
PHOTOIONIZATION DETECTOR

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	
<b>D</b>		
1,1-Dibromoethane	10.19	
1,1-Dichloroethane	11.12	X
1,1-Dimethoxyethane	9.65	
1,1-Dimethylhydrazine	7.28	
1,2-Dibromoethane	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

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
<b>E</b>		
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	

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
Ethylenimine	9.2	
Ethynylbenzene	8.82	
<b>F</b>		
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-trifluoroethane)	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	
<b>H</b>		
1-Hexene	9.46	



## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
<b>K</b>		
Ketene	9.61	
<b>L</b>		
2,3-Lutidine	8.85	
2,4-Lutidine	8.85	
2,6-Lutidine	8.85	
<b>M</b>		
2-Methyl furan	8.39	
2-Methyl naphthalene	7.96	
1-Methyl naphthalene	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

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
$\alpha$ -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	
<b>N</b>		
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	

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

TABLE 1

### SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
<b>O</b>		
Octane	9.82	
Oxygen	12.08	X
Ozone	12.08	X
<b>P</b>		
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	

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
<b>Q</b>		
Quinone	10.04	
<b>S</b>		
Stibine	9.51	
Styrene	8.47	
Sulfur dioxide	12.3	X
Sulfur hexafluoride	15.33	X
Sulfur monochloride	9.66	
Sulfuryl fluoride	13	X
<b>T</b>		
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

## CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

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	
<b>V</b>		
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	
<b>W</b>		
Water	12.59	X
<b>X</b>		
2,4-Xylidine	7.65	
m-Xylene	8.56	
o-Xylene	8.56	
p-Xylene	8.45	



## FOP 011.0

# CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR



## EQUIPMENT CALIBRATION LOG

## PROJECT INFORMATION:

Project Name: \_\_\_\_\_

Date: \_\_\_\_\_

Project No.: \_\_\_\_\_

Client: \_\_\_\_\_

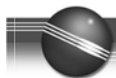
Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	POST CAL. READING	SETTINGS
<input type="checkbox"/> pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00 7.00 10.01		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	97060001450		0.4 100 800		
<input type="checkbox"/> Sp. Cond. meter	uS mS		Myron L Company Ultra Meter 6P			_____ mS @ 25 °C		
<input type="checkbox"/> PID	ppm		MinRAE 20			open air zero _____ ppm Iso. Gas		MIBK response factor = 1.0
<input type="checkbox"/> Dissolved Oxygen	ppm		YSI Model 5					
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/H					background area		
<input type="checkbox"/>								

## ADDITIONAL REMARKS: \_\_\_\_\_

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_



## 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:

$$\text{Conc. (mg/m}^3\text{)} = \frac{[\text{Conc. (ppmv)} \times \text{mol. wt. (g/mole)}]}{\text{molar gas volume (L)}}$$

For air at 25 °C (77 °F), the molar gas volume is 24.4 L/mole and the formula reduces to:

$$\text{Conc. (mg/m}^3\text{)} = \text{Conc. (ppmv)} \times \text{mol. wt. (g/mole)} \times 0.041$$

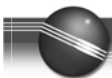
For example, if the instrument is calibrated with a gas standard in ppmv, such as 100 ppm isobutylene, and the user wants the display to read in  $mg/m^3$  of hexane, whose m.w. is 86 and CF is 4.3, the overall correction factor would be  $4.3 \times 86 \times 0.041$  equals 15.2.

### Correction Factors for Mixtures

The correction factor for a mixture is calculated from the sum of the mole fractions  $X_i$  of each component divided by their respective correction factors  $CF_i$ :

$$CF_{\text{mix}} = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + \dots X_i/CF_i)$$

Thus, for example, a vapor phase mixture of 5% benzene and 95% n-hexane would have a  $CF_{\text{mix}}$  of  $CF_{\text{mix}} = 1 / (0.05/0.53 + 0.95/4.3) = 3.2$ . 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:

$$\text{TLV mix} = 1 / (X_1/\text{TLV}_1 + X_2/\text{TLV}_2 + X_3/\text{TLV}_3 + \dots X_i/\text{TLV}_i)$$

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  $\text{TLV}_{\text{mix}} = 1 / (0.05/0.5 + 0.95/50) = 8.4$  ppm, corresponding to 8.0 ppm hexane and 0.4 ppm benzene. For an instrument calibrated on isobutylene, the reading corresponding to the TLV is:

$$\text{Alarm Reading} = \text{TLV}_{\text{mix}} / \text{CF}_{\text{mix}} = 8.4 / 3.2 = 2.6 \text{ ppm}$$

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).

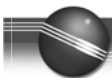
**4) T (or open tube) method:** The T method uses a T-junction with gas flow higher than the pump draw. The gas supply is connected to one end of the T, the instrument inlet is connected to a second end of the T, and excess gas flow escapes through the third, open end of the T. To prevent ambient air 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<sub>2</sub> and CO<sub>2</sub> 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:

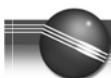
Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors. For accurate work, the instrument should be calibrated regularly under the operating conditions used. The factors in this table were measured in dry air at room temperature, typically at 50-100 ppm. CF values 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

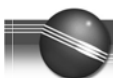
<http://www.raesystems.com>

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).



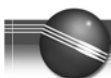
Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Acetaldehyde		75-07-0	C <sub>2</sub> H <sub>4</sub> O	NR	+	6	+	3.3	+	10.23	C25
Acetic acid	Ethanoic Acid	64-19-7	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	NR	+	22	+	2.6	+	10.66	10
Acetic anhydride	Ethanoic Acid Anhydride	108-24-7	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	NR	+	6.1	+	2.0	+	10.14	5
Acetone	2-Propanone	67-64-1	C <sub>3</sub> H <sub>6</sub> O	1.2	+	1.1	+	1.4	+	9.71	500
Acetone cyanohydrin	2-Hydroxyisobutyronitrile	75-86-5	C <sub>4</sub> H <sub>7</sub> NO					4	+	11.1	C5
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C <sub>2</sub> H <sub>3</sub> N					100		12.19	40
Acetylene	Ethyne	74-86-2	C <sub>2</sub> H <sub>2</sub>					2.1	+	11.40	ne
Acrolein	Propenal	107-02-8	C <sub>3</sub> H <sub>4</sub> O	42	+	3.9	+	1.4	+	10.10	0.1
Acrylic acid	Propenoic Acid	79-10-7	C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>			12	+	2.0	+	10.60	2
Acrylonitrile	Propenenitrile	107-13-1	C <sub>3</sub> H <sub>3</sub> N			NR	+	1.2	+	10.91	2
Allyl alcohol		107-18-6	C <sub>3</sub> H <sub>6</sub> O	4.5	+	2.4	+	1.6	+	9.67	2
Allyl chloride	3-Chloropropene	107-05-1	C <sub>3</sub> H <sub>5</sub> Cl			4.3		0.7		9.9	1
Ammonia		7664-41-7	H <sub>3</sub> N	NR	+	9.7	+	5.7	+	10.16	25
Amyl acetate	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	11	+	2.3	+	0.95	+	<9.9	100
Amyl alcohol	1-Pentanol	75-85-4	C <sub>5</sub> H <sub>12</sub> O			5		1.6		10.00	ne
Aniline	Aminobenzene	62-53-3	C <sub>7</sub> H <sub>7</sub> N	0.50	+	0.48	+	0.47	+	7.72	2
Anisole	Methoxybenzene	100-66-3	C <sub>7</sub> H <sub>8</sub> O	0.89	+	0.58	+	0.56	+	8.21	ne
Arsine	Arsenic trihydride	7784-42-1	AsH <sub>3</sub>			1.9	+			9.89	0.05
Benzaldehyde		100-52-7	C <sub>7</sub> H <sub>6</sub> O					1		9.49	ne
Benzenamine, N-methyl-	N-Methylphenylamine	100-61-8	C <sub>7</sub> H <sub>9</sub> N			0.7				7.53	
Benzene		71-43-2	C <sub>6</sub> H <sub>6</sub>	0.55	+	0.53	+	0.6	+	9.25	0.5
Benzonitrile	Cyanobenzene	100-47-0	C <sub>7</sub> H <sub>5</sub> N			1.6				9.62	ne
Benzyl alcohol	α-Hydroxytoluene, Hydroxymethylbenzene, Benzenemethanol	100-51-6	C <sub>7</sub> H <sub>8</sub> O	1.4	+	1.1	+	0.9	+	8.26	ne
Benzyl chloride	α-Chlorotoluene, Chloromethylbenzene	100-44-7	C <sub>7</sub> H <sub>7</sub> Cl	0.7	+	0.6	+	0.5	+	9.14	1
Benzyl formate	Formic acid benzyl ester	104-57-4	C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	0.9	+	0.73	+	0.66	+		ne
Boron trifluoride		7637-07-2	BF <sub>3</sub>	NR		NR		NR		15.5	C1
Bromine		7726-95-6	Br <sub>2</sub>	NR	+	1.30	+	0.74	+	10.51	0.1
Bromobenzene		108-86-1	C <sub>6</sub> H <sub>5</sub> Br			0.6		0.5		8.98	ne
2-Bromoethyl methyl ether		6482-24-2	C <sub>3</sub> H <sub>7</sub> OBr			0.84	+			~10	ne
Bromoform	Tribromomethane	75-25-2	CHBr <sub>3</sub>	NR	+	2.5	+	0.5	+	10.48	0.5
Bromopropane, 1-	n-Propyl bromide	106-94-5	C <sub>3</sub> H <sub>7</sub> Br	150	+	1.5	+	0.6	+	10.18	ne
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C <sub>4</sub> H <sub>6</sub>	0.8		0.85	+	1.1		9.07	2
Butadiene diepoxide, 1,3-	1,2,3,4-Diepoxybutane	298-18-0	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	25	+	3.5	+	1.2		~10	ne
Butanal	1-Butanal	123-72-8	C <sub>4</sub> H <sub>8</sub> O			1.8				9.84	
Butane		106-97-8	C <sub>4</sub> H <sub>10</sub>			67	+	1.2		10.53	800
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	C <sub>4</sub> H <sub>10</sub> O	70	+	4.7	+	1.4	+	9.99	20
Butanol, t-	tert-Butanol, t-Butyl alcohol	75-65-0	C <sub>4</sub> H <sub>10</sub> O	6.9	+	2.9	+			9.90	100
Butene, 1-	1-Butylene	106-98-9	C <sub>4</sub> H <sub>8</sub>			0.9				9.58	ne
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1.8	+	1.2	+	0.6	+	<10	25
Butoxyethanol acetate	Ethanol, 2-(2-butoxyethoxy)-, acetate	124-17-4	C <sub>10</sub> H <sub>20</sub> O <sub>4</sub>			5.6				≤10.6	
Butoxyethoxyethanol	2-(2-Butoxyethoxy)ethanol	112-34-5	C <sub>8</sub> H <sub>18</sub> O <sub>3</sub>			4.6				≤10.6	
Butyl acetate, n-		123-86-4	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>			2.6	+			10	150
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>			1.6	+	0.6	+		10
Butylamine, n-		109-73-9	C <sub>4</sub> H <sub>11</sub> 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 <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	2.0	+	1.6	+			<10	1
Butyl mercaptan	1-Butanethiol	109-79-5	C <sub>4</sub> H <sub>10</sub> S	0.55	+	0.52	+			9.14	0.5
Carbon disulfide		75-15-0	CS <sub>2</sub>	4	+	1.2	+	0.44		10.07	10
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl <sub>4</sub>	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										



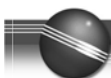


Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Chlorine		7782-50-5	Cl <sub>2</sub>					1.0	+	11.48	0.5
Chlorine dioxide		10049-04-4	ClO <sub>2</sub>	NR	+	NR	+	NR	+	10.57	0.1
Chlorobenzene	Monochlorobenzene	108-90-7	C <sub>6</sub> H <sub>5</sub> Cl	0.44	+	0.40	+	0.39	+	9.06	10
Chlorobenzotrifluoride, 4-	PCBTf, OXSOL 100	98-56-6	C <sub>7</sub> H <sub>4</sub> ClF <sub>3</sub>	0.74	+	0.63	+	0.55	+	<9.6	25
	p-Chlorobenzotrifluoride										
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C <sub>4</sub> H <sub>5</sub> Cl			3					10
Chloro-1,1-difluoroethane, 1-	HCFC-142B, R-142B	75-68-3	C <sub>2</sub> H <sub>3</sub> ClF <sub>2</sub>	NR		NR		NR		12.0	ne
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	CHClF <sub>2</sub>	NR		NR		NR		12.2	1000
Chloroethane	Ethyl chloride	75-00-3	C <sub>2</sub> H <sub>5</sub> Cl	NR	+	NR	+	1.1	+	10.97	100
Chloroethanol	Ethylene chlorhydrin	107-07-3	C <sub>2</sub> H <sub>5</sub> ClO					2.9		10.52	C1
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	8.6	+	3.0	+				5
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C <sub>3</sub> H <sub>7</sub> ClO			3					ne
Chloroform	Trichloromethane	67-66-3	CHCl <sub>3</sub>	NR	+	NR	+	3.5	+	11.37	10
Chloro-2-methylpropene, 3-	Methallyl chloride, Isobutenyl chloride	563-47-3	C <sub>4</sub> H <sub>7</sub> Cl	1.4	+	1.2	+	0.63	+	9.76	ne
Chloropicrin		76-06-2	CCl <sub>3</sub> NO <sub>2</sub>	NR	+	~400	+	7	+	?	0.1
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C <sub>7</sub> H <sub>7</sub> Cl			0.5		0.6		8.83	50
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C <sub>7</sub> H <sub>7</sub> Cl					0.6		8.69	ne
Chlorotrifluoroethene	CTFE, Chlorotrifluoroethylene	79-38-9	C <sub>2</sub> ClF <sub>3</sub>	6.7	+	3.9	+	1.2	+	9.76	5
	Genetron 1113										
Chlorotrimethylsilane		75-77-4	C <sub>3</sub> H <sub>9</sub> ClSi	NR		NR		0.82	+	10.83	ne
Cresol, m-	m-Hydroxytoluene	108-39-4	C <sub>7</sub> H <sub>8</sub> O	0.57	+	0.50	+	0.57	+	8.29	5
Cresol, o-	o-Hydroxytoluene	95-48-7	C <sub>7</sub> H <sub>8</sub> O			1.0				8.50	
Cresol, p-	p-Hydroxytoluene	106-44-5	C <sub>7</sub> H <sub>8</sub> O			1.4				8.35	
Crotonaldehyde	trans-2-Butenal	123-73-9	C <sub>4</sub> H <sub>6</sub> O	1.5	+	1.1	+	1.0	+	9.73	2
		4170-30-3									
Cumene	Isopropylbenzene	98-82-8	C <sub>9</sub> H <sub>12</sub>	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 <sub>6</sub> H <sub>12</sub>	3.3	+	1.4	+	0.64	+	9.86	300
Cyclohexanol	Cyclohexyl alcohol	108-93-0	C <sub>6</sub> H <sub>12</sub> O	1.5	+	0.9	+	1.1	+	9.75	50
Cyclohexanone		108-94-1	C <sub>6</sub> H <sub>10</sub> O	1.0	+	0.9	+	0.7	+	9.14	25
Cyclohexene		110-83-8	C <sub>6</sub> H <sub>10</sub>			0.8	+			8.95	300
Cyclohexylamine		108-91-8	C <sub>6</sub> H <sub>13</sub> N			1.2				8.62	10
Cyclopentane 85%		287-92-3	C <sub>5</sub> H <sub>10</sub>	NR	+	15	+	1.1		10.33	600
2,2-dimethylbutane 15%											
Cyclopropylamine	Aminocyclopropane	765-30-0	C <sub>3</sub> H <sub>7</sub> N	1.1	+	0.9	+	0.9	+		ne
Decamethylcyclopentasiloxane		541-02-6	C <sub>10</sub> H <sub>30</sub> O <sub>5</sub> Si <sub>5</sub>	0.16	+	0.13	+	0.12	+		ne
Decamethyltetrasiloxane		141-62-8	C <sub>10</sub> H <sub>30</sub> O <sub>3</sub> Si <sub>4</sub>	0.17	+	0.13	+	0.12	+	<10.2	ne
Decane		124-18-5	C <sub>10</sub> H <sub>22</sub>	4.0	+	1.4	+	0.35	+	9.65	ne
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	C <sub>6</sub> H <sub>12</sub> O <sub>2</sub>			0.7					50
Dibromochloromethane	Chlorodibromomethane	124-48-1	CHBr <sub>2</sub> Cl	NR	+	5.3	+	0.7	+	10.59	ne
Dibromo-3-chloropropane, 1,2-	DBCP	96-12-8	C <sub>3</sub> H <sub>5</sub> Br <sub>2</sub> Cl	NR	+	1.7	+	0.43	+		0.001
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	NR	+	1.7	+	0.6	+	10.37	ne
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	0.54	+	0.47	+	0.38	+	9.08	25
Dichlorodifluoromethane	CFC-12	75-71-8	CCl <sub>2</sub> F <sub>2</sub>			NR	+	NR	+	11.75	1000
Dichlorodimethylsilane		75-78-5	C <sub>2</sub> H <sub>6</sub> Cl <sub>2</sub> Si	NR		NR		1.1	+	>10.7	ne
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>			NR	+	0.6	+	11.04	10
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>			0.82	+	0.8	+	9.79	5
Dichloroethene, c-1,2-	c-1,2-DCE, cis-Dichloroethylene	156-59-2	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>			0.8				9.66	200
Dichloroethene, t-1,2-	t-1,2-DCE, trans-Dichloroethylene	156-60-5	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>			0.45	+	0.34	+	9.65	200
Dichloro-1-fluoroethane, 1,1-	R-141B	1717-00-6	C <sub>2</sub> H <sub>3</sub> Cl <sub>2</sub> F	NR	+	NR	+	2.0	+		ne
Dichloromethane	see Methylene chloride										





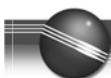
Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C IE (eV)	TWA
Dichloropentafluoropropane	AK-225, mix of ~45% 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca) & ~55% 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	442-56-0 507-55-1	C <sub>3</sub> HCl <sub>2</sub> F <sub>5</sub>	NR	+	NR	+	25	+	ne
Dichloropropane, 1,2-		78-87-5	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>					0.7	10.87	75
Dichloro-1-propene, 1,3-		542-75-6	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	1.3	+	0.96	+		<10	1
Dichloro-1-propene, 2,3-		78-88-6	C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub>	1.9	+	1.3	+	0.7	<10	ne
Dichloro-1,1,1-trifluoroethane, 2,2-	R-123	306-83-2	C <sub>2</sub> HCl <sub>2</sub> F <sub>3</sub>	NR	+	NR	+	10.1	+	11.5
Dichloro-2,4,6-trifluoropyridine, 3,5-	DCTFP	1737-93-5	C <sub>5</sub> Cl <sub>2</sub> F <sub>3</sub> N	1.1	+	0.9	+	0.8	+	ne
Dichlorvos *	Vapona; O,O-dimethyl O-dichlorovinyl phosphate	62-73-7	C <sub>4</sub> H <sub>7</sub> Cl <sub>2</sub> O <sub>4</sub> P			0.9	+		<9.4	0.1
Dicyclopentadiene	DCPD, Cyclopentadiene dimer	77-73-6	C <sub>10</sub> H <sub>12</sub>	0.57	+	0.48	+	0.43	+	8.8
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 <sub>4</sub> H <sub>11</sub> N			1	+		8.01	5
Diethylaminopropylamine, 3-		104-78-9	C <sub>7</sub> H <sub>18</sub> N <sub>2</sub>			1.3				ne
Diethylbenzene	See Dowtherm J									
Diethylmaleate		141-05-9	C <sub>8</sub> H <sub>12</sub> O <sub>4</sub>			4				ne
Diethyl sulfide	see Ethyl sulfide									
Diglyme	See Methoxyethyl ether	111-96-6	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>							
Diisobutyl ketone	DIBK, 2,2-dimethyl-4-heptanone	108-83-8	C <sub>9</sub> H <sub>18</sub> O	0.71	+	0.61	+	0.35	+	9.04
Diisopropylamine		108-18-9	C <sub>6</sub> H <sub>15</sub> N	0.84	+	0.74	+	0.5	+	7.73
Diketene	Ketene dimer	674-82-8	C <sub>4</sub> H <sub>4</sub> O <sub>2</sub>	2.6	+	2.0	+	1.4	+	9.6
Dimethylacetamide, N,N-	DMA	127-19-5	C <sub>4</sub> H <sub>9</sub> NO	0.87	+	0.8	+	0.8	+	8.81
Dimethylamine		124-40-3	C <sub>2</sub> H <sub>7</sub> N			1.5			8.23	5
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	NR	+	~70	+	1.7	+	~10.5
Dimethyl disulfide	DMDS	624-92-0	C <sub>2</sub> H <sub>6</sub> S <sub>2</sub>	0.2	+	0.20	+	0.21	+	7.4
Dimethyl ether	see Methyl ether									
Dimethylethylamine	DMEA	598-56-1	C <sub>4</sub> H <sub>11</sub> N	1.1	+	1.0	+	0.9	+	7.74
Dimethylformamide, N,N-	DMF	68-12-2	C <sub>3</sub> H <sub>7</sub> NO	0.7	+	0.7	+	0.8	+	9.13
Dimethylhydrazine, 1,1-	UDMH	57-14-7	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>			0.8	+	0.8	+	7.28
Dimethyl methylphosphonate	DMMP, methyl phosphonic acid dimethyl ester	756-79-6	C <sub>3</sub> H <sub>9</sub> O <sub>3</sub> P	NR	+	4.3	+	0.74	+	10.0
Dimethyl sulfate		77-78-1	C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	~23		~20	+	2.3	+	0.1
Dimethyl sulfide	see Methyl sulfide									
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C <sub>2</sub> H <sub>6</sub> OS			1.4	+		9.10	ne
Dioxane, 1,4-		123-91-1	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>			1.3			9.19	25
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	4.0	+	2.3	+	1.6	+	9.9
Dowtherm A see Therminol® *										
Dowtherm J (97% Diethylbenzene) *		25340-17-4	C <sub>10</sub> H <sub>14</sub>			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 <sub>2</sub> H <sub>5</sub> ClO	~200	+	8.5	+	1.4	+	10.2
Ethane		74-84-0	C <sub>2</sub> H <sub>6</sub>			NR	+	15	+	11.52
Ethanol	Ethyl alcohol	64-17-5	C <sub>2</sub> H <sub>6</sub> O			10	+	3.1	+	10.47
Ethanolamine *	MEA, Monoethanolamine	141-43-5	C <sub>2</sub> H <sub>7</sub> NO	5.6	+	1.6	+		8.96	3
Ethene	Ethylene	74-85-1	C <sub>2</sub> H <sub>4</sub>			9	+	4.5	+	10.51
Ethoxyethanol, 2-	Ethyl cellosolve	110-80-5	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>			1.3			9.6	5
Ethyl acetate		141-78-6	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>			4.6	+	3.5	10.01	400
Ethyl acetoacetate		141-97-9	C <sub>6</sub> H <sub>10</sub> O <sub>3</sub>	1.4	+	1.2	+	1.0	<10	ne
Ethyl acrylate		140-88-5	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>			2.4	+	1.0	<10.3	5
Ethylamine		75-04-7	C <sub>2</sub> H <sub>7</sub> N			0.8			8.86	5



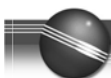
# Technical Note TN-106

Revised 08/2010

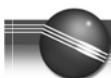
Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C IE (Ev)	TWA
Ethylbenzene		100-41-4	C <sub>8</sub> H <sub>10</sub>	0.52	+	0.52	+	0.51	+	8.77 100
Ethyl caprylate	Ethyl octanoate	106-32-1	C <sub>10</sub> H <sub>20</sub> O <sub>2</sub>		+	0.52	+	0.51	+	
Ethylenediamine	1,2-Ethanediamine; 1,2-Diaminoethane	107-15-3	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	0.9	+	0.8	+	1.0	+	8.6 10
Ethylene glycol *	1,2-Ethandiol	107-21-1	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>			16	+	6	+	10.16 C100
Ethylene glycol, Acrylate	2-hydroxyethyl Acrylate	818-61-1	C <sub>5</sub> H <sub>8</sub> O <sub>3</sub>			8.2				≤10.6
Ethylene glycol dimethyl ether	1,2-Dimethoxyethane, Monoglyme	110-71-4	C <sub>4</sub> H <sub>10</sub> O <sub>2</sub>	1.1		0.86		0.7		9.2 ne
Ethylene glycol monobutyl ether acetate	2-Butoxyethyl acetate	112-07-2	C <sub>8</sub> H <sub>16</sub> O <sub>3</sub>			1.3				≤10.6
Ethylene glycol, monothio	mercapto-2-ethanol	60-24-2	C <sub>2</sub> H <sub>6</sub> OS			1.5				9.65
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C <sub>2</sub> H <sub>4</sub> O			13	+	3.5	+	10.57 1
Ethyl ether	Diethyl ether	60-29-7	C <sub>4</sub> H <sub>10</sub> O			1.1	+	1.7		9.51 400
Ethyl 3-ethoxypropionate	EEP	763-69-9	C <sub>7</sub> H <sub>14</sub> O <sub>3</sub>	1.2	+	0.75	+			ne
Ethyl formate		109-94-4	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>					1.9		10.61 100
Ethylhexyl □acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	C <sub>11</sub> H <sub>20</sub> O <sub>2</sub>			1.1	+	0.5	+	ne
Ethylhexanol	2-Ethyl-1-hexanol	104-76-7	C <sub>8</sub> H <sub>18</sub> O			1.9				≤10.6
Ethylidenenorbornene	5-Ethylidene bicyclo(2,2,1)hept-2-ene	16219-75-3	C <sub>9</sub> H <sub>12</sub>	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 <sub>5</sub> H <sub>10</sub> O <sub>3</sub>	13	+	3.2	+	1.6	+	~10 ne
Ethyl mercaptan	Ethanethiol	75-08-1	C <sub>2</sub> H <sub>6</sub> S	0.60	+	0.56	+			9.29 0.5
Ethyl sulfide	Diethyl sulfide	352-93-2	C <sub>4</sub> H <sub>10</sub> S			0.5	+			8.43 ne
Formaldehyde	Formalin	50-00-0	CH <sub>2</sub> O	NR	+	NR	+	1.6	+	10.87 C0.3
Formamide		75-12-7	CH <sub>3</sub> NO			6.9	+	4		10.16 10
Formic acid		64-18-6	CH <sub>2</sub> O <sub>2</sub>	NR	+	NR	+	9	+	11.33 5
Furfural	2-Furaldehyde	98-01-1	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>			0.92	+	0.8	+	9.21 2
Furfuryl alcohol		98-00-0	C <sub>5</sub> H <sub>6</sub> O <sub>2</sub>			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 <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	1.1	+	0.8	+	0.6	+	C0.05
Glycidyl methacrylate	2,3-Epoxypropyl methacrylate	106-91-2	C <sub>7</sub> H <sub>10</sub> O <sub>3</sub>	2.6	+	1.2	+	0.9	+	0.5
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	C <sub>2</sub> HBrClF <sub>3</sub>					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 <sub>7</sub> H <sub>16</sub>	45	+	2.8	+	0.60	+	9.92 400
Heptanol, 4-	Dipropylcarbinol	589-55-9	C <sub>7</sub> H <sub>16</sub> O	1.8	+	1.3	+	0.5	+	9.61 ne
Hexamethyldisilazane, 1,1,1,3,3,3- *	HMDS	999-97-3	C <sub>6</sub> H <sub>19</sub> NSi <sub>2</sub>			0.2	+	0.2	+	~8.6 ne
Hexamethyldisiloxane	HMDSx	107-46-0	C <sub>6</sub> H <sub>18</sub> OSi <sub>2</sub>	0.33	+	0.27	+	0.25	+	9.64 ne
Hexane, n-		110-54-3	C <sub>6</sub> H <sub>14</sub>	350	+	4.3	+	0.54	+	10.13 50
Hexanol, 1-	Hexyl alcohol	111-27-3	C <sub>6</sub> H <sub>14</sub> O	9	+	2.5	+	0.55	+	9.89 ne
Hexene, 1-		592-41-6	C <sub>6</sub> H <sub>12</sub>			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 <sub>4</sub> N <sub>2</sub>	>8	+	2.6	+	2.1	+	8.1 0.01
Hydrazoic acid	Hydrogen azide		HN <sub>3</sub>							10.7
Hydrogen	Synthesis gas	1333-74-0	H <sub>2</sub>	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 <sub>2</sub> O <sub>2</sub>	NR	+	NR	+	NR	+	10.54 1
Hydrogen sulfide		7783-06-4	H <sub>2</sub> S	NR	+	3.3	+	1.5	+	10.45 10
Hydroxypropyl methacrylate		27813-02-1	C <sub>7</sub> H <sub>12</sub> O <sub>3</sub>	9.9	+	2.3	+	1.1	+	ne
		923-26-2								
Iodine *		7553-56-2	I <sub>2</sub>	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 <sub>3</sub> I	0.21	+	0.22	+	0.26	+	9.54	2
Isoamyl acetate	Isopentyl acetate	123-92-2	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>	10.1		2.1		1.0		<10	100
Isobutane	2-Methylpropane	75-28-5	C <sub>4</sub> H <sub>10</sub>			100	+	1.2	+	10.57	ne
Isobutanol	2-Methyl-1-propanol	78-83-1	C <sub>4</sub> H <sub>10</sub> O	19	+	3.8	+	1.5		10.02	50
Isobutene	Isobutylene, Methyl butene	115-11-7	C <sub>4</sub> H <sub>8</sub>	1.00	+	1.00	+	1.00	+	9.24	Ne
Isobutyl acrylate	Isobutyl 2-propenoate	106-63-8	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>			1.5	+	0.60	+		Ne
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether, forane	26675-46-7	C <sub>3</sub> H <sub>2</sub> ClF <sub>5</sub> O	NR	+	NR	+	48	+	~11.7	Ne
Isooctane	2,2,4-Trimethylpentane	540-84-1	C <sub>8</sub> H <sub>18</sub>			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 <sub>5</sub> H <sub>12</sub>			8.2					Ne
Isophorone		78-59-1	C <sub>9</sub> H <sub>14</sub> O					3		9.07	C5
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C <sub>5</sub> H <sub>8</sub>	0.69	+	0.63	+	0.60	+	8.85	Ne
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C <sub>3</sub> H <sub>8</sub> O	500	+	6.0	+	2.7		10.12	200
Isopropyl acetate		108-21-4	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>			2.6				9.99	100
Isopropyl ether	Diisopropyl ether	108-20-3	C <sub>6</sub> H <sub>14</sub> O			0.8				9.20	250
Jet fuel JP-4	Jet B, Turbo B, F-40	8008-20-6 +	m.w. 115			1.0	+	0.4	+		Ne
	Wide cut type aviation fuel	64741-42-0									
Jet fuel JP-5	Jet 5, F-44, Kerosene type aviation fuel	8008-20-6 +	m.w. 167			0.6	+	0.5	+		29
		64747-77-1									
Jet fuel JP-8	Jet A-1, F-34, Kerosene type aviation fuel	8008-20-6 +	m.w. 165			0.6	+	0.3	+		30
		64741-77-1									
Jet fuel A-1 (JP-8)	F-34, Kerosene type aviation fuel	8008-20-6 +	m.w. 145			0.67					34
		64741-77-1									
Jet Fuel TS	Thermally Stable Jet Fuel, Hydrotreated kerosene fuel	8008-20-6 +	m.w. 165	0.9	+	0.6	+	0.3	+		30
		64742-47-8									
Limonene, D-	(R)-(+)-Limonene	5989-27-5	C <sub>10</sub> H <sub>16</sub>			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 <sub>4</sub> H <sub>2</sub> O <sub>3</sub>							~10.8	0.1
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C <sub>9</sub> H <sub>12</sub>	0.36	+	0.35	+	0.3	+	8.41	25
Methallyl chloride – see 3-Chloro-2-methylpropene											
Methane	Natural gas	74-82-8	CH <sub>4</sub>	NR	+	NR	+	NR	+	12.61	Ne
Methanol	Methyl alcohol, carbinol	67-56-1	CH <sub>4</sub> O	NR	+	NR	+	2.5	+	10.85	200
Methoxyethanol, 2-	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	4.8	+	2.4	+	1.4	+	10.1	5
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy)ethanol	111-77-3	C <sub>7</sub> H <sub>16</sub> O	2.3	+	1.2	+	0.9	+	<10	Ne
	Diethylene glycol monomethyl ether										
Methoxyethyl ether, 2-	bis(2-Methoxyethyl) ether, Diethylene glycol dimethyl ether, Diglyme	111-96-6	C <sub>6</sub> H <sub>14</sub> O <sub>3</sub>	0.64	+	0.54	+	0.44	+	<9.8	Ne
Methyl acetate		79-20-9	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	NR	+	6.6	+	1.4	+	10.27	200
Methyl acrylate	Methyl 2-propenoate, Acrylic acid methyl ester	96-33-3	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>			3.7	+	1.2	+	(9.9)	2
Methylamine	Aminomethane	74-89-5	CH <sub>5</sub> N			1.2				8.97	5
Methyl amyl ketone	MAK, 2-Heptanone, Methyl pentyl ketone	110-43-0	C <sub>7</sub> H <sub>14</sub> O	0.9	+	0.85	+	0.5	+	9.30	50
Methyl bromide	Bromomethane	74-83-9	CH <sub>3</sub> Br	110	+	1.7	+	1.3	+	10.54	1
Methyl t-butyl ether	MTBE, <i>tert</i> -Butyl methyl ether	1634-04-4	C <sub>5</sub> H <sub>12</sub> O			0.9	+			9.24	40
Methyl cellosolve	see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH <sub>3</sub> Cl	NR	+	NR	+	0.74	+	11.22	50
Methylcyclohexane		107-87-2	C <sub>7</sub> H <sub>14</sub>	1.6	+	0.97	+	0.53	+	9.64	400
Methylene bis(phenylisocyanate), 4,4'- *	MDI, Mondur M		C <sub>15</sub> H <sub>10</sub> N <sub>2</sub> O <sub>2</sub>							Very slow ppb level response	0.005

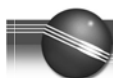


Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Methylene chloride	Dichloromethane	75-09-2	CH <sub>2</sub> Cl <sub>2</sub>	NR	+	NR	+	0.89	+	11.32	25
Methyl ether	Dimethyl ether	115-10-6	C <sub>2</sub> H <sub>6</sub> O	4.8	+	3.1	+	2.5	+	10.03	Ne
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3	C <sub>4</sub> H <sub>8</sub> O	0.86	+	0.9	+	1.1	+	9.51	200
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	C <sub>2</sub> H <sub>6</sub> N <sub>2</sub>	1.4	+	1.2	+	1.3	+	7.7	0.01
Methyl isoamyl ketone	MIAC, 5-Methyl-2-hexanone	110-12-3	C <sub>7</sub> H <sub>14</sub> O	0.8	+	0.76	+	0.5	+	9.28	50
Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	C <sub>6</sub> H <sub>12</sub> O	0.9	+	0.8	+	0.6	+	9.30	50
Methyl isocyanate	CH <sub>3</sub> NCO	624-83-9	C <sub>2</sub> H <sub>3</sub> NO	NR	+	4.6	+	1.5		10.67	0.02
Methyl isothiocyanate	CH <sub>3</sub> NCS	551-61-6	C <sub>2</sub> H <sub>3</sub> NS	0.5	+	0.45	+	0.4	+	9.25	ne
Methyl mercaptan	Methanethiol	74-93-1	CH <sub>4</sub> S	0.65		0.54		0.66		9.44	0.5
Methyl methacrylate		80-62-6	C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	2.7	+	1.5	+	1.2	+	9.7	100
Methyl nonafluorobutyl ether	HFE-7100DL	163702-08-7, 163702-07-6	C <sub>5</sub> H <sub>3</sub> F <sub>9</sub> O			NR	+	~35	+		ne
Methyl-1,5-pentanediamine, 2-(coats lamp) *	Dytek-A amine, 2-Methyl pentamethylenediamine	15520-10-2	C <sub>6</sub> H <sub>16</sub> N <sub>2</sub>			~0.6	+			<9.0	ne
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	C <sub>5</sub> H <sub>12</sub> 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 <sub>5</sub> H <sub>9</sub> NO	1.0	+	0.8	+	0.9	+	9.17	ne
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	1.3	+	0.9	+	0.9	+	~9	ne
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C <sub>9</sub> H <sub>10</sub>			0.5				8.18	50
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C <sub>2</sub> H <sub>6</sub> S	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 <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> S			0.6					0.0005
Naphtha - see VM & P Naptha											
Naphthalene	Mothballs	91-20-3	C <sub>10</sub> H <sub>8</sub>	0.45	+	0.42	+	0.40	+	8.13	10
Nickel carbonyl (in CO)	Nickel tetracarbonyl	13463-39-3	C <sub>4</sub> NiO <sub>4</sub>			0.18				<8.8	0.001
Nicotine		54-11-5	C <sub>10</sub> H <sub>14</sub> N <sub>2</sub>			2.0				≤10.6	
Nitric oxide		10102-43-9	NO	~6		5.2	+	2.8	+	9.26	25
Nitrobenzene		98-95-3	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	2.6	+	1.9	+	1.6	+	9.81	1
Nitroethane		79-24-3	C <sub>2</sub> H <sub>5</sub> NO <sub>2</sub>					3		10.88	100
Nitrogen dioxide		10102-44-0	NO <sub>2</sub>	23	+	16	+	6	+	9.75	3
Nitrogen trifluoride		7783-54-2	NF <sub>3</sub>	NR		NR		NR		13.0	10
Nitromethane		75-52-5	CH <sub>3</sub> NO <sub>2</sub>					4		11.02	20
Nitropropane, 2-		79-46-9	C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>					2.6		10.71	10
Nonane		111-84-2	C <sub>9</sub> H <sub>20</sub>			1.4				9.72	200
Norpar 12	n-Paraffins, mostly C <sub>10</sub> -C <sub>13</sub>	64771-72-8	m.w. 161	3.2	+	1.1	+	0.28	+		ne
Norpar 13	n-Paraffins, mostly C <sub>13</sub> -C <sub>14</sub>	64771-72-8	m.w. 189	2.7	+	1.0	+	0.3	+		ne
Octamethylcyclotetrasiloxane		556-67-2	C <sub>8</sub> H <sub>24</sub> O <sub>4</sub> Si <sub>4</sub>	0.21	+	0.17	+	0.14	+		ne
Octamethyltrisiloxane		107-51-7	C <sub>8</sub> H <sub>24</sub> O <sub>2</sub> Si <sub>3</sub>	0.23	+	0.18	+	0.17	+	<10.0	ne
Octane, n-		111-65-9	C <sub>8</sub> H <sub>18</sub>	13	+	1.8	+			9.82	300
Octene, 1-		111-66-0	C <sub>8</sub> H <sub>16</sub>	0.9	+	0.75	+	0.4	+	9.43	75
Pentane		109-66-0	C <sub>5</sub> H <sub>12</sub>	80	+	8.4	+	0.7	+	10.35	600
Peracetic acid *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	NR	+	NR	+	2.3	+		ne
Peracetic/Acetic acid mix *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>			50	+	2.5	+		ne
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C <sub>2</sub> Cl <sub>4</sub>	0.69	+	0.57	+	0.31	+	9.32	25
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	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 <sub>6</sub> H <sub>12</sub> O <sub>3</sub>	1.65	+	1.0	+	0.8	+		ne
Phenol	Hydroxybenzene	108-95-2	C <sub>6</sub> H <sub>6</sub> O	1.0	+	1.0	+	0.9	+	8.51	5
Phosgene	Dichlorocarbonyl	75-44-5	CCl <sub>2</sub> O	NR	+	NR	+	8.5	+	11.2	0.1
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl <sub>2</sub> O	NR	+	NR	+	6.8	+	11.2	0.1
Phosphine (coats lamp)		7803-51-2	PH <sub>3</sub>	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 <sub>6</sub> H <sub>7</sub> N			0.9				9.04	ne
Pinene, α-		2437-95-8	C <sub>10</sub> H <sub>16</sub>			0.31	+	0.47		8.07	ne
Pinene, β-		18172-67-3	C <sub>10</sub> H <sub>16</sub>	0.38	+	0.37	+	0.37	+	~8	100
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C <sub>5</sub> H <sub>8</sub>	0.76	+	0.69	+	0.64	+	8.6	100
Propane		74-98-6	C <sub>3</sub> H <sub>8</sub>			NR	+	1.8	+	10.95	2500
Propanol, n-	Propyl alcohol	71-23-8	C <sub>3</sub> H <sub>8</sub> O			5		1.7		10.22	200
Propene	Propylene	115-07-1	C <sub>3</sub> H <sub>6</sub>	1.5	+	1.4	+	1.6	+	9.73	ne
Propionaldehyde	Propanal	123-38-6	C <sub>3</sub> H <sub>6</sub> O			1.9				9.95	ne
Propyl acetate, n-		109-60-4	C <sub>5</sub> H <sub>10</sub> O <sub>2</sub>			3.5		2.3		10.04	200
Propylamine, n-	1-Propylamine, 1-Aminopropane	107-10-8	C <sub>3</sub> H <sub>9</sub> N	1.1	+	1.1	+	0.9	+	8.78	ne
Propylene carbonate *		108-32-7	C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>			62	+	1	+	10.5	ne
Propylene glycol	1,2-Propanediol	57-55-6	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	18		5.5	+	1.6	+	<10.2	ne
Propylene glycol propyl ether	1-Propoxy-2-propanol	1569-01-3	C <sub>6</sub> H <sub>14</sub> O <sub>2</sub>	1.3	+	1.0	+	1.6	+		ne
Propylene oxide	Methyloxirane	75-56-9	C <sub>3</sub> H <sub>6</sub> O	~240		6.6	+	2.9	+	10.22	20
		16088-62-3									
		15448-47-2									
Propyleneimine	2-Methylaziridine	75-55-8	C <sub>3</sub> H <sub>7</sub> N	1.5	+	1.3	+	1.0	+	9.0	2
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl mercaptan	75-33-2	C <sub>3</sub> H <sub>8</sub> S	0.64	+	0.66	+			9.15	ne
Pyridine		110-86-1	C <sub>5</sub> H <sub>5</sub> N	0.78	+	0.7	+	0.7	+	9.25	5
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C <sub>4</sub> H <sub>9</sub> N	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 <sub>4</sub> H <sub>10</sub> O <sub>2</sub> / C <sub>6</sub> H <sub>12</sub> O <sub>3</sub>			1.4	+	1.0	+		ne
Sarin	GB, Isopropyl methylphosphonofluoridate	107-44-8	C <sub>4</sub> H <sub>10</sub> FO <sub>2</sub> P			~3					
		50642-23-4									
Stoddard Solvent - see Mineral Spirits		8020-83-5									
Styrene		100-42-5	C <sub>8</sub> H <sub>8</sub>	0.45	+	0.40	+	0.4	+	8.43	20
Sulfur dioxide		7446-09-5	SO <sub>2</sub>	NR		NR	+	NR	+	12.32	2
Sulfur hexafluoride		2551-62-4	SF <sub>6</sub>	NR		NR		NR		15.3	1000
Sulfuryl fluoride	Vikane	2699-79-8	SO <sub>2</sub> F <sub>2</sub>	NR		NR		NR		13.0	5
Tabun *	Ethyl N, N-dimethylphosphoramidocyanidate	77-81-6	C <sub>5</sub> H <sub>11</sub> N <sub>2</sub> O <sub>2</sub> P			0.8					15ppt
Tetrachloroethane, 1,1,1,2-		630-20-6	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>					1.3		~11.1	ne
Tetrachloroethane, 1,1,1,2-		79-34-5	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	NR	+	NR	+	0.60	+	~11.1	1
Tetrachlorosilane		10023-04-7	SiCl <sub>4</sub>	NR		NR		15	+	11.79	ne
Tetraethyl lead	TEL	78-00-2	C <sub>8</sub> H <sub>20</sub> Pb	0.4		0.3		0.2		~11.1	0.008
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	C <sub>8</sub> H <sub>20</sub> O <sub>4</sub> Si			0.7	+	0.2	+	~9.8	10
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>			NR		NR			ne
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C <sub>2</sub> F <sub>4</sub>			~15				10.12	ne
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF <sub>4</sub>			NR	+	NR	+	>15.3	ne
Tetrahydrofuran	THF	109-99-9	C <sub>4</sub> H <sub>8</sub> O	1.9	+	1.7	+	1.0	+	9.41	200
Tetramethyl orthosilicate	Methyl silicate, TMOS	681-84-5	C <sub>4</sub> H <sub>12</sub> O <sub>4</sub> Si	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	C <sub>12</sub> H <sub>10</sub> O			0.4	+				1
		92-52-4	C <sub>12</sub> H <sub>10</sub>								
Toluene	Methylbenzene	108-88-3	C <sub>7</sub> H <sub>8</sub>	0.54	+	0.50	+	0.51	+	8.82	50



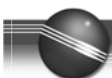


Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Tolylene-2,4-diisocyanate	TDI, 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	C <sub>9</sub> H <sub>6</sub> N <sub>2</sub> O <sub>2</sub>	1.4	+	1.4	+	2.0	+		0.002
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	0.7	+	0.46	+			9.04	C5
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>			NR	+	1	+	11	350
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	NR	+	NR	+	0.9	+	11.0	10
Trichloroethene	TCE, Trichloroethylene	79-01-6	C <sub>2</sub> HCl <sub>3</sub>	0.62	+	0.54	+	0.43	+	9.47	50
Trichloromethylsilane	Methyltrichlorosilane	75-79-6	CH <sub>3</sub> Cl <sub>3</sub> Si	NR		NR		1.8	+	11.36	ne
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	C <sub>2</sub> Cl <sub>3</sub> F <sub>3</sub>			NR		NR		11.99	1000
Triethylamine	TEA	121-44-8	C <sub>6</sub> H <sub>15</sub> N	0.95	+	0.9	+	0.65	+	7.3	1
Triethyl borate	TEB; Boric acid triethyl ester	150-46-9	C <sub>6</sub> H <sub>15</sub> O <sub>3</sub> B			2.2	+	1.1	+	~10	ne
Triethyl phosphate	Ethyl phosphate	78-40-0	C <sub>6</sub> H <sub>15</sub> O <sub>4</sub> P	~50	+	3.1	+	0.60	+	9.79	ne
Trifluoroethane, 1,1,2-		430-66-0	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>					34		12.9	ne
Trimethylamine		75-50-3	C <sub>3</sub> H <sub>9</sub> N			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 <sub>3</sub> H <sub>9</sub> O <sub>3</sub> B			5.1	+	1.2	+	10.1	ne
Trimethyl phosphate	Methyl phosphate	512-56-1	C <sub>3</sub> H <sub>9</sub> O <sub>4</sub> P			8.0	+	1.3	+	9.99	ne
Trimethyl phosphite	Methyl phosphite	121-45-9	C <sub>3</sub> H <sub>9</sub> O <sub>3</sub> P			1.1	+		+	8.5	2
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	C <sub>10</sub> H <sub>16</sub>	0.37	+	0.30	+	0.29	+	~8	20
Undecane		1120-21-4	C <sub>11</sub> H <sub>24</sub>			2				9.56	ne
Varsol – see Mineral Spirits											
Vinyl acetate		108-05-4	C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	1.5	+	1.2	+	1.0	+	9.19	10
Vinyl bromide	Bromoethylene	593-60-2	C <sub>2</sub> H <sub>3</sub> Br			0.4				9.80	5
Vinyl chloride	Chloroethylene, VCM	75-01-4	C <sub>2</sub> H <sub>3</sub> Cl			2.0	+	0.6	+	9.99	5
Vinyl-1-cyclohexene, 4-	Butadiene dimer, 4-Ethenylcyclohexene	100-40-3	C <sub>8</sub> H <sub>12</sub>	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 <sub>6</sub> H <sub>9</sub> NO	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 naphtha	64742-89-8	m.w. 111 (C <sub>8</sub> -C <sub>9</sub> )	1.7	+	0.97	+				300
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C <sub>8</sub> H <sub>10</sub>	0.50	+	0.44	+	0.40	+	8.56	100
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C <sub>8</sub> H <sub>10</sub>	0.56	+	0.46	+	0.43		8.56	100
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C <sub>8</sub> H <sub>10</sub>	0.48	+	0.39	+	0.38	+	8.44	100
None				1		1		1			
Undetectable				1E+6		1E+6		1E+6			

\* Compounds indicated in green can be detected using a MiniRAE 2000 or ppbRAE/+ with slow response, but may be lost by adsorption on a MultiRAE or EntryRAE. Response on multi-gas meters can give an indication of relative concentrations, but may not be quantitative and for some chemicals no response is observed.

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**Appendix I:****Example of Automatic Calculation of Correction Factors, TLVs and Alarm Limits for Mixtures**

(Calculations performed using Excel version of this database, available on request)

Compound	CF 9.8 eV	CF 10.6 eV	CF 11.7eV	Mol. Frac	Conc ppm	TLV ppm	STEL Ppm
Benzene	0.55	0.53	0.6	0.01	1	0.5	2.5
Toluene	0.54	0.5	0.51	0.06	10	50	150
Hexane, n-	300	4.3	0.54	0.06	10	50	150
Heptane, n-	45	2.8	0.6	0.28	50	400	500
Styrene	0.45	0.4	0.42	0.06	10	20	40
Acetone	1.2	1.1	1.4	0.28	50	750	1000
Isopropanol	500	6	2.7	0.28	50	400	500
None	1	1	1	0.00	0	1	
Mixture Value:	2.1	1.5	0.89	1.00	181	56	172
TLV Alarm Setpoint when Calibrated to Isobutylene:	26 ppm	37 ppm	62 ppm		ppm	ppm	ppm
STEL Alarm Setpoint, same Calibration	86 ppm	115 ppm	193 ppm				

# FIELD OPERATING PROCEDURES

## Calibration and Maintenance of Portable Specific Conductance Meter

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## FOP 012.0

### CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

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#### 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  $\pm 1$  percent of full-scale, with repeatability of  $\pm 1$  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.

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## FOP 012.0

### CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

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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

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## FOP 012.0

### CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

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- 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.

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## FOP 012.0

### CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

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**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)



# FOP 012.0

## CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER



### 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	SETTLE
<input type="checkbox"/> pH meter	units		Myron L. Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
						< 0.4		
<input type="checkbox"/> Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		20		
						100		
						800		
<input type="checkbox"/> Sp. conductance meter	uS/mS		Myron L. Company Ultra Meter 6P	606987		uS @ 25 °C		
<input type="checkbox"/> PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						ppm Iso. Gas		factor :
<input type="checkbox"/> Particulate meter	mg/m <sup>3</sup>					zero air		
<input type="checkbox"/> Oxygen	%					open air		
<input type="checkbox"/> Hydrogen sulfide	ppm					open air		
<input type="checkbox"/> Carbon monoxide	ppm					open air		
<input type="checkbox"/> LEL	%					open air		
<input type="checkbox"/> Radiation Meter	uR/h					background area		
<input type="checkbox"/>								

#### ADDITIONAL REMARKS:

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_

FIELD OPERATING PROCEDURES

Composite Sample  
Collection Procedure  
for Non-VOC Analysis

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## FOP 013.0

### COMPOSITE SAMPLE COLLECTION PROCEDURE FOR NON-VOLATILE ORGANIC ANALYSIS

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#### 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.

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## FOP 013.0

### COMPOSITE SAMPLE COLLECTION PROCEDURE FOR NON-VOLATILE ORGANIC ANALYSIS

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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

Benchmark FOPs:

- 040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*  
046 *Sample Labeling, Storage and Shipment*

## COMPOSITE SAMPLE COLLECTION PROCEDURE FOR NON-VOLATILE ORGANIC ANALYSIS



**BENCHMARK**  
ENVIRONMENTAL  
ENGINEERING &  
SCIENCE, PLLC

# FIELD OPERATING PROCEDURES

## Documentation Requirements for Drilling and Well Installation



**DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL  
INSTALLATION**

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**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.

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## FOP 015.0

### DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

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- 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.

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## FOP 015.0

### DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

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- 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.

**DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL  
INSTALLATION**

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- 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.

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## FOP 015.0

### DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

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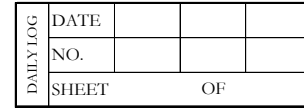
#### ***Other Project Field Forms***

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)

## DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

[illegible]

**BENCHMARK**  
ENVIRONMENTAL  
ENGINEERING &  
SCIENCE, PLLC



## DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION



## FIELD BOREHOLE LOG

[illegible]



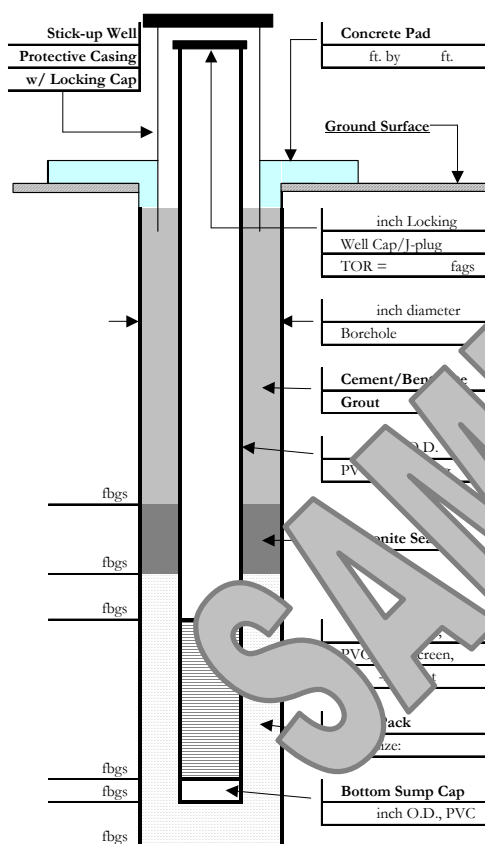
## FOP 015.0

# DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION



### 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 Location:	fmsl (approximate)
Drilling Method:	
Soil Sample Collection Method:	
Filtering Fluid:	
Filtering Fluid During Drilling:	gallons (approximate)

Well Construction	
Casing:	
Screen:	
Grout:	
Seal:	
Cap:	

Well Development	
Purpose:	
Technique(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	ftTOR
Pump Depth:	
Purge Duration:	minutes
Yield:	gpm
Specific Capacity:	gpm/ft

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

PREPARED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

## DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION



The diagram illustrates a cross-section of a well assembly. Key components and dimensions are labeled as follows:

- Flush Mount**: The top section of the well casing.
- Concrete Pad**: The base of the well assembly.
- Ground Surface**: The level of the ground.
- inch Locking**: The locking mechanism for the well cap.
- Well Cap/J-plug**: The cap at the top of the well casing.
- TOR = fbg**: The top of the casing, marked by a flange.
- inch diameter Borehole**: The diameter of the hole drilled into the ground.
- Cement/Ber Grout**: The material used to seal the annular space around the casing.
- PVC**: The material of the well casing.
- ite Seal**: The seal at the bottom of the casing.
- fbg**: Flange or flange gasket, indicating the location of several flanges along the casing.
- Back**: The back of the casing.
- Size:**: The size of the casing.
- Bottom Sump Cap**: The cap at the bottom of the well casing.
- inch O.D., PVC**: The outer diameter and material of the bottom sump cap.

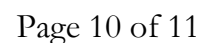
Company:
Driller:
Helper:
Permit Number:
Drill Rig Type:

Land Surface Elevation:	fmsl (approximate)
Drilling Method:	
Soil Sample Collection Method:	
Fluid:	
Fluid Volume During Drilling:	gallons (approximate)

Back: \_\_\_\_\_  
 An Seal: \_\_\_\_\_

Well purpose:	
Technique(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	ftTOR
Pump Depth:	
Purge Duration:	minutes
Yield:	gpm
Specific Capacity:	gpm/ft

PREAPRED BY: \_\_\_\_\_ DATE: \_\_\_\_\_



# FOP 015.0

## DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION



### 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, etc.

ITEM OR SERVICE	LOCATION	TOTALS
Starting depth (fbgs)		--
Ending depth (fbgs)		--
Total footage drilled (feet)		--
Drilling Method (HSA, air, 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/bentonite grout		
<input type="checkbox"/> Protective casing <input type="checkbox"/> Flushmount road box		
Lockable J-plug		
Lock		

PERSONNEL TIME LOG:

POSITION	NAME	HOURS
Observer		
Drillers		

DRILLER (optional):	BM REP.
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# FIELD OPERATING PROCEDURES

## Drill Site Selection Procedure



**DRILL SITE SELECTION PROCEDURE**

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**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

FIELD OPERATING PROCEDURES

Drilling and Excavation  
Equipment  
Decontamination  
Procedures

**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.

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## FOP 018.0

### DRILLING AND EXCAVATION EQUIPMENT DECONTAMINATION PROCEDURES

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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

# FIELD OPERATING PROCEDURES

## Establishing Horizontal and Vertical Control

**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.



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## FOP 021.0

### ESTABLISHING HORIZONTAL AND VERTICAL CONTROL

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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.

# FIELD OPERATING PROCEDURES

## Groundwater Level Measurement

**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.

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## FOP 022.0

### GROUNDWATER LEVEL MEASUREMENT

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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*

## GROUNDWATER LEVEL MEASUREMENT



Client:

Location:

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Date:

Weather:

PREAPRED BY:

DATE:



FIELD OPERATING PROCEDURES

# Groundwater Purging Procedures Prior to Sample Collection



**GROUNDWATER PURGING PROCEDURES PRIOR  
TO SAMPLE COLLECTION**

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**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

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## FOP 023.1

### GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

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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,

**GROUNDWATER PURGING PROCEDURES PRIOR  
TO SAMPLE COLLECTION**

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A = Total Depth of Well (feet below measuring point)

B = Casing diameter (inches)

C = Static Water Level (feet below measuring point)

9. **For wells where the water level is 20 feet or less below the top of riser**, a peristaltic pump may be used to purge the well. Measure the purged volume using a calibrated container (i.e., graduated 5-gallon bucket) and record measurements on the attached Groundwater Well Development and Purge Log. Use new and dedicated tubing for each well. During the evacuation of shallow wells, the intake opening of the pump tubing should be positioned just below the surface of the water. As the water level drops, lower the tubing as needed to maintain flow. For higher yielding wells, the intake level should not be lowered past the top of the screen. Pumping from the top of the water column will ensure proper flushing of the well. Continue pumping until the required volumes are removed (typically three well volumes). For higher yielding wells, adjust the purging rate to maintain the water level above the screen. For lower yielding wells or wells where the screen straddles the water table, maintain purging at a rate that matches the rate of recovery of the well (well yield). If the well purges to dryness and is slow to recharge (greater than 15 minutes), terminate evacuation. **A peristaltic pump and dedicated tubing cannot be used to collect VOC or SVOC project-required samples; only non-organic compounds may be collected using this type of pump.**
10. **For wells where the water level is initially below 20 feet**, or drawn down to this level because of slow recharge rate, conduct purging using one of three devices listed below:
- Bailer – A bottom filling dedicated polyethylene bailer attached to a length of dedicated hollow-braid polypropylene rope. Purging a well utilizing a bailer should be conducted smoothly and slowly as not to agitate the groundwater or damage the well.
  - Well Wizard Purge Pump (or similar) – This pneumatic bladder pump uses compressed air to push water to the surface. Groundwater is not in contact

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## FOP 023.1

### GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

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with the drive air during the pumping process, therefore the pump may be used for sample collection.

- Submersible Pump (12 or 24 volt, or similar) – These submersible pumps are constructed of PVC or stainless steel and are capable of pumping up to 70 feet from ground surface using a 12 volt battery (standard pump) and standard low flow controller. For depths up to 200 feet from ground surface, a high performance power booster controller is used with a 12 volt battery. Unless these pumps are dedicated to the monitoring well location, decontamination between locations is necessary and an equipment blank may be required.
- Waterra™ Pump – This manually operated pump uses dedicated polyethylene tubing and a check valve that can be used as an optional method for purging deeper wells. The pump utilizes positive pressure to evacuate the well, therefore the pump may be used for sample collection, and however over-agitation groundwater should be avoided.

Prior to use in a well, non-dedicated bailers, exterior pump bodies and pump tubing should be cleaned in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Dedicated and/or disposable equipment should be contained within the sealed original manufacturers packaging and certified pre-cleaned by the manufacturer with a non-phosphate laboratory detergent and rinsed using de-ionized water.

8. Purging will continue until a predetermined volume of water has been removed (typically three well volumes) or to dryness. Measurements for pH, temperature, specific conductance, dissolved oxygen (optional), Eh (optional), and turbidity will be recorded following removal of each well volume. Purge the well to dryness or until the readings for indicator parameters listed above (or well-specific indicator parameters) stabilize within the following limits for each parameter measured:

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## FOP 023.1

### GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

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Field Parameter	Stabilization Criteria
Dissolved Oxygen	$\pm 0.3$ mg/L
Turbidity	$\pm 10$ %
Specific Conductance	$\pm 3$ %
Eh	$\pm 10$ mV
PH	$\pm 0.1$ 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.

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## FOP 023.1

### GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

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#### 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*



## FOP 023.1

# GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION



## GROUNDWATER FIELD FORM

Project Name:

Date:

Location:

Project No.:

Field Team:

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			Date: (if different from above)						
S1									
S2									

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			Date: (if different from above)						
S1									
S2									

## REMARKS:

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Note: All water level measurements are in feet, distance from top of riser.

## Volume Calculation

Diam.	Vol. (g/ft)
1"	0.041
2"	0.163
4"	0.653
6"	1.469

## Stabilization Criteria

Parameter	Criteria
pH	± 0.1 unit
SC	± 3%
Turbidity	± 10%
DO	± 0.3 mg/L
ORP	± 10 mV

PREPARED BY: \_\_\_\_\_

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FOP 023.1

GROUNDWATER PURGING PROCEDURES PRIOR  
TO SAMPLE COLLECTION

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GROUNDWATER WELL INSPECTION FORM

Project:	WELL I.D.:
Client:	
Job No.:	
Date:	
Time:	
<b>EXTERIOR INSPECTION</b>	
Protective Casing:	
Lock:	
Hinge/Lid:	
Concrete Surface Seal:	
Bollards:	
Label/I.D.:	
Other:	
<b>INTERIOR INSPECTION</b>	
Well Riser:	
Annular Space:	
Well Cap:	
Water Level (fbTOR):	
Total Depth (fbTOR):	
Other:	
<b>Comments/Corrective Actions:</b>	

PREPARED BY: \_\_\_\_\_

DATE: \_\_\_\_\_

FIELD OPERATING PROCEDURES

Perfluorooctanoic Acid  
(PFOA)  
&  
Perfluorooctanesulfonic  
Acid (PFOS)  
Groundwater Sample  
Collection Procedures

**PFOA & PFOS GROUNDWATER SAMPLE COLLECTION PROCEDURES**

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**PURPOSE**

This procedure describes the methods for collecting perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) groundwater samples from monitoring wells and domestic supply wells following purging and sufficient recovery. This procedure is specific to sites where PFOA & PFOS sample analysis is required and analysis specific collection and handling procedures are needed.

**PROCEDURE**

Prior to sampling discuss with the Sites Project Manager whether the monitoring wells that are to be sampled for the PFOA & PFOS analytical parameters are new monitoring wells or existing monitoring wells. The specific handing and collection procedures for PFOA & PFOS sampling is solely based on job preparation and sampling equipment used for the job. The standard practice of a ten (10) volume surge and purge of a newly installed monitoring well for development as discussed in Benchmark's FOP 036.0 – Monitoring Well Development Procedures and three (3) volume well purge and/or low flow sampling that are discussed in Benchmarks FOP 023.1 for Groundwater Procedures Prior to Sample Collection remain the same.

**FIELD CLOTHING**

For both the lead sampling technician and the field technician should be prepared with clothing, equipment and sampling containers appropriate for PFOA & PFOS sampling.

***Unacceptable Field Clothing***

- No Gore-Tex® this includes but not limited to; boots, gloves, coveralls, hats and coats.

**PFOA & PFOS GROUNDWATER SAMPLE COLLECTION PROCEDURES**

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- No Tyvex® this includes but not limited to; coveralls, boots, hoods and head coverings. Tyvex® is also found in every day items such as envelopes, receipts and adhesives.
- No clothes, jackets, boots or gloves that have been pretreated with Teflon® water proofing. Teflon® can be found in every day items such as scissors, plumers tape, adhesive tapes, Teflon ® paper for crafting and cooking and utensils.
- No brand new unwashed cotton clothing.
- Don't use any fabric softener with your washed clothes prior to sampling.
- Do not apply cosmetics or moisturizers prior to sampling.
- Don't use standard commercial sunscreen or insect repellents. Use only all natural or organic products.

**Acceptable Field Clothing**

- Well-worn washed clothes, jackets hats and coveralls w/out fabric softener usage.
- Rain Gear made from PVC or polyurethane only (it cannot contain any of the products listed above.)
- Only use natural and/or organic sun screens and insect repellants.
- Disposable powder free nitrile gloves.

**PFOA & PFOS GROUNDWATER SAMPLE COLLECTION PROCEDURES**

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**FIELD EQUIPMENT**

**Unacceptable Field Equipment**

- Sampling Equipment containing Teflon® or Low-Density Polyethylene (LDPE). Sampling equipment that may contain these materials are; submersible pumps, bailers, tubing, braided poly rope or cord, fishing line.
- Water proof field books, binders, plastic clip boards, spiral hard cover note books.
- No adhesives or permanent makers can be used (i.e Post-It® notes and Sharpies).
- No Aluminum foil or sampling tins.
- No blue ice packs

**Acceptable Field Equipment**

- Sampling Equipment made from High Density Polyethylene (HDPE), stainless steel, acetate, silicon, or polypropylene.

**ATTACHMENTS**

Groundwater Field Form (sample)

**REFERENCES**

**Benchmark FOPs:**

036 *Monitoring Well Development Procedures*

## PFOA &amp; PFOS GROUNDWATER SAMPLE COLLECTION PROCEDURES



## GROUNDWATER FIELD FORM

Project Name:

Date:

Location:

Project No.:

Field Team:

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			Date: (if different from above)						
S1									
S2									

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			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: \_\_\_\_\_



# FIELD OPERATING PROCEDURES

## Hand Augering Procedures

**HAND AUGERING PROCEDURES**

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**PURPOSE**

This guideline presents a method for hand augering, which enables the recovery of representative surface and shallow subsurface samples for classification and sample collection (ASTM D1452).

**PROCEDURE**

1. Review project objectives and the Project Health and Safety Plan (HASP).
2. Follow Benchmark's FOP: Drill Site Selection Procedure prior to implementing any hand augering activity.
3. Establish a central staging area for storage of augering supplies and for equipment decontamination (include plastic-covered work bench/table as necessary). Locate a secure storage area for augered samples.
4. Assemble auger and decontaminate in accordance with Benchmark's FOP: Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
5. Cover the area to be sampled with plastic sheeting, as determined by the Project Work Plan.
6. Make the auger boring through the plastic sheeting by rotating and advancing the auger to the desired depth below ground surface.
7. Withdraw the auger from the hole and remove soil for examination, soil classification, on-site testing (if applicable) and laboratory physical/chemical sample collection (if applicable) in accordance with specific Benchmark FOPs (Soil Description Procedures Using the Unified Soil Classification System; Composite Sample Collection Procedure for Non-Volatile Organic Analysis; and/or Soil Sample Handling for VOC Analysis) and as directed by the Project Work Plan.

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## FOP 025.0

### HAND AUGERING PROCEDURES

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8. Document all properties and sample locations in the Project Field Book and Hand Auger Borehole Log (sample attached). Specifically, total depth, borehole diameter, depth of sample collection, personnel, etc. should be recorded.
9. Place sample in appropriate container(s), label and store for future reference or ship to laboratory for analysis in accordance with Benchmark's Field Operating Procedure for Sample Labeling, Storage and Shipment.
10. Decontaminate auger in accordance with Benchmark's Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
11. Advance auger to next sample interval and repeat steps 7 through 12 as necessary.
12. Backfill auger holes in accordance with approved procedures outlined in the Project Work Plan.

#### ATTACHMENTS

Hand Auger Borehole Log (sample)

#### REFERENCES

##### Benchmark FOPs:

- 013 *Composite Sample Collection Procedure for Non-Volatile Organic Analysis*
- 017 *Drill Site Selection Procedure*
- 040 *Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment*
- 054 *Soil Description Procedures Using the Unified Soil Classification System*
- 057 *Soil Sample Handling for Volatile Organic Compound Analysis – Encore Sampling*

# FOP 025.0

## HAND AUGERING PROCEDURES



### HAND AUGER BOREHOLE LOG

Project:	BOREHOLE I.D.:
Project No.:	Excavation Date:
Client:	Excavation Method:
Location:	Logged / Checked By:

Hand Auger Location: <i>NOT TO SCALE</i>		Hand Auger Cross Section:			
		Grade - 0' 2' 4' 6' 8' 10'			
TIME		BOREHOLE DIMENSIONS			
Start:		Diameter: (approx.)			
End:		Depth: (approx.)			
Depth (fbs)	SAMPLE DESCRIPTION			Photos Y / N	Samples Collected (fbs)
	USCS Classification: Color, Moisture Condition of Soil, Temperature, Scale (mm)				
	Plasticity, Fabric, Bedding, Weathering / Fracture, Other				
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.:	

# FIELD OPERATING PROCEDURES

## Hollow Stem Auger Drilling Procedures

**HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES**

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**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.

**HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES**

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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,



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## FOP 026.1

### HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

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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*

## FOP 026.1

### HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



#### DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**

Date:

Project No.: **0041-009-500**

Drilling Company:

Client: **RealCo., Inc.**

Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, either swaged Coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or load side? Clamps should not be alternated and should be of the correct size and number for the cable size to which it is installed. Clamps are complete with no missing parts?		
Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation?		
Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load?		
Drive shafts, belts, chain drives and universal joints shall be guarded to prevent accidental insertion of hands and fingers or tools.		
Outriggers shall be extended prior to and whenever the boom is raised off its cradle. Hydraulic outriggers must maintain pressure to continuously support and stabilize the drill rig even while unattended.		
Outriggers shall be properly supported on the ground surface to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement. Controls should not be blocked or locked in an action position.		
Safeties on any device shall not be bypassed or neutralized.		
Controls shall be operated smoothly and cables and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		

ITEMS TO CHECK	OK	ACTION NEEDED
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## FOP 026.1

# HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



### DRILLING SAFETY CHECKLIST

Project: <b>Supplemental Phase II RFI/ICMs</b>	Date:
Project No.: <b>0041-009-500</b>	Drilling Company:
Client: <b>RealCo., Inc.</b>	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.		
<p>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:</p> <p>.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</p> <p><b>Benchmark Policy: Maintain 20 feet clearance</b></p>		
<p>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:</p> <p>Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 720 kV - 16 feet</p>		

Name: \_\_\_\_\_ (printed)

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

## FOP 026.1

### HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES



#### TAILGATE SAFETY MEETING FORM

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

#### **HOSPITAL INFORMATION:**

Name: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
Phone No.: \_\_\_\_\_ Ambulance Phone No. \_\_\_\_\_

#### **SAFETY TOPICS PRESENTED:**

Chemical Hazards: \_\_\_\_\_  
\_\_\_\_\_  
Physical Hazards: \_\_\_\_\_ Slips, Trips, Falls  
\_\_\_\_\_

#### **PERSONAL PROTECTIVE EQUIPMENT:**

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

New Equipment: \_\_\_\_\_  
\_\_\_\_\_

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

#### **ATTENDEES**

Name Printed	Signatures
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting conducted by: \_\_\_\_\_  
\_\_\_\_\_

FIELD OPERATING PROCEDURES

Low-Flow (Minimal  
Drawdown)  
Groundwater Purging  
& Sampling Procedure

**LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER  
PURGING & SAMPLING PROCEDURES**

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**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

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## FOP 031.2

### LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

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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.



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## FOP 031.2

### LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

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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.

**LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER  
PURGING & SAMPLING PROCEDURES**

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The low flow rate determined during purging will be maintained during the collection of analytical samples. At some sites where geologic heterogeneities are sufficiently different within the screened interval, high conductivity zones may be preferentially sampled.

12. Measure and record field parameters (pH, specific conductance, Eh, dissolved oxygen (DO), temperature, and turbidity) during purging activities. In lieu of measuring all of the parameters, a minimum subset could be limited to pH, specific conductance, and turbidity or DO. A reduction in the field parameter list must be approved by the Project Manager and/or the NYSDEC Project Manager.

Water quality indicator parameters should be used to determine purging needs prior to sample collection in each well. Stabilization of indicator parameters should be used to determine when formation water is first encountered during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by Eh, DO and turbidity. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. An in-line flow through cell to continuously measure the above parameters may be used. The in-line device should be disconnected or bypassed during sample collection.

13. Purging will continue until parameters of water quality have stabilized or at least a minimum of three (3) well volumes have been removed. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.
14. Record well purging and sampling data in the Project Field Book or on the Groundwater Field Form (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.

**LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER  
PURGING & SAMPLING PROCEDURES**

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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  $\pm 0.1$  units for pH,  $\pm 3\%$  for specific conductance,  $\pm 10$  mV for Eh, and  $\pm 10\%$  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-

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## FOP 031.2

### LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

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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

## FOP 031.2

# LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES



## GROUNDWATER FIELD FORM

Project Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Location: \_\_\_\_\_ Project No.: \_\_\_\_\_ Field Team: \_\_\_\_\_

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			Date: (if different from above)						
S1									
S2									

<b>Well No.</b>			Diameter (inches):			Sample Time:			
Product Depth (ftTOR):			Water Column (ft):			DTW when sampled:			
DTW (static) (ftTOR):			Casing Volume:			Purpose: <input type="checkbox"/> Development <input type="checkbox"/> Sample			
Total Depth (ftTOR):			Purge Volume (gal):			Purge Method:			
Time	Water Level (ftTOR)	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									
<b>Sample Information:</b>			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: \_\_\_\_\_

FIELD OPERATING PROCEDURES

Management of  
Investigative-Derived  
Waste (IDW)

**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.



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## FOP 032.1

### MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

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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:

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## FOP 032.1

### MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

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- 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

**FOP 032.1**

**MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)**



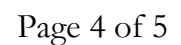
Location:

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Personnel:

[illegible]

Signed:




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FOP 032.1

MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

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IDW Container Label (sample):


Project Name: _____
Project Number: _____
Container I.D.: _____
Contents/Matrix: _____
Estimated Quantity: _____
Date of Generation: _____
Date of Sample Collection: _____
Contact Name: _____
Contact Phone Number: _____

FIELD OPERATING PROCEDURES

# Monitoring Well Construction for Hollow Stem Auger Boreholes

**MONITORING WELL CONSTRUCTION FOR  
HOLLOW STEM AUGER BOREHOLES**

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**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.)

**MONITORING WELL CONSTRUCTION FOR  
HOLLOW STEM AUGER BOREHOLES**

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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.



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## FOP 033.0

### MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

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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)

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## FOP 033.0

### MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

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#### 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*

# MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

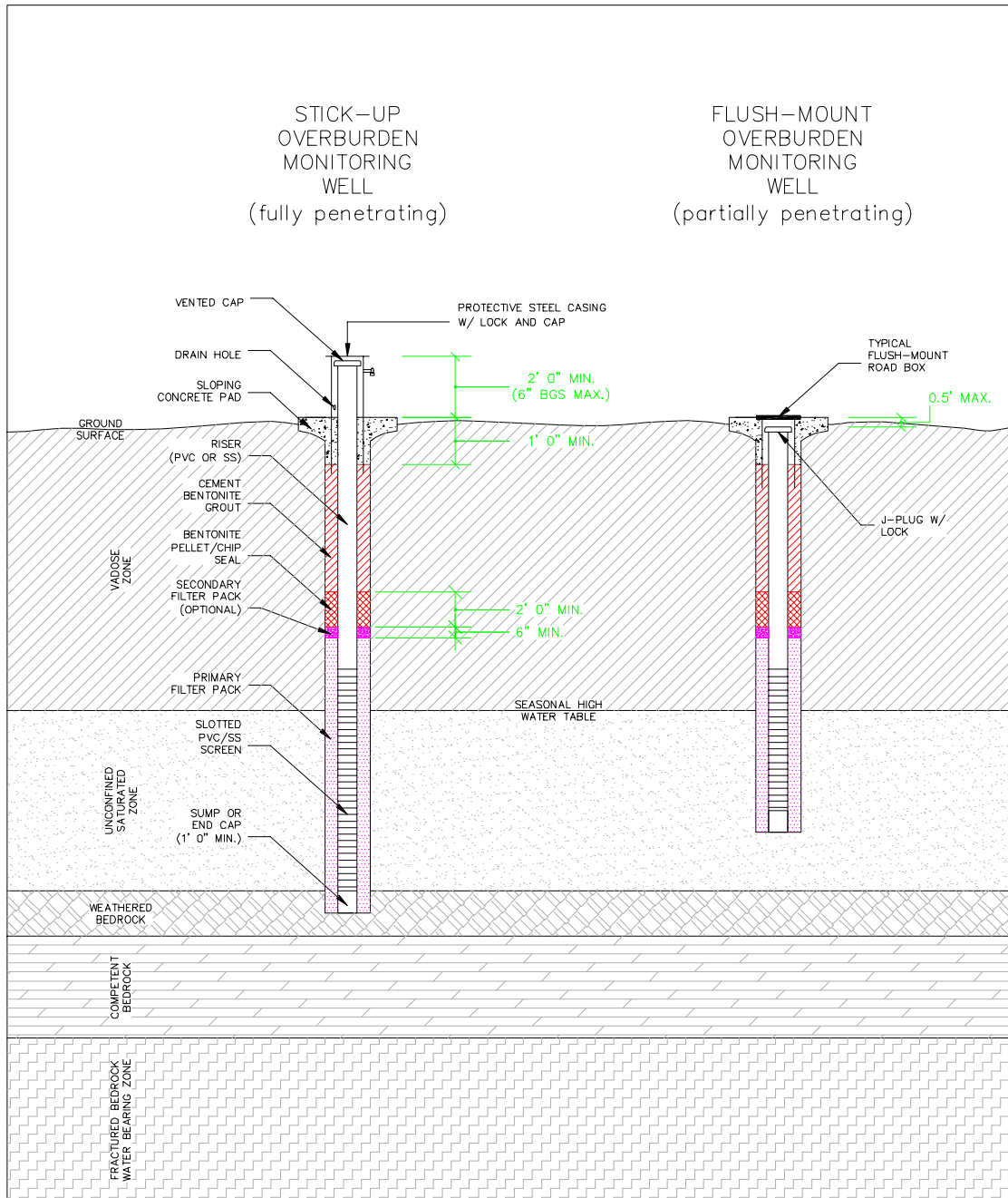


# FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

[illegible]

**MONITORING WELL CONSTRUCTION FOR  
HOLLOW STEM AUGER BOREHOLES**

**FIGURE 1**



FIELD OPERATING PROCEDURES

# Monitoring Well Construction in Bedrock

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## FOP 035.0

### MONITORING WELL CONSTRUCTION IN BEDROCK

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#### PURPOSE

This guideline presents a method for the construction of monitoring wells and piezometers in consolidated materials (i.e., bedrock).

#### PROCEDURE

1. Follow Benchmark's Drill Site Selection Procedure FOP prior to implementing any drilling activity.
2. Advance boring to top of competent bedrock as per Benchmark's Hollow Stem Auger (HSA) Drilling Procedures FOP and/or the Overburden Casing Installation Procedures FOP, or approved other as per the project work plan.
3. Advance the boring into consolidated bedrock by standard rock coring procedures (i.e., Benchmark's Air Rotary Drilling Procedure FOP or approved other as per the project work plan) using a triple wall core barrel of NX or HQ size. Log bedrock core in accordance with Benchmark's Rock Core Classification FOP. Temporary casing may be used if circulation of drill water is desired.
4. 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 (sample attached).
5. Review the borehole/well installation program with the drilling contractor to ensure that the contractor has the necessary equipment and supplies and is familiar with the program requirements.
6. Perform packer permeability testing in accordance with Benchmark's Pressure Packer Test FOP as determined by project requirements.

**MONITORING WELL CONSTRUCTION  
IN BEDROCK**

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7. Construct the open hole or screened well using appropriate materials identified in Benchmark's Well/Piezometer Construction Materials and Design FOP. Typical bedrock monitoring well construction is presented in Figure 1 (attached) and described in the following steps:

**A. Screened Installations**

- a. Ream NX core hole to nominal 4-inch diameter with 3 7/8-inch roller bit.
- b. Verify borehole depth using weighted measuring tape. (Ensure that the rig is turned off and all equipment that may obstruct well installation or represent a safety hazard is removed.)
- c. Add a minimum of two inches to a maximum of six inches of filter pack material of appropriate grade through the permanent or temporary casing 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 at the base of the borehole or a well constructed with a sump (1 foot minimum).)
- d. Insert well screen and riser pipe equipped with centralizers located at the center of the well string and/or immediately above the well screen into borehole through the permanent or temporary casing.
- e. Add filter pack materials to the screen section of the well through a tremie pipe while slowly backing temporary casing (if used) out of the borehole. The primary filter pack, when complete, should extend no more than two feet above the well screen within the borehole. Measure the depth of the sand pack carefully and frequently with a weighted tape while adding sand.
- f. Add a thin (6-inch) layer of secondary filter pack material above the primary filter pack as required.



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## FOP 035.0

### MONITORING WELL CONSTRUCTION IN BEDROCK

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- g. Add bentonite pellet seal above the secondary filter pack and again remove the temporary casing slowly (if used). The bentonite seal should extend at least one foot above the top of the filter pack section. Measure the depth with a weighted tape. (Note: If bentonite seal is placed above the ground water level within the borehole, potable water should be added to hydrate the bentonite pellets.) The required hydration time for the pellets should be established prior to setting the seal. (Note: The position of the bentonite seal is dependent on the program requirements.)
- h. Tremie grout into the remaining annular space under pressure to 3 feet below surface while slowly backing the HSA or temporary casing out of the borehole. Allow grout to set up for 6 to 12 hours, install protective casing, with surface weep holes, cap and lock. Complete concrete surface completion sloping away from protective casing. Under circumstances where the borehole is deep and the formation has a low hydraulic conductivity, it may be desirable to add potable water to the well prior to grouting to offset the pressure (weight) of the grout to minimize the potential for the grout to penetrate the sand pack.
- i. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.
- j. Permanently label the well with the appropriate well identifier on the protective casing or install a permanent marker post as determined by the Project Manager or specified in the Work Plan.
- k. 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

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## FOP 035.0

### MONITORING WELL CONSTRUCTION IN BEDROCK

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well, and elevation (≈) of the ground surface, the pad, and the top of riser.

- l. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.
- m. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.
- n. Document all soil/bedrock properties and sample locations (if any) in the Project Field Book and on Field Borehole/Monitoring Well Installation Logs (sample attached) in accordance with Benchmark's Field Operating Procedure for Documentation Requirements for Drilling and Well Installation. Specifically, total depth, depth of sample collection, personnel, etc.

#### **B. Open Bedrock Installations**

- a. Open bedrock boreholes should only be used where the length of the open borehole is less than about twenty feet.
- b. Once bedrock is encountered during conventional drilling using hollow stem augers or temporary casing the hollow stem augers or temporary casing should be seated into the top of bedrock. The rig should be converted to rock coring and the borehole advanced approximately five feet into bedrock or until two feet of competent bedrock is encountered, based on inspection of the rock core. The core hole should then be reamed using an appropriate sized bit to create a socket into the top of rock.
- c. Verify borehole depth using weighted measuring tape. (Ensure that the rig is turned off and all equipment, which may represent a hazard, is removed.)

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## FOP 035.0

### MONITORING WELL CONSTRUCTION IN BEDROCK

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- d. Appropriately sized permanent casing (containing a drillable plug at its base if tremie grout methods are used) should then be centered in the socket. Using tremie pipe, pressure packer or other methods, which introduce grout from the base of the annular space, grout the borehole annulus from bottom to top of borehole. An optional method involves grouting the bedrock socket and inserting the casing to the base of socket prior to the grout setting up. If a bentonite pellet seal is used at the base of the annular space before placement of the grout, a minimum of 60 minutes should be allowed for the bentonite to swell before grouting. Select the size and shape of the seal such that the bentonite can reach the socket and form a complete seal around the casing.
- e. Allow 48 hours for the grout to set and assess the integrity of the grout seal by either filling the casing with potable water and monitoring water level decline or bailing the casing dry and monitoring any water level increase.
- f. Drilling may proceed through the casing following hydrostatic testing of the grout seal, to create an open borehole to predetermined depth. After drilling is complete, install protective casing, with surface weep holes, cap and lock.
- g. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.
- h. Permanently label the well with the appropriate well identifier on the protective casing or install a permanent marker post as determined by the Project Manager or specified in the Work Plan.
- i. 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

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## FOP 035.0

### MONITORING WELL CONSTRUCTION IN BEDROCK

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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.

- j. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.
- k. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.
- l. Document all soil/bedrock properties and sample locations (if any) in the Project Field Book and on Field Borehole/Monitoring Well Installation Logs (sample attached) in accordance with Benchmark's Field Operating Procedure for Documentation Requirements for Drilling and Well Installation. Specifically, total depth, depth of sample collection, personnel, etc.

#### ATTACHMENTS

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

#### REFERENCES

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

#### Benchmark FOPs:

003 *Air Rotary Drilling Procedure*  
015 *Documentation Requirements for Drilling and Well Installation*  
017 *Drill Site Selection Procedure*  
026 *Hollow Stem Auger Drilling Procedures*

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**FOP 035.0**

**MONITORING WELL CONSTRUCTION  
IN BEDROCK**

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- 032 Management of Investigation Derived Waste*
- 036 Monitoring Well Development Procedures*
- 041 Overburden Casing Installation Procedure*
- 042 Pressure Packer Test Procedure*
- 043 Rock Core Classification Procedure*
- 070 Well/Piezometer Construction Materials and Design*

# MONITORING WELL CONSTRUCTION IN BEDROCK

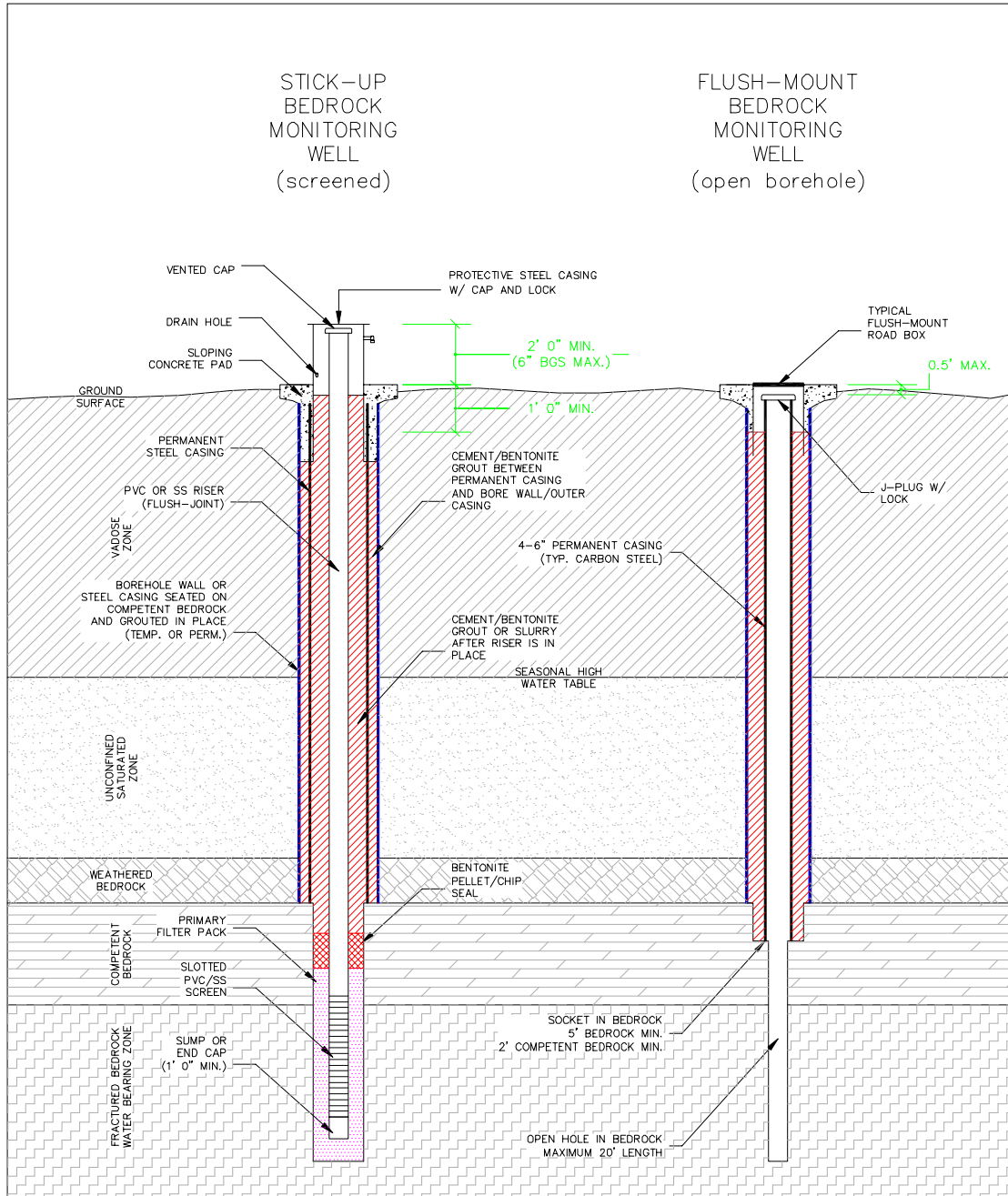


## FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

[illegible]

# MONITORING WELL CONSTRUCTION IN BEDROCK

FIGURE 1





# FIELD OPERATING PROCEDURES

## Monitoring Well Development Procedures

**MONITORING WELL DEVELOPMENT PROCEDURES**

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**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

**MONITORING WELL DEVELOPMENT PROCEDURES**

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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:
    - o Dissolved Oxygen:  $\pm 0.3$  mg/L
    - o Turbidity:  $\pm 10\%$
    - o Specific Conductance:  $\pm 3\%$
    - o ORP:  $\pm 10$  mV
    - o pH:  $\pm 0.1$  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*

## MONITORING WELL DEVELOPMENT PROCEDURES



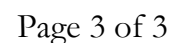
<b>WELL DATA:</b>	DATE:	TIME:
Casing Diameter (inches):	Casing Material:	
Screened interval (ftTOR):	Screen Material:	
Static Water Level (ftTOR):	Bottom Depth (ftTOR):	
Elevation Top of Well Riser (fmsl):	Datum Ground Surface: Mean Sea Level	
Elevation Top of Screen (fmsl):	Stick-up (feet):	

(A) Total Depth of Well (ft/TOR):		Well Diameter	Volume gal/ft	Water	Criteria
(B) Casing Diameter (inches):			0.041	DO	+/- 0.3 mg/L
(C) Static Water Level (ft/TOR):				Turbidity	+/- 10%
One Well Volume (V, gallons):				SC	+/- 3%
$V = 0.0408 \times (B)^2 \times \{ (A) - (C) \}$		3"	0.0		

Field Personnel:

[illegible]

**PREPARED BY:**



FIELD OPERATING PROCEDURES

Non-Aqueous Phase  
Liquid (NAPL)  
Detection and Sample  
Collection Procedure

**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

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## FOP 039.1

### NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

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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.



**NON-AQUEOUS PHASE LIQUID DETECTION  
AND SAMPLE COLLECTION PROCEDURE**

---

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.

**NON-AQUEOUS PHASE LIQUID DETECTION  
AND SAMPLE COLLECTION PROCEDURE**

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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.

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## FOP 039.1

### NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

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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

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## FOP 039.1

### NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE

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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*

## FOP 039.1

# NON-AQUEOUS PHASE LIQUID DETECTION AND SAMPLE COLLECTION PROCEDURE



## GROUNDWATER WELL PURGE & SAMPLE COLLECTION LOG

Project Name: \_\_\_\_\_ WELL NUMBER: \_\_\_\_\_  
 Project Number: \_\_\_\_\_ Sample Matrix: \_\_\_\_\_  
 Client: \_\_\_\_\_ Weather: \_\_\_\_\_

<b>WELL DATA:</b>	DATE:	TIME:
Casing Diameter (inches):	Casing Material:	
Screened interval (ft/TOR):	Screen Material:	
Static Water Level (ft/TOR):	Bottom Depth (ft/TOR):	
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):	
Elevation Top of Screen (fmsl):	Stick-up (feet):	

<b>PURGING DATA:</b>	DATE:	START TIME:	END TIME:
Method:	Is purge equipment 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:**

Volume Calculation		Stabilization Criteria	
Well Diameter	Volume gal/ft	Parameter	Criteria
1"	0.041	pH	+/- 0.1 ur
2"	0.163	SC	+/- 3%
3"	0.347	Turbidity	+/- 10%
4"	0.653	DO	+/- 0.3 m
5"	1.020	ORP	+/- 10 mV
6"	1.462		

(A) Total Depth of Well (ft/TOR): \_\_\_\_\_  
 (B) Casing Diameter (inches): \_\_\_\_\_  
 (C) Static Water Level (ft/TOR): \_\_\_\_\_  
 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 diameter.

**EVACUATION STABILIZATION TEST DATA:**

Time	Water Level (ft/TOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (uS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance Odor
		initial							

<b>SAMPLING DATA:</b>	DATE:	START TIME:	END TIME:
Method:	Is sampling equipment dedicated to sample location? yes		
Initial Water Level (ft/TOR):	Was well sampled to dryness? yes		
Final Water Level (ft/TOR):	Was well sampled below top of sand pack? yes		
Air Temperature (°F):	Field Personnel:		
Source and type of water used in the field for QC purposes:			

**PHYSICAL & CHEMICAL DATA:**

DESCRIPTION OF WATER SAMPLE		
Odor		
Color		
NAPL		
Contains Sediment?		yes    no

WATER QUALITY MEASUREMENTS							
Sample	Time	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
initial							
final							

REMARKS:

PREPARED BY:

FIELD OPERATING PROCEDURES

Non-Disposable and  
Non-Dedicated  
Sampling Equipment  
Decontamination

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## FOP 040.1

### NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

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#### 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:



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## FOP 040.1

### NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

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- 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.

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## FOP 040.1

### NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

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- 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.

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## FOP 040.1

### NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

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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<sub>3</sub>).
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*

FIELD OPERATING PROCEDURES

# Overburden Casing Installation Procedure

**OVERBURDEN CASING INSTALLATION PROCEDURES**

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**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.

OVERBURDEN CASING INSTALLATION PROCEDURES

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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.

OVERBURDEN CASING INSTALLATION PROCEDURES

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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 regouted at the Subcontractor's expense.

$$Q_{(\text{allowable})} = 2.75 \text{ DKH}$$

Where:

$Q_{(\text{allowable})}$  = 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



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## FOP 041.0

### OVERBURDEN CASING INSTALLATION PROCEDURES

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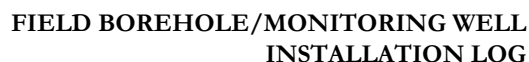
#### REFERENCES

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*

## OVERBURDEN CASING INSTALLATION PRCEДУRES

[illegible]



## OVERBURDEN CASING INSTALLATION PROCEDURES

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, $K$		
	$\text{cm}^2$	$\text{ft}^2$	darcy	m/s	ft/s	U.S. gal/day/ft <sup>2</sup>
$\text{cm}^2$	1	$1.08 \times 10^{-3}$	$1.01 \times 10^8$	$9.80 \times 10^2$	$3.22 \times 10^3$	$1.85 \times 10^9$
$\text{ft}^2$	$9.29 \times 10^2$	1	$9.42 \times 10^{10}$	$9.11 \times 10^5$	$2.99 \times 10^6$	$1.71 \times 10^{12}$
darcy	$9.87 \times 10^{-9}$	$1.06 \times 10^{-11}$	1	$9.66 \times 10^{-6}$	$3.17 \times 10^{-5}$	$1.82 \times 10^1$
m/s	$1.02 \times 10^{-3}$	$1.10 \times 10^{-6}$	$1.04 \times 10^5$	1	3.28	$2.12 \times 10^6$
ft/s	$3.11 \times 10^{-4}$	$3.35 \times 10^{-7}$	$3.15 \times 10^4$	$3.05 \times 10^{-1}$	1	$6.46 \times 10^5$
U.S. gal/day/ft <sup>2</sup>	$5.42 \times 10^{-10}$	$5.83 \times 10^{-13}$	$5.49 \times 10^{-2}$	$4.72 \times 10^{-7}$	$1.55 \times 10^{-6}$	1

\*To obtain  $k$  in  $\text{ft}^2$ , multiply  $k$  in  $\text{cm}^2$  by  $1.08 \times 10^{-3}$ .

# FIELD OPERATING PROCEDURES

## Pressure Packer Test Procedure

**PRESSURE PACKER TEST PROCEDURE**

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**PURPOSE**

This procedure is presented for calculating the permeability of the bedrock within a borehole. It is most valid when stratum thickness is at least five times the diameter of the hole tested. The packer test is a method of monitoring the rate of disappearance of water in a confined, high-pressure environment. Generally, a portion of the borehole to be tested is sealed off with inflatable packers, which expand to the walls of the borehole to prohibit movement of water past the packer. The seal allows water pumped into the test zone between the packers to escape only into the available joints and interstices of the rock.

**EQUIPMENT**

1. Pneumatic Packers – Pneumatic packers consist of metal and rubber cylinders whose central rubber portions are a minimum of 12 inches in length and are pneumatically inflatable to seal off a zone of the borehole. The packers are attached together by a perforated pipe to allow water to escape into the test zone.
2. Water Flow Meter – Measures water flow in gallons. This meter shall be easily readable and calibrated to an accuracy within 1.5% (i.e., 0.75 gallons over 50 gallons). The units of graduation shall not exceed 1 gallon.
3. Water Pressure Gauge – Measures water pressure in pounds per square inch (psi). This gauge shall be easily readably and calibrated to an accuracy of  $\pm 2.5$  psi. The units of graduation shall not exceed 5 psi.
4. Surge Chamber (optional) – A heavy, metal, air-filled cylinder installed to prevent the pulsating water delivery yielded by some pumps. The surge chamber should be capable of withstanding the maximum water pressure.
5. Flow Valve (optional) – Controls flow from the pump into the test system and water pressure as shown on the water pressure gauge.

**PRESSURE PACKER TEST PROCEDURE**

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6. Bypass Valve – Permits bypassing any desired portion of the flow back into the pump.
7. Nitrogen Tank or Compressed Air – Nitrogen or compressed air shall be used to inflate the pneumatic packers because of their nonflammable character. The tank shall be equipped with a pressure regulator and gauges.
8. Minimum Nominal  $\frac{3}{4}$ -inch I.D. Pipe – Used to lower the packer assembly to the appropriate depth and transport water down to the test zone.
9. Air Hose – The air hose shall be made of materials capable of withstanding twice the allowable net pressure of the pneumatic packers.
10. Pumps – A positive displacement or Moyno pump having a minimum capacity of 20 gpm at a pressure of 100 psi should be used.

**DATA COLLECTION PROCEDURES**

1. Test the water flow meter prior to use by running a known volume through the meter and checking its calibration.
2. Record on the Pressure Packer Testing Log form (sample attached) all measurements listed below:
  - Length of zone tested (note: this must be at least five times greater than the hole diameter;
  - Length of packer, rubber portion only;
  - Length of portion of hole not tested if double packer assembly is used;
  - Length of entire assembly;



**PRESSURE PACKER TEST PROCEDURE**

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- Elevation difference between water pressure gauge and mid-point of test segment (the water table should be allowed to stabilize for 24 hours prior to testing when practical); and
3. Calculate maximum test pressure. The maximum test pressure will not exceed a value equal to 1 psi per floor depth of hole, calculated at the midpoint of the test segment. Maximum test pressure equals the sum of the gauge pressure ( $P_p$ ) and the weight of the water column between the gauge and the midpoint of the test segment ( $P_w$ ). For example, if the depth to the midpoint of the test segment is 50-feet and the gauge is mounted 3-feet above the collar of the hole, then the maximum gauge pressure will be calculated as follows:
- $$\begin{array}{lll} 50 \text{ psi} & = \text{gauge pressure (psi)} & = (50 + 3) \times (62.4/144) \\ & = \text{gauge pressure (psi)} & = 53 \times 0.43333 \\ & = \text{gauge pressure (psi)} & = 22.97 \text{ psi} \end{array}$$
- $$50 - 22.97 = 27.03 \text{ psi}$$
- Maximum gauge pressure = 27 psi
4. Select the packer pressure. The approximate packer pressure can be determined as follows:
- $$P_p = \text{packer pressure} = \text{inflation (resistance of rubber) pressure in air} + \frac{1}{2} \text{ of hydrostatic head on the packer (approximate static water pressure)} + 1.2 P_w \text{ max.}$$
- The packer pressure shall not exceed the design pressure of the packer. The nitrogen or compressed air tank shall be set at the selected packer pressure and the pressure recorded on the filed form.
5. Thoroughly clean the borehole and allow the water table 24 hours to stabilize, if practical.
6. Insert packer assembly into borehole and inflate. The hole should be tested from the bottom upwards.

**PRESSURE PACKER TEST PROCEDURE**

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7. Begin water flow at the appropriate pressure and allow the necessary time interval depending upon the grain of test material.
8. Conduct water pressure testing in four phases as outlined below:

Phase No.	Test Pressure	Packer Pressure
1	$(\frac{1}{2}) P_w$	$P_p$
2	$P_w$	$P_p$
3	$P_w$	$P_p$ plus 20 psi

If there is no water taken in during Phase 2, the geologist or engineer may end the test.

The third phase is a check on the second phase to determine whether leakage past the packer has occurred. Increase of packer pressure of 20 psi is often sufficient, but higher increases may be used as the situation dictates.

9. Take gauge measurements every 30 seconds for the first 5 minutes of operation, and every 60 seconds thereafter until stabilization; i.e., until three or more readings of water intake and pressure taken at 5-minute intervals are essentially equal.
10. The geologist or engineer may end the test if the following occurs:
  - In the event that a zone will not take water in the first 3 minutes of testing;
  - In the event that a zone will not hold water test pressure of  $(\frac{1}{2}) P_w$ ; or
  - In the event that the measure flow in Phase 3 is greater than that in Phase 2 (i.e., hydraulic jacking of the rock).

**PRESSURE PACKER TEST PROCEDURE**

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**DOCUMENTATION OF TEST RESULTS**

1. All readings and other pertinent test data shall be recorded on the Pressure Packer Testing Log form (sample attached).
2. A pressure test report shall be completed by the drilling contractor or geologist or engineer, or both, for each test conducted. This includes all measurements taken prior to the test as well as all test results.
3. A field log shall also be kept to list all tests performed and their locations.

**CALCULATION OF HYDRAULIC CONDUCTIVITY**

Calculate hydraulic conductivity according to procedures given in Ground Water Manual, 1985, U.S. Department of Interior, Bureau of Reclamation.

**ATTACHMENTS**

Pressure Packer Testing Log (sample)

**REFERENCES**

None



# FIELD OPERATING PROCEDURES

## Rock Core Classification Procedure

**ROCK CORE CLASSIFICATION PROCEDURE**

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**PURPOSE**

This guideline presents rock classification procedures and descriptive terminology for rock core samples collected by standard bedrock coring methods. Rock coring is defined as the removal of continuous formation sample from a borehole. To the extent possible, rock core samples are recovered undamaged, preserving the physical and mechanical integrity of the bedrock. The formation material may be solid rock, friable rock, conglomerates, unconsolidated sands, coal, shales, gumbos, or clays. Rock core drilling is accomplished with mechanical, engine-powered rotary drills designed to drill rock and to recover the undisturbed cylindrical cores of rock material. All core drills are equipped with pumps or compressors to circulate drill media through use of water, drilling mud, air, or air-foam to cool and lubricate the coring bits and to transport the drill cuttings out of the borehole. Rock coring can be conducted by various methods with a variety of tools in a wide range of borehole sizes.

A common field method of rock coring techniques and core barrel size employed by Benchmark is as follows. Hollow stem augers (size varies) are advanced to refusal at the overburden/bedrock interface, seated into the bedrock and temporarily left in place during rock coring activities to prevent sloughing of the overburden soils. Overburden steel casing may be driven to the overburden/bedrock interface as an alternative to hollow stem augers (see Benchmark's FOP 041.0: Overburden Casing Installation Procedures). Once the augers are seated, an NX sized double-tube, swivel-type core barrel is attached to rotary drill rods and lowered to the bottom of the borehole. The drill rig rotates the drill rods and core barrel assembly, generally at intervals, or runs, of 5 or 10 feet, depending on the length of the core barrel and/or competency of bedrock (i.e., highly fractured bedrock generally will not allow runs longer than 5-feet in length, however competent massive bedrock is conducive to a 10-foot run). An NX core barrel will obtain a 2.155-inch diameter bedrock core sample creating a 2.98-inch diameter hole. Following coring activities, a 3<sup>7</sup>/<sub>8</sub>-inch tri-cone roller bit

**ROCK CORE CLASSIFICATION PROCEDURE**

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is used to ream the borehole to the desired depth to facilitate monitoring well installation. [Figure 1](#) illustrates a standard double-tube, swivel-type core barrel in action.

**PROCEDURE**

1. Label the core box in accordance with the Labeling, Storing, and Transport of Rock Core Boxes section of this FOP (see [Figure 2](#)).
2. Upon advancing the core barrel the appropriate run length (generally 5 or 10 feet in length) and retrieving the core barrel from the borehole, assist the driller as necessary to remove the bedrock core from the core barrel placing the core sample in a standard core box as shown in [Figure 2](#) (i.e., with core box lid flipped open and away, start placing core in upper left hand corner moving left to right, top to bottom). Extreme care should be taken so as not to cause mechanical breaking of the core sample. A rubber mallet should be used to strike the outside of the core barrel to dislodge the core sample.
3. The beginning of each core run should be marked on the core and also noted with a marked wooden block (see [Figure 2](#)).
4. Place the core sample in good light, remove any extraneous material and wash the sample to clean it of drilling fluid, residue or mudcake.
5. Label the fractures and mark the core:
  - a. Place a strike mark perpendicular across all fractures judged to be “natural”
  - b. Place a two-color parallel strike mark along the entire core to indicate correct end up
  - c. Photograph core with color chart and scale (as necessary)
6. Calculate core recovery and rock quality designation in accordance with Benchmark’s FOP 044.0: Rock Quality Designation (RQD) Procedure.
7. Describe the wetted rock core sample according to the following hierarchy (see next section):



**ROCK CORE CLASSIFICATION PROCEDURE**

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- a. Formation Name
  - b. Rock Type
  - c. Field Strength
  - d. Color
  - e. Texture
  - f. Structure
  - g. Decomposition/Weathering
  - h. Disintegration
  - i. Bedding Thickness
  - j. Hardness
  - k. Fracturing
8. Document descriptions in the Project Field Book and on the appropriate field forms (Field Borehole Log or Field Borehole/Monitoring Well Installation Log; samples attached).

**ROCK CORE LOG DESCRIPTIONS**

Rock classification procedures presented in this FOP generally use the Bureau of Reclamation Standards ([reference 1](#)), the Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation (ASTM D 2113) ([reference 2](#)) and the Field Guide for Rock Core Logging and Fracture Analysis prepared by Midwest Geosciences Group Press (2001 – 2004) ([reference 3](#)). The detail of description provided for a particular material should be dictated by the complexity and objectives of the project. However, since field work completed for one purpose is often later used for another, an attempt should always be made to describe the rock core as completely as possible.

Intensely weathered or decomposed bedrock that is friable and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil, however when performing rock coring activities as part of landfill construction, such material is considered bedrock which requires a minimum of ten feet vertical separation be maintained between the base of a constructed landfill liner and bedrock (viz. 6NYCRR Part 360-2.13(e)). If the weathered or decomposed bedrock is classified as a soil, the classified soil should be followed by the parent bedrock name in parenthesis.

Use the following descriptive terms when classifying bedrock core samples:

**ROCK CORE CLASSIFICATION PROCEDURE**

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1. **FORMATION NAME** – Use formal state geological survey nomenclature when possible, if not possible; assign a site-specific unit name according to stratigraphic position.
2. **ROCK TYPE** – Document rock lithology. The following basic names are applied to sedimentary rock types common to New York State:
  - o ***Sandstone*** – Made up predominantly of granular materials ranging between 1/16 and 2 inches in diameter.
  - o ***Siltstone*** – Made up of granular materials less than 1/16 inch in diameter. Fractures irregularly. Medium thick to thick bedded.
  - o ***Claystone*** – Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
  - o ***Shale*** – A fissile very fine-grained rock. Fractures along bedding planes.
  - o ***Limestone*** – Rock made up predominantly of calcite ( $\text{CaCO}_3$ ). effervesces upon the application of hydrochloric acid.
  - o ***Coal*** – Rock consisting mainly of organic remains.
  - o ***Others*** – Numerous other rock types are present in the geologic section. Their overall abundance is dependent upon geographical location. These include halite, gypsum, dolomite, anhydrite, lignite, etc.

In most cases, a rock will be a combination of several rock types, (e.g., sandy siltstone, or silty sandstone). The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers include carbonaceous, calcareous, siliceous, etc.

Grain size diameters are used for the classification of clastic sedimentary rocks. The attached [Table 1](#) specifies the classification that should be applied to sedimentary rocks. For field determination of grain sizes, a scale can be used for the coarse grained rocks. The division between very fine sand and silt is probably not measurable in the field. The boundary should be determined by use of a hand lens. If the grain cannot be seen with the naked

**ROCK CORE CLASSIFICATION PROCEDURE**

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eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

A general list of common rock types is presented at Figure 3 (attached).

3. **FIELD STRENGTH**

- o ***Very Weak*** – crumbled by hand, scratched easily with thumbnail
- o ***Weak*** – broken by hand into pieces, peeled by pocket knife
- o ***Moderate*** – broken with difficulty in two hands, easily scratched with knife
- o ***Strong*** – scratched with knife, indentation made by firm blow with rock hammer
- o ***Very Strong*** – chipped by firm blow with rock hammer

4. **COLOR** - Rock colors should be described utilizing a Munsell Color Chart. A single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures should be used when describing. A rock could, therefore be referred to as “gray” or “light gray”. Since color can be utilized in correlating units between sampling locations, it is important that color descriptions be kept consistent throughout the field operations.

Rock core samples should be classified while fresh and wet. If sample is not fresh or wet, note any discoloration due to oxidation, noting the distribution and occurrence. If no discoloration has occurred, note any distribution, position, and occurrence of secondary color(s) if present.

5. **TEXTURE**

- o ***Sedimentary Rocks***
  - *Microcrystalline* – crystals are indistinguishable (for [bio]chemical rocks)
  - *Aphanitic* – constituents are indistinguishable (for detrital rocks)
  - *Fossiliferous* – fossilized
  - *Grain size* – note degree of cementation and grading when applicable
    - Fine-grained: 0.06 mm to 0.25 mm
    - Medium-grained: 0.25 mm to 0.5 mm

**ROCK CORE CLASSIFICATION PROCEDURE**

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- Coarse-grained: 0.5 mm to 2.0 mm

- ***Metamorphic Rocks***

- *Slatey* – grains are indistinguishable, may be cleavable but can be oblique to bedding, dull
- *Phyllitic* - grains are indistinguishable, parallelism is silky, or crenulated (small scale folds)
- *Schistose* – grains are platy or elongated and parallel
- *Gneissic* – crudely foliated with subparallel and unevenly distributed grains
- *Nonfoliated* – no visible orientation of grains

- ***Igneous Rocks***

- *Contains megacrysts*
  - Porphyritic – compatible in composition, larger crystals (phenocrysts) are set in a finer-grained groundmass, which may be crystalline or glassy or both
  - Xenocrystic – foreign in composition, a crystal that resembles a phenocrysts in igneous rock but is foreign to the body of rock in which it occurs
- *Aphanitic* – grains are indistinguishable with the unaided eye
- *Phaneritic* – grains are distinguishable with the unaided eye

**6. STRUCTURE**

- ***Massive*** – uniform
- ***Thickly Bedded or Foliated or Banded*** – bedding, foliation, or bands from 1 to 10 feet (300 mm to 3m)
- ***Medium Bedded or Foliated or Banded*** – bedding, foliation, or bands from 0.3 to 1 foot (100 to 300 mm)
- ***Thinly Bedded or Foliated or Banded*** – bedding, foliation, or bands from 0.03 to 0.3 foot (10 to 100 mm)
- ***Laminated or Intensely Foliated or Intensely Banded*** – laminations, foliation, or bands from less than 0.03 feet (< 10 mm)

**ROCK CORE CLASSIFICATION PROCEDURE**

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7. **DECOMPOSITION/WEATHERING** - The degree of decomposition/ weathering is a significant parameter that is important in determining decomposition/ weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of decomposition/ weathering.
- o ***Fresh*** – no decomposition or discoloration apparent. Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.
  - o ***Slightly Decomposed*** – mostly fresh but discoloration near fractures. Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.
  - o ***Moderately Decomposed*** – mostly discolored, easily broken by rock hammer. Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to decomposition/ weathering and can be easily broken with hammer.
  - o ***Highly Decomposed*** – completely discolored, easily broken by hand. All bedrock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.
  - o ***Residual Soil*** (note pedogenic development, pertaining to soil formation) – can be crumbled by hand (and in near-surface position).
8. **DISINTIGRATION**
- o ***Competent*** – no mineralization or dissolution (to either bedrock or cementation)
  - o ***Slightly Disintegrated*** – trace mineralization or dissolution
  - o ***Moderately Disintegrated*** – some mineralization or dissolution
  - o ***Intensely Disintegrated*** – highly mineralized or dissolved (see Fracture Characterization for describing voids)
9. **BEDDING THICKNESS** - Bedding thickness designations for rock classification are given in [Table 2](#) (attached).

**ROCK CORE CLASSIFICATION PROCEDURE**

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10. **HARDNESS** - The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- o **Soft** – Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).
- o **Medium soft** – Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.
- o **Medium hard** – No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.
- o **Hard** – Requires several hammer blows to break and has sharp concoidal breaks. Cannot be scratched with screwdriver.

11. **FRACTURING** - Determine the degree of fracturing or brokenness of a rock by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracture structure is described by the following terms.

- o **Very broken** (V.BR.) – Less than 2 in
- o **Broken** (BR.) – 2 in. to 1 ft.
- o **Blocky** (BL.) – 1 to 3 ft.
- o **Massive** (M.) – 3 to 10 ft.

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered in accordance with Benchmark's Rock Quality Designation FOP.

- o **Fracture Density** – characterize fractures using the following section
  - *Unfractured* – no observed fractures
  - *Slightly Fractured* – core recovered mostly in lengths greater than 1 foot

**ROCK CORE CLASSIFICATION PROCEDURE**

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- *Moderately Fractured* – core recovered mostly in lengths from 0.33 to 1 foot
- *Intensely Fractured* – core lengths average from 0.1 to 0.33 feet
- *Very Intensely Fractured* – core recovered mostly as non-intact (NI) fragments

**FRACTURE CHARACTERIZATION GUIDE**

Use the following descriptive terms when characterizing fractures within rock core samples:

1. **DEPTH** – Distance below ground surface
2. **TYPE**
  - o ***Joint*** – structural break where little or no differential movement has occurred
  - o ***Shear*** – structural break where differential movement has occurred
  - o ***Bedding Plane Joint*** – division plane that separates successive layers or beds
  - o ***Microjoint*** – tight, often discontinuous plane, may be separated by hand along plane
  - o ***Fracture Zone*** – numerous intersecting joints
  - o ***Shear Zone*** – width of fracture zone indicating numerous joints, shears, or fault
  - o ***Mechanical Break*** – break due to drilling, blasting, or handling
3. **DIP ANGLE** – degrees from horizontal
4. **APERTURE FOR OPENINGS**
  - o ***Wide*** – greater than 200 mm
  - o ***Moderately Wide*** – 60 to 200 mm

ROCK CORE CLASSIFICATION PROCEDURE

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- o *Moderately Narrow* – 20 to 60 mm
- o *Narrow* – 6 to 20 mm
- o *Very Narrow* – 2 to 6 mm
- o *Extremely Narrow* – greater than 0 to 2 mm
- o *Tight* – no visible separation

5. APPERTURE FOR VOIDS

- o *Pit (pitted)* – pinhole openings
- o *Vug (vuggy)* – small opening up to 4 inches
- o *Cavity* – opening larger than 4 inches
- o *Honeycombed* – cell-like form of vugs and pits
- o *Vesicle (vesicular)* – openings formed by trapped gas

6. HEALING

- o *Totally Healed* – all parts bonded, completely healed or re-cemented
- o *Moderately Healed* – greater than 50% fractured/sheared discontinuities healed, re-cemented, or filled
- o *Partly Healed* – less than 50% fractured/sheared discontinuities healed, re-cemented, or filled
- o *Not Healed* – no fractures or shears are healed, re-cemented, or filled

7. INFILLING

- o *Clean* – no apparent infilling or coating
- o *Surface Oxidation or Staining* – oxidation or secondary staining along fracture face
- o *Decomposed or Disintegrated Rock* – decomposition or disintegration along fracture



ROCK CORE CLASSIFICATION PROCEDURE

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- ***Non-Cohesive Sediment*** – sediment that is non-plastic
- ***Cohesive Sediment*** – sediment that yields plasticity
- ***Mineralization*** (i.e., quartz, calcite, manganese, kaolin) – secondary mineralization
- ***Other (note observation)*** - other

8. **UNEVENESS**

- ***Rough*** – large or angular asperities (an irregularity on a fracture surface, typically a projection that reduces the aperture size)
- ***Smooth*** – no asperities
- ***Slickensided*** – polished or striated
- ***Stepped*** – with near normal steps or ridges
- ***Undulating*** – with wavy surface
- ***Planar*** – with even surface

9. **MOISTURE CONDITIONS**

- ***Restricted*** – water flow does not appear possible along fracture
- ***Dry*** – fracture is dry, but water flow appears possible
- ***Dry with Staining or Leaching*** – fracture is dry, but shows staining or leaching
- ***Damp*** – fracture filling (where present) is damp, but no apparent water flow
- ***Wet with Minor Seepage*** – fracture filling is wet (or stained), with apparent minor seepage
- ***Wet with Continuous Seepage*** – fracture filling is washed and wet, with apparent continuous seepage

**ROCK CORE CLASSIFICATION PROCEDURE**

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**LABELING, STORING, AND TRANSPORT OF ROCK CORE BOXES**

All core boxes should be clearly and correctly labeled both on the top outside of the box as well as along one end (for ease of identifying boxes when in racks) and include project name, borehole number, date, box number and depths of core inside the box (see [Figure 2](#)).

All rock cores should be stored in strong wooden boxes with suitable wooden covers that allows for easy access, protection and prevents loss of core pieces. Core boxes should be stored under cover out of rain (core shed, under plastic or weatherproof tarps) and preferably on racks rather than not directly on top of each other, which typically leads to breakage of covers and possible loss of core.

Care should be exercised when transporting rock cores so as to not to drop core boxes which may induce mechanical/non-natural breaks as well as possibly cause core pieces to fall out and become mixed out of order. The covers of core boxes should be well secured and tightly closed and fastened to prevent their opening during any transport.

**REQUIRED EQUIPMENT**

- Knife
- Ruler
- Permanent Marker
- 10x Hand lens
- Hydrochloric acid
- Camera
- Munsell rock color chart
- Rubber mallet
- Potable water

ROCK CORE CLASSIFICATION PROCEDURE

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ATTACHMENTS

Field Borehole Log (sample)

Field Borehole/Monitoring Well Installation Log (sample)

Table 1; Grain Size Classification for Rocks

Table 2; Bedding Thickness Classification

Figure 1; Standard Double-Tube, Swivel-Type Core Barrel in Action

Figure 2; Core Placement & Core Box Labeling

Figure 3; List of Common Rock Names

REFERENCES

1. *Earth Manual*, U.S. Department of the Interior, Bureau of Reclamation, Part I, Third Edition, 1998.
2. *Field Guide for Rock Core Logging and Fracture Analysis™*, Midwest Geosciences Group Press, 2001 – 2004.
3. *Soil & Rock Logging Classification Manual (Field Guide)*, State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1995.
4. *Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation*, ASTM D 2113.

Benchmark FOPs:

041 *Overburden Casing Installation Procedures*

044 *Rock Quality Designation (RQD) Procedures*





ROCK CORE CLASSIFICATION PROCEDURE

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TABLE 1

GRAIN SIZE CLASSIFICATION FOR ROCKS

<u>Particle Name</u>	<u>Grain Size Diameter</u>
Cobbles	>64 mm
Pebbles	4-64 mm
Granules	2-4 mm
Very Coarse Sand	1 – 2 mm
Coarse Sand	1 – 2 mm
Medium Sand	0.25 – 0.5 mm
Fine Sand	0.125 – 0.25 mm
Very Fine Sand	0.0625 – 0.125 mm
Silt	0.0039 – 0.0625 mm

ROCK CORE CLASSIFICATION PROCEDURE

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TABLE 2

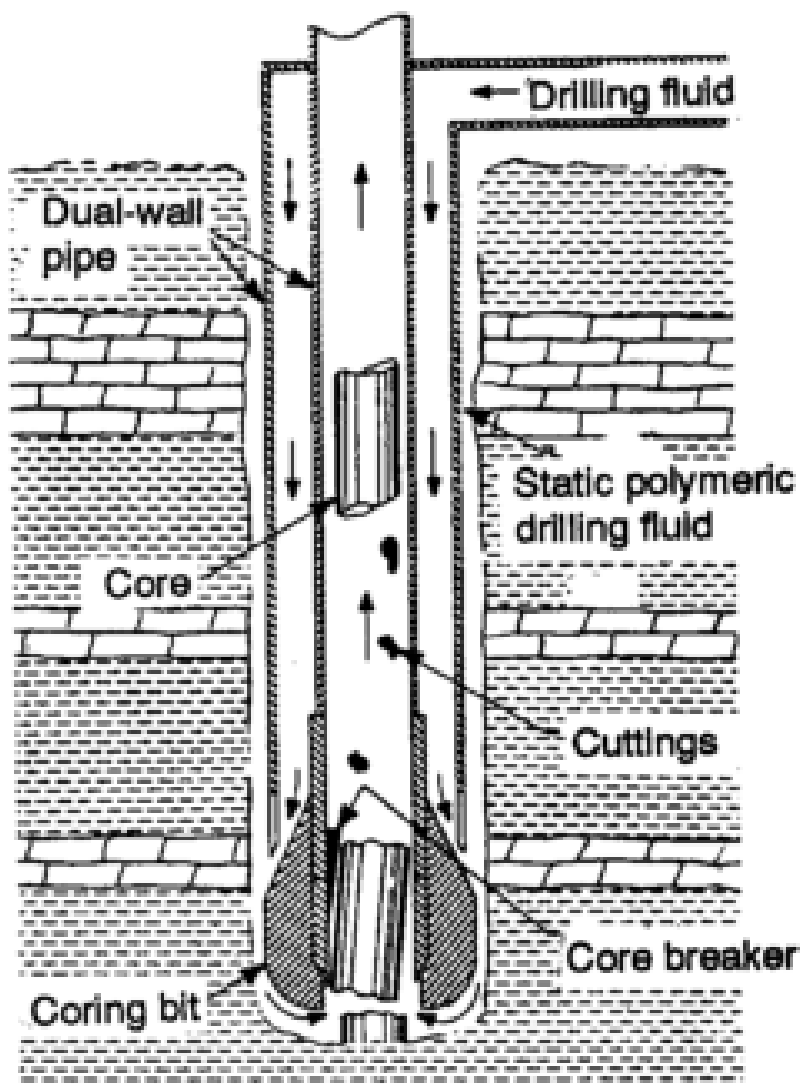
BEDDING THICKNESS CLASSIFICATION

<u>Thickness (Metric)</u>	<u>Approx. English Equivalent</u>	<u>Classification</u>
> 1.0 meter	>3.3 feet	Massive
30 cm – 1 meter	1.0 ft – 3.3 ft	Thick Bedded
10 cm – 30 cm	4 in. – 1.0 ft	Medium Bedded
3 cm - 10 cm	1 in. – 4 in.	Thin Bedded
1 cm – 3 cm	2/5 in. – 1 in.	Very Thin Bedded
3 mm – 1 cm	1/8 in. – 2/5 in.	Laminated
1 mm – 3 mm	1/32 in. – 1/8 in.	Thinly Laminated
< 1 mm	<1/32 in.	Micro Laminated

ROCK CORE CLASSIFICATION PROCEDURE

FIGURE 1

STANDARD DOUBLE-TUBE, SWIVEL-TYPE CORE BARREL IN ACTION

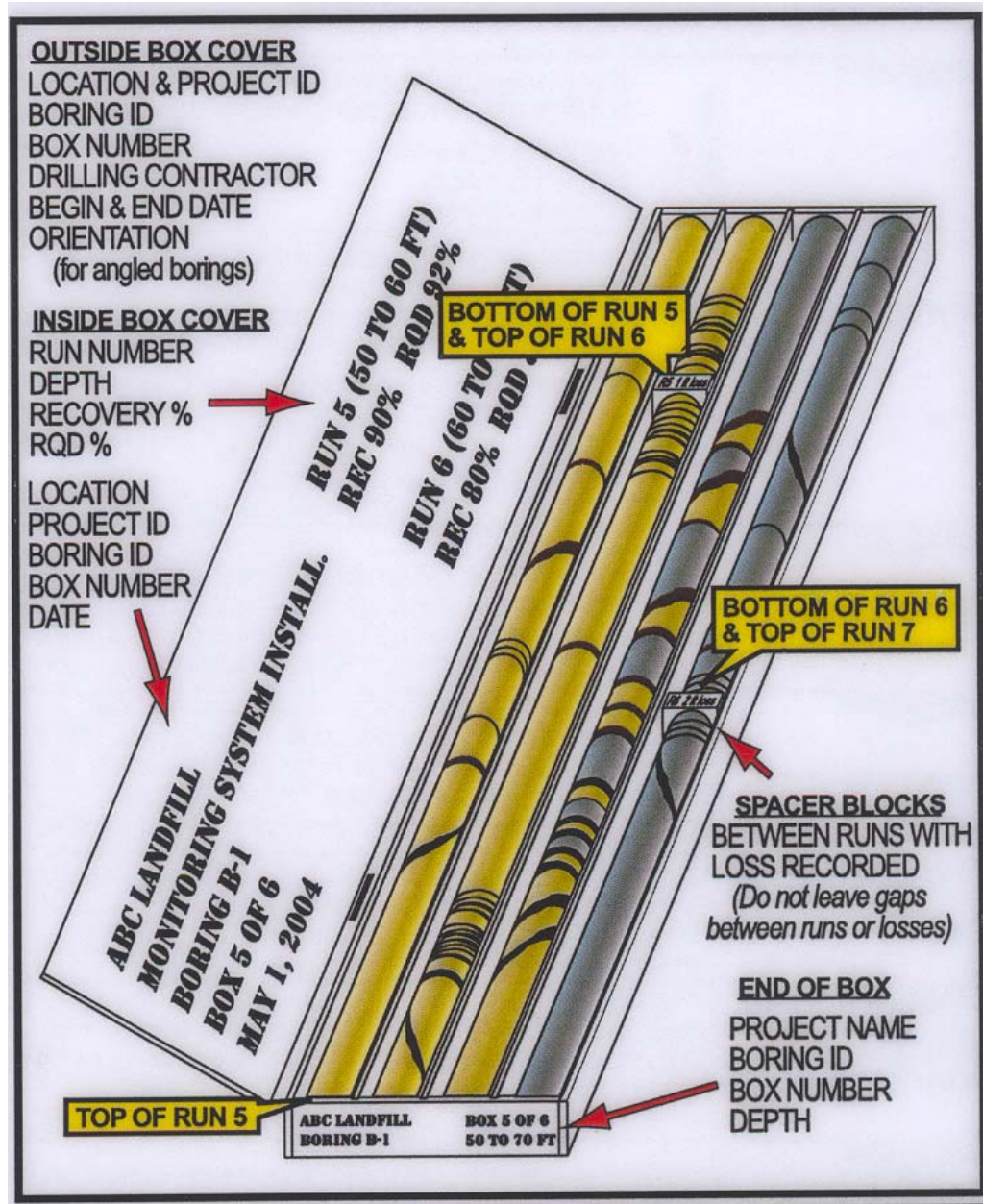




ROCK CORE CLASSIFICATION PROCEDURE

FIGURE 2

CORE PLACEMENT & CORE BOX LABELING



## ROCK CORE CLASSIFICATION PROCEDURE

FIGURE 3

### LIST OF COMMON ROCK NAMES

METAMORPHIC ROCKS	NON-FOLIATED	FAULT BRECCIA QUARTZITE MARBLE HORNFELS		
	FOLIATED	AMPHIBOLITE GNEISS	SCHIST SLATE	MYLONITE / PHYLLITE

IGNEOUS ROCKS	QUARTZ RICH	PEGMATITE	COARSE-GRAINED GRANITE MEDIUM-GRAINED APLITE	FINE-GRAINED RHYOLITE RHYODACITE
			DIORITE GRANODIORITE	DACITE
	SOME QUARTZ		QUARTZ MONZONITE QUARTZ SYENITE	QUARTZ LACITE QUARTZ TRACHYTE TRACHYANDESITE ANDESITE
	QUARTZ POOR		GABBRO	BASALT PERIDOTITE
			LAMPROPHYRE	

PYROCLASTIC ROCKS	PYROCLASTIC BRECCIA	LAPILLI TUFF	COARSE ASH TUFF	FINE ASH TUFF
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SEDIMENTARY ROCKS	Chemical & Biochemical Rocks	LIMESTONE, DOLOMITE, AND EVAPORITES		
				CHERT
SEDIMENTARY ROCKS	Detrital Rocks	SEDIMENTARY BRECCIA / CONGLOMERATE	SANDSTONE	SILTSTONE SHALE COAL

FIELD OPERATING PROCEDURES

Rock Quality  
Designation (RQD)  
Procedure

**ROCK QUALITY DESIGNATION (RQD) PROCEDURE**

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**PURPOSE**

This guideline presents a method to describe the Rock Quality Designation (RQD), which is a simple and direct means of indicating rock mass properties. RQD is based on a modified core recovery procedure, which, in turn, is based indirectly on the number of fractures and the amount of softening, or alternation in the rock mass as observed in the rock cores from the borehole. Core recovery is the ratio of the length of core recovered to the length drilled (i.e., no recovery = 0 and full recovery = 100). This procedure is an indicator of the general quality of rock for engineering purposes and provides a numerical value, which is more sensitive and consistent than gross percentage core recovery.

**PROCEDURE**

Sum the total length of core recovered by counting only those pieces of hard and sound core which are two times the core diameter (4 inches (10cm) for NX core) or greater in length and divide that sum by the total length of that core run. RQD is presented as a percentage and descriptive modifier as presented below.

<b>Rock Quality Designation (RQD) (%)</b>	<b>Description of Rock Quality</b>
0 – 25	Very Poor
26 – 50	Poor
51 – 75	Fair
76 – 90	Good
91 – 100	Excellent

**ROCK QUALITY DESIGNATION (RQD) PROCEDURE**

---

**LIMITATIONS**

1. RQD should not be applied to core less than 2 inches (5.4 cm) in diameter as a false RQD may be obtained because smaller cores can be frequently broken during the coring operation.
2. Care must be taken when removing the core from the core barrel. If a core is broken by handling or during drilling, the fresh broken pieces should be fitted together and counted as one piece.
3. Some judgment is necessary in the case of thinly bedded sedimentary rock and foliated metamorphic rocks. The method is most suitable for igneous rock, thick-bedded limestone, sandstone, etc. However, this procedure can be applied to shales, although it is necessary to log the cores immediately upon removal from the core barrel before air slaking and cracking can occur.
4. Although this procedure is less applicable where core recovery is poor, the results are indicative of poor quality rock. It should however be noted that poor drilling techniques and equipment can also cause poor recovery. It is for this reason that proper equipment and procedure along with competent supervision of the drilling procedure are imperative.

**EXAMPLE**

An example RQD calculation is attached to this FOP.

**ATTACHMENTS**

none

**REFERENCES**

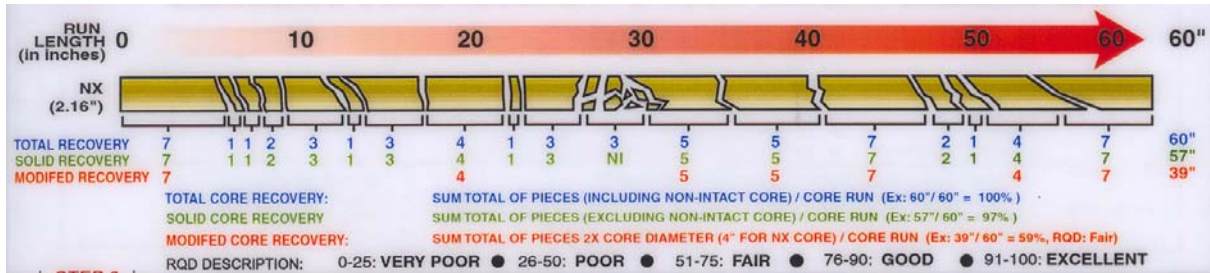
none



## ROCK QUALITY DESIGNATION (RQD) PROCEDURE

### EXAMPLE

#### MODIFIED CORE RECOVERY AS AN INDEX OF ROCK QUALITY



From the figure above:

Total Core Recovery (in.)	Modified Core Recovery (in.)
7	7
1	
1	
2	
3	
1	
3	
4	4
1	
3	
3	
5	5
5	5
7	7
2	
1	
4	
7	7
60	39

ROCK QUALITY DESIGNATION (RQD) PROCEDURE

---

**NOTES:**

60 inches = length of run.

Core Recovery =  $(60''/60'') \times 100 = 100\%$

RQD =  $(39''/60'') \times 100 = 59\%$ , therefore RQD is Fair.

In this case, the core barrel was advanced 60 inches with a total recovery of 60 inches. However, due to fractures, soft zones, etc., the modified recovery was only 39 inches. This equates to an RQD of 59%, which can be used as a modifier in the geologic description of the rock, which in this case would be "Fair."

# FIELD OPERATING PROCEDURES

## Sample Labeling, Storage, and Shipment Procedures



**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:

<b>Sample I.D. Example: GW051402047</b>	
<b>GW</b>	<b>Sample matrix</b> GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
<b>05</b>	Month of sample collection
<b>14</b>	Day of sample collection
<b>02</b>	Year of sample collection
<b>047</b>	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 47<sup>th</sup> sample retained for analysis during the field investigation, collected on May 14, 2002.

**SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES**

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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.

**SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES**

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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.

**SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES**

---

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

## SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]

**FOP 046.0**

**SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES**



## CHAIN OF CUSTODY RECORD

[illegible]

## SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]

## SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]



## SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

[illegible]

FIELD OPERATING PROCEDURES

Screening of Soil  
Samples for Organic  
Vapors During Drilling  
Activities

**SCREENING OF SOIL SAMPLES FOR ORGANIC  
VAPORS DURING DRILLING ACTIVITIES**

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**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  $\frac{1}{2}$  to  $\frac{3}{4}$  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.

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## FOP 047.0

### SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

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6. Place field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit.
7. Leave the field screening sample bag for at least 30 minutes, but no more than 60 minutes.
8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.
9. Record the maximum reading in parts per million by volume (ppmv) on the Field Borehole Log or Field Borehole/Monitoring Well Installation Log form (see attached samples) (see Documentation Requirements for Drilling and Well Installation FOP), at the depth interval corresponding to the depth of sample collection.

#### ATTACHMENTS

Field Borehole Log (sample)

Field Borehole/Monitoring Well Installation Log (sample)

#### REFERENCES

##### Benchmark FOPs:

- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 015 *Documentation Requirements for Drilling and Well Installation*
- 058 *Split Spoon Sampling Procedures*

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**FOP 047.0**

**SCREENING OF SOIL SAMPLES FOR ORGANIC  
VAPORS DURING DRILLING ACTIVITIES**




Page 4 of 4

FIELD OPERATING PROCEDURES

Soil Description  
Procedures Using The  
Visual-Manual Method

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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**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.



**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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**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.

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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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

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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- 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

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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- 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 difficulty 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

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- 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

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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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 DESCRIPTION PROCEDURES  
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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 wax 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 1/2 to 3/4 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:

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- 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



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- 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

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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

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

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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. If 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.

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- 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,

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can be very helpful and are recommended in the ASTM Standard. If additional tests are performed, in addition to plasticity, to classify the fines, record them with the soil description on the logs. Doing this will assist the reader (i.e., Project Manager) to follow the logic used to describe a soil (e.g., medium plasticity, low dry strength = elastic silt [MH]; not a lean clay [CL]).

Fines described in the classification should be modified by their plasticity (e.g., non-plastic fines, low plasticity fines, etc.) reserving the words “silt” and “clay” for the soil name.

In summary, adhering to the ASTM Standard and the guidelines outlined in this FOP will provide uniformity in soil descriptions provided by all field personnel. Prior to mobilization to the field, field staff should make sure to have laminated copies of the ASTM Standard flow charts and tables as well as this FOP (as necessary). Some examples of complete soil descriptions are as follows:

**Coarse-grained Soil**

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

**Fine-grained Soil**

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

**Soil/Fill (option 1) – visual evidence of fill**

FILL: Black, moist, mostly fines with some fine sand, slag, cinders, metal, brick, non-plastic, loose when disturbed, strong odor

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**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

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- 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).*

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## FOP 054.2

### SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

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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:

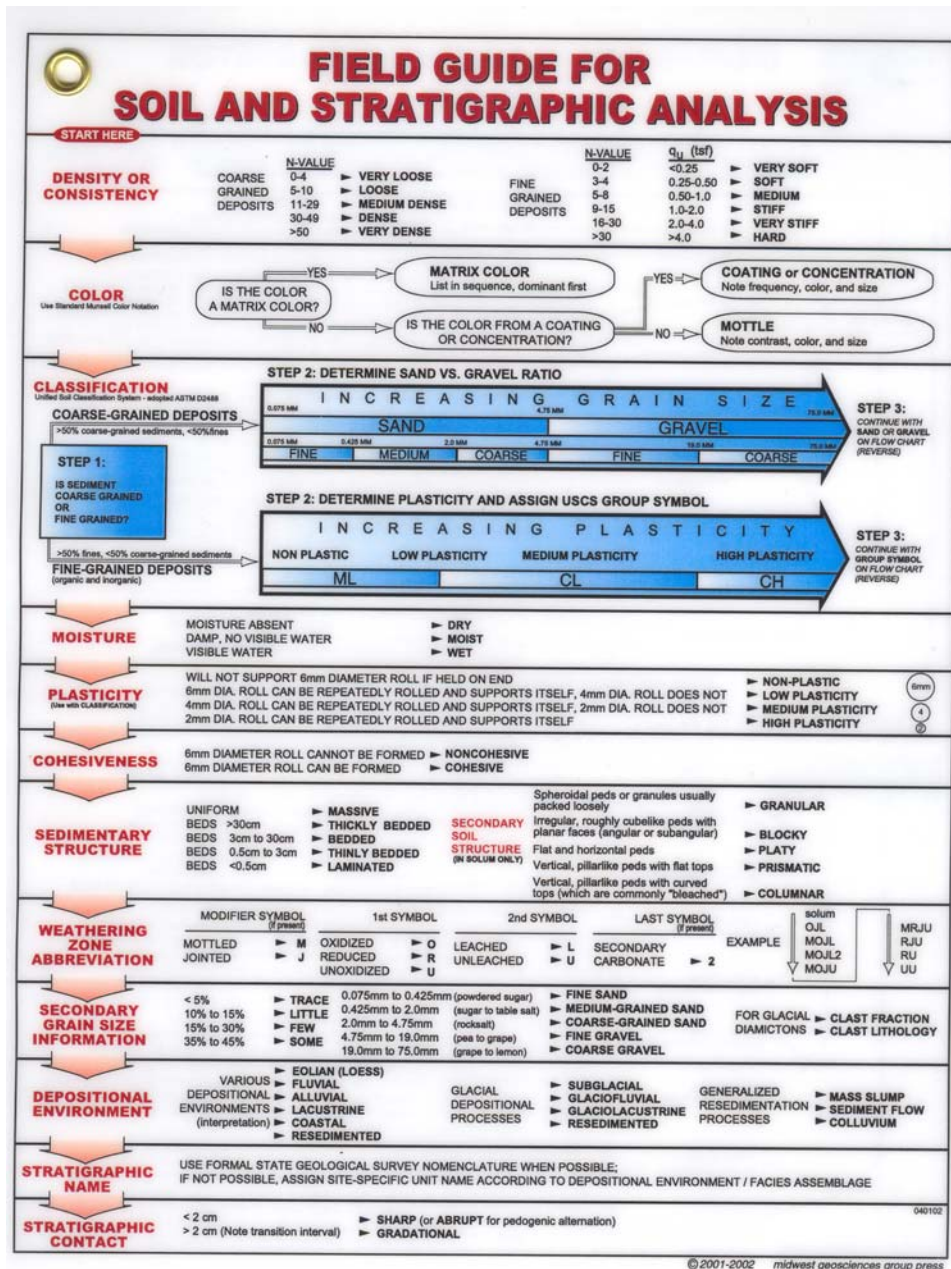
- 010 *Calibration and Maintenance of Portable Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 015 *Documentation Requirements for Drilling and Well Installation*
- 025 *Hand Augering Procedures*
- 032 *Management of Investigation-Derived Waste*
- 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*



# SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 1

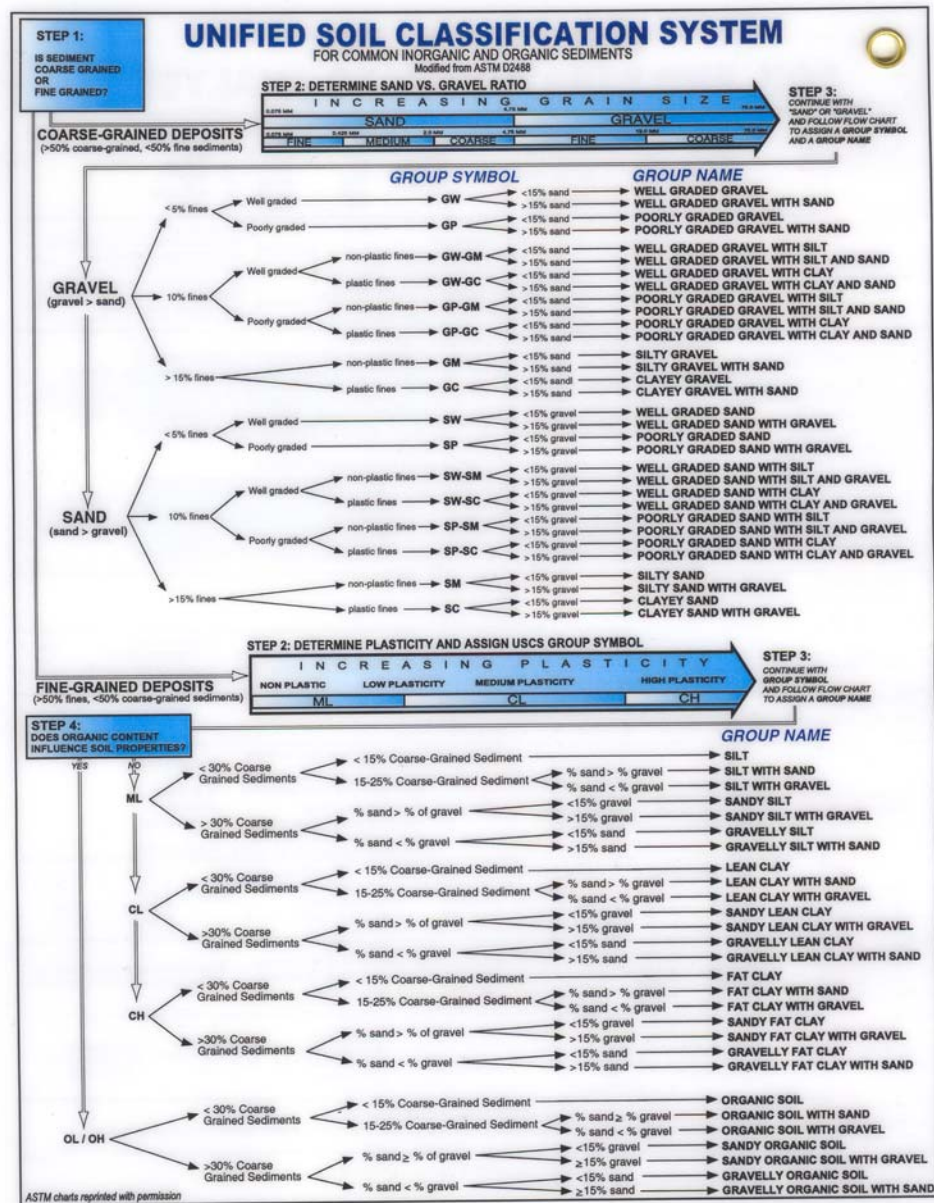
## FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



## SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

FIGURE 2

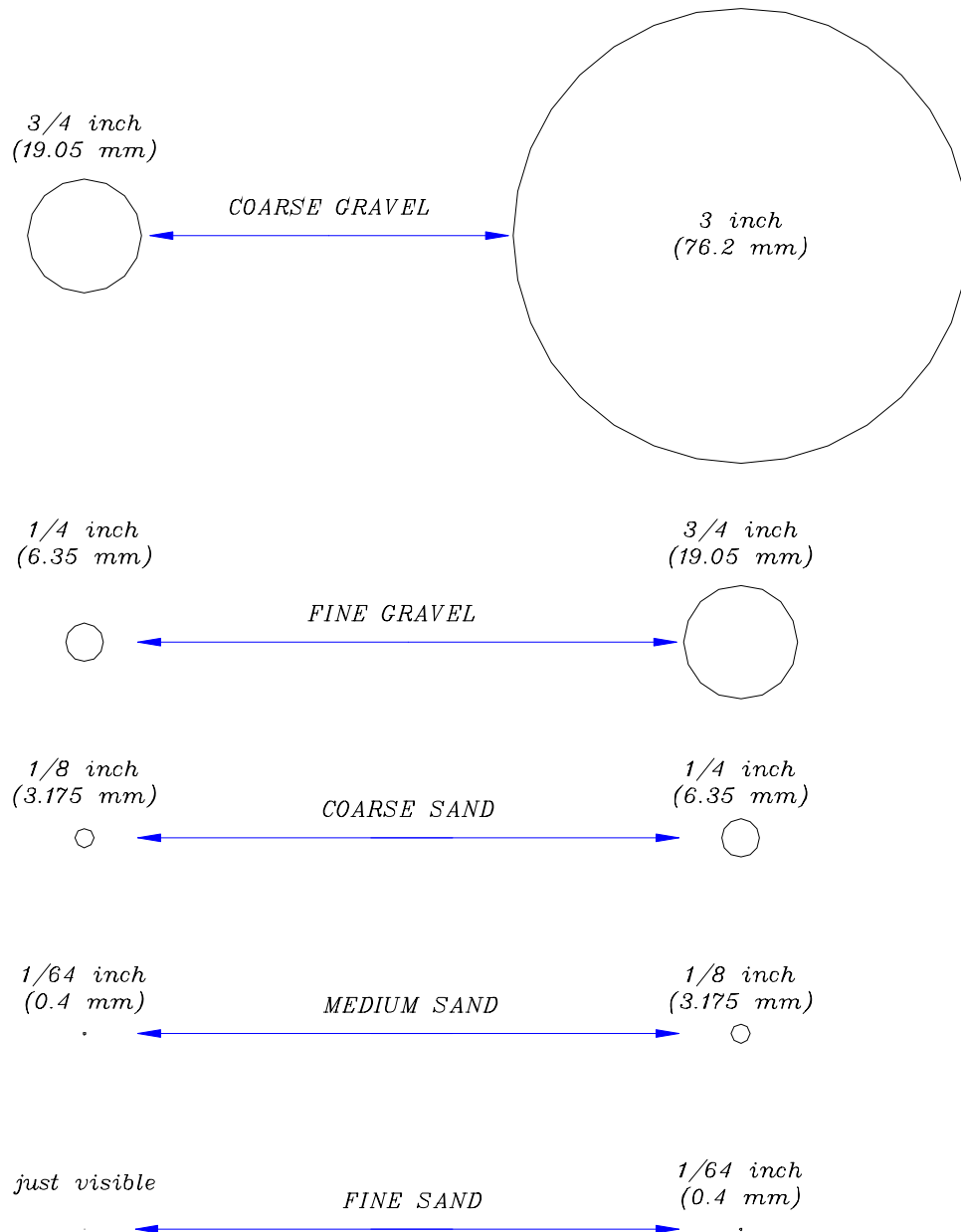
### USCS SOIL CLASSIFICATION FLOW CHART (MODIFIED FROM ASTM D2488)



SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD

FIGURE 3

ILLUSTRATION OF PARTICLE SIZES



## SOIL DESCRIPTION PROCEDURES USING THE VISUAL-MANUAL METHOD

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* ( $\varphi$ ) scale, a modification of the Wentworth scale created by W. C. Krumbein, is a logarithmic scale computed by the equation:  $\varphi = -\log_2(\text{grain size in mm})$ .

$\varphi$ 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	$\frac{1}{2}$ –1 mm	0.020–0.039 in	Coarse sand
2 to 1	$\frac{1}{4}$ – $\frac{1}{2}$ mm	0.010–0.020 in	Medium sand
3 to 2	125–250 $\mu\text{m}$	0.0049–0.010 in	Fine sand
4 to 3	62.5–125 $\mu\text{m}$	0.0025–0.0049 in	Very fine sand
8 to 4	3.90625–62.5 $\mu\text{m}$	0.00015–0.0025 in	Silt
$> 8$	$< 3.90625$ $\mu\text{m}$	$< 0.00015$ in	Clay
$< 10$	$< 1$ $\mu\text{m}$	$< 0.000039$ 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  $-6$   $\varphi$ ).*

FOP 054.2

**SOIL DESCRIPTION PROCEDURES  
USING THE VISUAL-MANUAL METHOD**

<i>Project No:</i> <span style="color: blue;">Borehole Number:</span>					 <b>BENCHMARK</b> ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC <small>Benchmark Environmental Engineering &amp; Science, PLLC 726 Exchange Street, Suite 624 Buffalo, NY (716) 856-0599</small>									
<i>Project:</i>														
<i>Client:</i>										<i>Logged By:</i>				
<i>Site Location:</i>										<i>Checked By:</i>				

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

<i>Drilled By:</i> <i>Drill Rig Type:</i> <i>Drill Method:</i>  <i>Drill Date(s):</i>	<i>Hole Size:</i> <i>Stick-up:</i> <i>Datum:</i>  <i>Sheet: 1 of 1</i>
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FIELD OPERATING PROCEDURES

Soil Sample Collection  
for VOC Analysis  
(EnCore Sampling)



**SOIL SAMPLE COLLECTION FOR VOC  
ANALYSIS – ENCORE SAMPLING**

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**BACKGROUND AND PURPOSE**

This procedure describes the methods for collecting soil samples for VOC analysis to ensure that the sample adequately represents the VOC concentrations in the soil in accordance with SW-846 Method 5035A (effective July 1, 2002). These compounds tend to volatilize from the soil after disturbance or introduction to the atmosphere. Therefore, care must be exercised to ensure that the sample collected is not altered during the collection and storage procedures. A variety of sampling options are allowed and Appendix A of Method 5035A provides details regarding the many options available for sample collection. The collection and preservation procedures are intended to prevent loss of VOCs during sample transport, handling and analysis.

Method 5035A is a method designed for volatile sample collection and analysis of soils and solid wastes for volatile organic compounds. This method is described in Update III to the Third Edition of SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, and is required for all analytical methods using purge and trap techniques (8021, 8015B, and 8260B). Alternative protocols may be used in some states (including New York), however this method is strongly recommended.

The volatile analysis is performed over two ranges:

	<u>GC/MS (µg/kg)</u>	<u>GC (µg/kg)</u>
Low Level	5 – 300	Not Available
High Level	>250	>20

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## FOP 057.0

### SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

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The different levels require different sampling techniques. The low level method can only handle samples within a specific concentration range (these samples CANNOT be diluted), therefore a high level sample MUST be collected to ensure that all the target analytes can be quantified.

Naturally occurring carbonates in some soils may cause effervescence (foaming) on contact with the sodium bisulfate (NaHSO<sub>4</sub>) solution used as preservative for the low-level preparation. This interference makes it necessary for the laboratory to use the high-level prep or an alternative technique for low level. Check with the NYSDEC to discuss acceptable options.

Typically, analytical laboratories will support the following options for the two levels:

Option	No. of Containers	Sample Size (g)	Holding Time (days)
A – Low Level EnCore™ Samplers	3*	5	14**
B – High Level EnCore™ Sampler	1*	5	14**
C – High Level Methanol vial w/syringe	1	10	14
* Additional EnCore™ Samplers are required for MS/MSD.			
** The sample MUST be extracted and preserved in sodium bisulfate or methanol within 48 hours of collection.			

**NOTE:** The EnCore™ Sampler is disposable – it can only be used ONCE. It CANNOT be cleaned and/or reused. The samplers MUST be used in conjunction with an EnCore™ T-handle.



**SOIL SAMPLE COLLECTION FOR VOC  
ANALYSIS – ENCORE SAMPLING**

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**PROCEDURE**

The preferred method for collecting and storing a soil sample for VOC analysis is using the EnCore™ method. This field procedure is described in this FOP.

1. The sampling team should reference the manufacturers' directions prior to sample collection (attached).
  - a. Ensure that the EnCore™ Sampler is present at the sampling location before collecting the sample from the borehole or surface sample location. The necessary parts of the EnCore™ Sampler will consist of three disposable coring bodies, three disposable caps, and a reusable stainless steel T-handle.
  - b. Retrieve the sampling tool from the borehole or sample location.
  - c. Expose a surface of the soil sample. For Shelby tube samples, this would require the extrusion of the sample. For split spoon samples, this would require the spoon be disassembled and opened. If liners are being used in conjunction with a split spoon or solid barrel sampler, this would require the removal of the liners from the sampler, so that the soil at the liner's end is exposed.
  - d. Following the manufacturer's directions for the use of the EnCore™ Sampler (attached), collect three aliquots of soil from the exposed soil surface, using the three coring bodies. After the collection of each aliquot, cap and label each aliquot. The manufacturer's direction for use of the EnCore™ Sampler are attached
2. If the use of the EnCore™ Sampler is not possible due to soil texture (e.g. gravels) the sample must be field preserved with acid and methanol in accordance with SW-846 Method 5035A.

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## FOP 057.0

### SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

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3. If the soil material is too coarse for sampling with the EnCore™ Sampler and contains excessive calcium carbonate material that reacts with the acid preservative, the sample will be retained in the brass or stainless steel liner of the split-spoon sampler or similar device. The ends of these liners will be covered with Teflon™ rounds, capped and sealed with tape.
4. Record all information associated with sample collection in the Project Field Book.
5. The samples will be labeled, stored and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

#### ATTACHMENTS

EnCore™ Sampling Procedure (manufacturers instructions)

#### REFERENCES

Benchmark FOPs:

046 *Sample Labeling, Storage and Shipment Procedures*

## SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

### ATTACHMENT

#### EnCore™ Sampling Procedure (manufacturers instructions)

### Disposable EnCore® Sampler



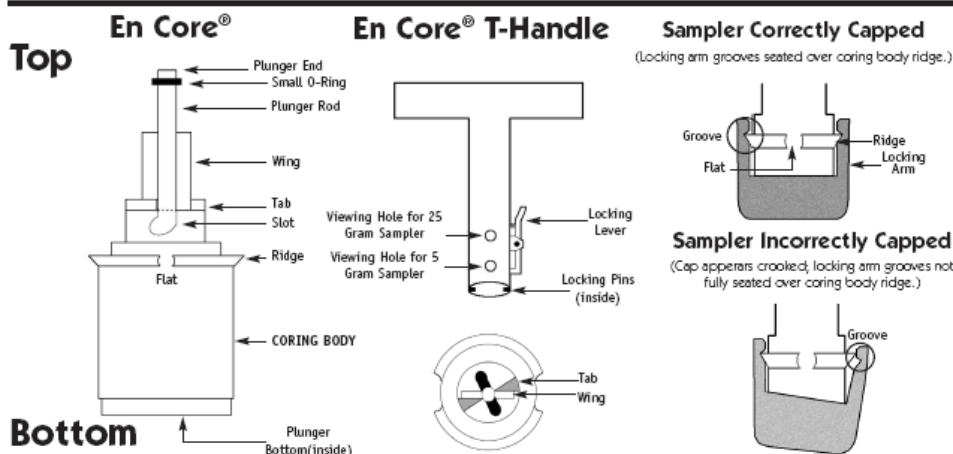
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[www.ennovativetech.com](http://www.ennovativetech.com)

### Sampling Procedures

#### Using The En Core® T-Handle

**NOTE:**

1. En Core® Sampler is a SINGLE USE device. It cannot be cleaned and/or reused.
2. En Core® Sampler is designed to store soil. Do not use En Core Sampler to store solvent or free product!
3. En Core® Sampler must be used with En Core® T-Handle and/or En Core® Extrusion Tool exclusively. (These items are sold separately.)



**BEFORE TAKING SAMPLE:**

1. Hold coring body and push plunger rod down until small o-ring rests against tabs. This will assure that plunger moves freely.

2. Depress locking lever on En Core T-Handle. Place coring body, plunger end first, into open end of T-Handle, aligning the (2) slots on the coring body with the (2) locking pins in the T-Handle. Twist coring body clockwise to lock pins in slots. Check to ensure Sampler is locked in place. Sampler is ready for use.

**TAKING SAMPLE:**

3. Turn T-Handle with T-up and coring body down. This positions plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push Sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-Handle viewing hole. Remove Sampler from soil. Wipe excess soil from coring body exterior.

4. Cap coring body while it is still on T-handle. *Push* cap over flat area of ridge *and twist* to lock cap in place. **CAP MUST BE SEATED TO SEAL SAMPLER** (see diagram).

**PREPARING SAMPLER FOR SHIPMENT:**

5. Remove the capped Sampler by depressing locking lever on T-Handle while twisting and pulling Sampler from T-Handle.
6. Lock plunger by rotating extended plunger rod fully counter-clockwise until wings rest firmly against tabs (see plunger diagram).
7. Attach completed tear-off label (from En Core Sampler bag) to cap on coring body.
8. Return full En Core Sampler to zipper bag. Seal bag and put on ice.

## SOIL SAMPLE COLLECTION FOR VOC ANALYSIS – ENCORE SAMPLING

### Disposable EnCore® Sampler EXTRUSION PROCEDURES

#### USING THE EnCore® EXTRUSION TOOL

**CAUTION!** Always use the Extrusion Tool to extrude soil from the En Core Sampler. If the Extrusion Tool is not used, the Sampler may fragment, causing injury.

1. Use a pliers to break locking arms on cap of En Core Sampler. Do not remove cap at this time. (CAUTION: Broken edges will be sharp.)
2. To attach En Core Sampler to En Core Extrusion Tool: Depress locking lever on Extrusion Tool and place Sampler, plunger end first, into open end of Extrusion Tool, aligning slots on coring body with pins in Extrusion Tool. Turn coring body clockwise until it locks into place. Release locking lever.
3. Rotate and gently push Extrusion Tool plunger knob clockwise until plunger slides over wings of coring body. (When properly positioned plunger will not rotate further.)
4. Hold Extrusion Tool with capped Sampler pointed upward so soil does not fall out when cap is removed. To release soil core, remove cap from Sampler and push down on plunger knob of En Core Extrusion Tool. Remove and properly dispose of En Core Sampler.

#### Warranty and Disclaimers

**IMPORTANT:** FAILURE TO USE THE EN CORE® SAMPLER IN COMPLIANCE WITH THE WRITTEN INSTRUCTIONS PROVIDED HEREIN VOIDS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

**PRINCIPLE OF USE.** The En Core Sampler Cartridge System is a volumetric sampling system designed to collect, store and deliver a soil sample. The En Core Sampler comes in two sizes for sample volumes of approximately 25 or 5 grams. There are four components: the cartridge with a movable plunger; a cap with two locking arms; a T-handle (purchased separately); and an extrusion handle (purchased separately). NOTE: The En Core Sampler is designed to store soil. It is not designed to store solvent or free product.

The soil is stored in a sealed headspace-free state. The seals are achieved by three special Viton® \* o-rings, two located on the plunger and one on the cap of the Sampler. At no time and under no condition should these o-rings be removed or disturbed.

**QUALITY CONTROL.** The cartridge is sealed in an airtight package to prevent contamination prior to use. Due to the stringent quality control requirements associated with the use of this system, the disposable cartridge is designed to be used only once.

**WARRANTY.** En Novative Technologies, Inc. ("En Novative Technologies") warrants that the En Core Sampler shall perform consistent with the research conducted under En Novative Technologies' approval, within thirty (30) days from the date of delivery, provided that the Customer gives En Novative Technologies prompt notice of any defect or failure to perform and satisfactory proof thereof. THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING, AS SOLELY DETERMINED BY EN NOVATIVE TECHNOLOGIES: (a) Damage caused by accident, abuse, mishandling or dropping; (b) Samplers that have been opened, taken apart or mishandled; (c) Samplers not used in accordance with the directions; and (d) Damages exceeding the cost of the sampler. Seller warrants that all En Core Samplers shall be free from defects in title. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY INFORMATION PROVIDED BY SALES REPRESENTATIVES OR IN MARKETING LITERATURE. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. En Novative Technologies' warranty obligations and Customer's remedies, except as to title, are solely and exclusively as stated herein.

**LIMITATION OF LIABILITY.** IN NO EVENT SHALL EN NOVATIVE TECHNOLOGIES

BE LIABLE FOR ANTICIPATED PROFITS, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF REVENUE, DOWNTIME, REMEDIATION ACTIVITIES, REMOBILIZATION OR RESAMPLING, COST OF CAPITAL, SERVICE INTERRUPTION OR FAILURE OF SUPPLY, LIABILITY OF CUSTOMER TO A THIRD PARTY, OR FOR LABOR, OVERHEAD, TRANSPORTATION, SUBSTITUTE SUPPLY SOURCES OR ANY OTHER EXPENSE, DAMAGE OR LOSS, INCLUDING PERSONAL INJURY OR PROPERTY DAMAGE. En Novative Technologies' liability on any claim of any kind shall be replacement of the En Core Sampler or refund of the purchase price. En Novative Technologies shall not be liable for penalties of any description whatsoever. In the event the En Core Sampler will be utilized by Customer on behalf of a third party, such third party shall not occupy the position of a third-party beneficiary of the obligation or warranty provided by En Novative Technologies, and no such third party shall have the right to enforce same. All claims must be brought within one (1) year of shipment, regardless of their nature.



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The En Core™ Sampler is covered by One or More of the Following U.S. Patents: 5,343,771; 5,505,098; 5,517,868; 5,522,271. Other U.S. and Foreign Patents Pending.

\* Viton® is a registered trademark of DuPont Dow Elastomers.

# FIELD OPERATING PROCEDURES

## Split-Spoon Sampling Procedures

**SPLIT-SPOON SAMPLING PROCEDURES**

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**PURPOSE**

This guideline presents the methods for using a split-spoon sampler for collecting soil samples from a boring and for estimating the relative in-situ compressive strength of subsurface materials (ASTM D 1586). Representative samples for lithologic description, geochemical analysis, and geotechnical testing will be collected from the subsurface materials using the split-spoon sampler.

**PROCEDURE**

1. Place plastic sheeting on a sturdy surface to prevent the split-spoon and its contents from coming in contact with the surface (several layers of sheeting may be placed on the surface so that they may be removed between each sample or as needed).
2. Lower the sampling string to the base of the borehole. Measure the portion of the sampling string that extends above surrounding grade (i.e. the stickup). The depth of sampling will equal the total length of the string (sampler plus rods) minus the stickup length.
3. Measure sampling depths to an accuracy of 0.1 feet. If field measurements indicate the presence of more than 0.3 feet of disturbed materials in the base of the borehole (i.e. slough), the sampler will be used to remove this material, after which a second sampling trip will be made.
4. Select additional sampler components as required (i.e., leaf spring core retainer for clays or a sand trap for non-cohesive sands). If a retainer or trap is not used, a spacer ring will be used to hold the liners in position inside the sampler.
5. For driving samples, attach the drive head sub and hammer to the drill rods without the weight resting on the rods. For pushing samples using the rig hydraulics, skip to Step 9.

**SPLIT-SPOON SAMPLING PROCEDURES**

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6. Mark four 6-inch intervals on the drill rods relative to a reference point on the drill rig. With the sampler resting on the bottom of the hole, drive the sampler with the 140 lb. hammer falling freely over a 30-inch fall until 24 inches have been penetrated or 50 blows applied.
7. Record the number of blows per 6 inches. Determine the “N” value by adding the blows for the 6 to 12-inch and 12 to 18-inch intervals of each sample drive.
8. After penetration is complete, remove the sampling string. Avoid removing sampling string by hitting up on the string with the hammer as this can cause the sample to fall from the bottom of the split-spoon sampler. The sampling string should be removed via cable lifting or rig hydraulics. If sample retention has been poor, let the sampling string rest in place for at least 3 minutes, then rotate clockwise at least 3 times before removing from the borehole.
9. For pushed samples (i.e., using rig hydraulics), mark four 6-inch intervals on the drill rods relative to a reference point on the rig. Use the rig pull-down to press the sampler downward until 24 inches have been penetrated or no further progress can be made with the full weight of the rig on the sampler.
10. Remove the split-spoon sampler from the sampling string and place on the plastic-covered surface.
11. Open the split-spoon sampler only when the Benchmark field geologist is prepared to describe and manage the sample.
12. Describe the sample in accordance with the Unified Soil Classification System in accordance with the Benchmark FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).
13. Record all information in accordance with Benchmark’s FOP: Documentation Requirements for Drilling and Well Installation.

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## FOP 058.0

### SPLIT-SPOON SAMPLING PROCEDURES

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14. Collect a portion of the sample for field screening as described in the Benchmark FOP: Screening of Soil Samples for Organic Vapors During Drilling Activities.
15. If applicable, collect soil samples for volatile organic constituents (VOCs). If applicable, collect sample for semi-volatile, metals, geotechnical, or other off-site analysis.
16. The samples will be labeled, stored and shipped in accordance with the Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures.

#### ATTACHMENTS

none

#### REFERENCES

##### Benchmark FOPs:

- 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)*



# FIELD OPERATING PROCEDURES

## Surface and Subsurface Soil Sampling Procedures

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## FOP 063.2

### SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

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#### 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.

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## FOP 063.2

### SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

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#### 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.

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## FOP 063.2

### SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

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2. Transfer samples for chemical (VOC, SVOC, Metals etc.) and physical (i.e., Atterberg Limits, Grain Size, Permeability etc.) analytical testing by direct grab (i.e., directly from the bucket of the excavation equipment, split-spoon sampler, hand auger etc.) using the dedicated (or decontaminated non-dedicated) sampling tools into appropriate laboratory-supplied containers and seal. The chemical or physical laboratory selected to perform the analysis should determine minimum sample volume for analysis.
3. Prepare collected samples in accordance with Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures. Do not allow the chemical soil samples to freeze during storage and shipping. It should be noted, ice is not required for physical soil samples and all physical soil samples should be kept at the collected soil moisture by securing with a tight sealing lid. Do not allow physical soil samples to gain or lose moisture from the collected soil moisture prior to analysis.
4. Record all sampling details (i.e., depth and location) in the Project Field Book; appropriate Benchmark log sheets depending on method of intrusion (i.e., drilling, test pitting, hand augering etc.); and on the Soil/Sediment Sample Collection Summary Log (sample attached).

#### PARAMETER-SPECIFIC PROCEDURES

1. Volatile Organic Compound (VOCs): Transfer sufficient soil volume to fill the laboratory-supplied container (typically 4 ounces) by packing the soil sample with the sampling tool to the top of the container leaving no headspace. At no time should a gloved hand (i.e., latex, nitrile etc.) be used to pack the sample into the sample container as the sample may be compromised via cross-contamination.
2. All Other Parameters: All other parameters include, but are not limited to, Semi-VOCs (SVOCs), polychlorinated biphenyls (PCBs), herbicides, pesticides, total metals etc. Transfer sufficient soil volume to fill the laboratory-supplied container by packing the soil sample with the sampling

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## FOP 063.2

### SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

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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

##### 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*
- 040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*
- 046 *Sample Labeling, Storage and Shipment Procedures*
- 073 *Real-Time Air Monitoring During Intrusive Activities*

## FOP 063.2

### SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES



#### TAILGATE SAFETY MEETING FORM

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

#### **HOSPITAL INFORMATION:**

Name: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
Phone No.: \_\_\_\_\_ Ambulance Phone No. \_\_\_\_\_

#### **SAFETY TOPICS PRESENTED:**

Chemical Hazards: \_\_\_\_\_  
\_\_\_\_\_  
Physical Hazards: \_\_\_\_\_ Slips, Trips, Falls  
\_\_\_\_\_

#### **PERSONAL PROTECTIVE EQUIPMENT:**

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

New Equipment: \_\_\_\_\_  
\_\_\_\_\_

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

#### ATTENDEES

Name Printed	Signatures
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting conducted by: \_\_\_\_\_  
\_\_\_\_\_

## SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

SOIL/SEDIMENT  
SAMPLE COLLECTION SUMMARY LOG[illegible]





FIELD OPERATING PROCEDURES

Well/Piezometer  
Construction Materials  
and Design

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## FOP 070.0

### WELL/PIEZOMETER CONSTRUCTION MATERIALS AND DESIGN

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#### PURPOSE

This guideline presents construction materials and design requirements for monitoring well/piezometer installations in accordance with NYSDEC recommended specifications (6NYCRR Part 360).

#### CONSTRUCTION MATERIALS

1. Well Screen and Riser – Only new flush threaded screen and riser materials will be used. Screen and riser materials, well dimensions, screen slot opening size and length to be determined based on formation characteristics and suspect water quality or as specified by the project geologist/hydrogeologist. A vented cap or J-plug should be placed over the riser. A V-slot cut in the riser or permanent marking, both placed on the north side of the riser, will act as a monitoring reference point.
2. Bentonite Well Seal – The bentonite should be from a commercial source free of chemical additives (granular or powdered for grout and pelletized for seal).
3. Concrete – Low heat of hydration concrete should be used for grout and cementing protective casing if well construction materials are composed of PVC (ASTM Type II or Type IV Portland Cement).
4. Water – Water should be from a potable source of known chemistry and free of chemical constituents which may compromise integrity of installation.
5. Grout – Mixture of bentonite, cement and water in accordance with the following specifications. Premix bentonite and water prior to adding cement.

#### Grout Slurry Composition (% Weight)

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

**WELL/PIEZOMETER CONSTRUCTION MATERIALS  
AND DESIGN**

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6. Filter Pack – The filter pack should consist of clean, inert, siliceous, rounded to subrounded particles. Filter pack particle size is dependent on the formation and the slot size of the screen.

A secondary filter about 6-inches thick may be placed between filter pack and the bentonite seal and potentially between the bentonite seal and the grout backfill, to minimize grout penetration of the seal. A uniformly graded fine sand (100% passing No. 30 sieve) should be used as a secondary filter.

7. Protective Casing, Locking Cap and Lock – Protective casing with a lockable cap should be cemented in place around the riser. The inside diameter of the protective casing should be a minimum of 2-inches larger than the outside diameter of the well riser. The annular space between the casing and the riser should be filled with pea gravel or coarse sand. A weep hole should be drilled near the base of the casing to facilitate drainage of standing water. If more than one well is installed, all locks should be keyed alike.
8. A sample of all cement, bentonite and sand used in well construction should be saved in a labeled, Teflon-sealed, precleaned glass jar.

**REFERENCES**

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

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

Sara, M. N., *Proposed Recommended Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers: ASTM Subcommittee D18.21*.

# FIELD OPERATING PROCEDURES

## Real-Time Air Monitoring During Intrusive Activities

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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#### 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

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## FOP 073.2

### **REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE**

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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.

**REAL-TIME AIR MONITORING DURING INTRUSIVE  
ACTIVITIES PROCEDURE**

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**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

**REAL-TIME AIR MONITORING DURING INTRUSIVE  
ACTIVITIES PROCEDURE**

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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.
- **Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures**
  - When work areas are within 20 feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and



**REAL-TIME AIR MONITORING DURING INTRUSIVE  
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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/m<sup>3</sup>, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 mcg/m<sup>3</sup> 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.

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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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

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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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

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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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 ( $\mu\text{g}/\text{m}^3$ ) 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  $\mu\text{g}/\text{m}^3$  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  $\mu\text{g}/\text{m}^3$  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  $\mu\text{g}/\text{m}^3$  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

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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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<sup>3</sup> 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.

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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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.

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## FOP 073.2

### REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

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#### ATTACHMENTS

Real-Time Air Monitoring Log (sample)

#### REFERENCES

TurnKey FOPs:

- 006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
- 010 *Calibration and Maintenance of Flame Ionization Detector*
- 011 *Calibration and Maintenance of Portable Photoionization Detector*
- 084 *Calibration and Maintenance of Portable Particulate Meter*

## REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE



WEATHER CONDITIONS:		
Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

[illegible]

Prepared By: \_\_\_\_\_ Date: \_\_\_\_\_



# FIELD OPERATING PROCEDURES

## “Before Going Into The Field” Procedure

**“BEFORE & AFTER”  
PROJECT PROCEDURES FOR FIELD PERSONNEL**

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**PURPOSE**

This procedure describes the required field and office activities to be preformed “before and after” project assignments by field personnel. Field activities may include, but are not limited to, drilling oversight, excavation contractor oversight, matrix sample collection (e.g., soil, sediment, groundwater, surface water, wipe, and/or air), third party oversight, and site reconnaissance to name a few. Office activities may include, but are not limited to, photocopying field book entries, completing all field forms, tabulating collected field and laboratory data, and preparation of report text.

The primary goal of this procedure is to eliminate delays and unnecessary budgetary “strain” due to a lack of preparedness and knowledge of the site by the field team members. This procedure also seeks to streamline the preparation and transfer of field information/data from field personnel to the Project Manager upon field work completion.

**PROJECT ASSIGNMENT**

During the initial meeting with the Project Manager, several questions should be raised by the field team member and answered by the Project Manager. A pad of paper and pen should be in hand to record all pertinent job information. At a minimum, the following questions should be answered:

1. *What is the job number?*
2. *Who is the client and the on-site representative (if applicable)?*
3. *What is the name of the project?*
4. *What are the job responsibilities and how should they be accomplished?*
5. *How much time do I have to complete the assigned tasks?*
6. *Are there any project required documents? What are they?*

Any deviation from the above questions should be approved by the Project Manager prior to contravention, not at the end of the day or following the project completion.

**“BEFORE & AFTER”  
PROJECT PROCEDURES FOR FIELD PERSONNEL**

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**“BEFORE” CHECKLISTS**

Checklists should be developed and used so that all of the required steps prior to going into the field are undertaken. A good checklist will include:

- Adequate review of the documents listed in this FOP
- Any documents, equipment, and supplies presented in this FOP
- Providing adequate notification to the laboratory (so that holding times are not exceeded) and to the owner of the site and the primary regulatory agency (usually in writing) that a round of sampling is to commence in order to facilitate sampling and allow for a sampling audit or split sampling.
- Specifying and documenting the equipment maintenance and calibration undertaken prior to going into the field relative to the sampling event.
- Checking and calibrating the equipment.
- Listing the documents, equipment, and supplies required to collect samples at the site as presented in this FOP.

Prior to going into the field, sampling personnel should reacquaint themselves with the sampling plan. The review is undertaken so that the required specific protocol such as sampling from the least to the most contaminated wells, knowing where quality control samples are to be taken, knowing the disposition of purge water, etc., is understood and followed.

The amount of equipment maintenance and calibration required prior to going into the field should be clearly specified in the presampling equipment maintenance and calibration checklists, which are based on the manufacturer’s recommendations, sampling objectives, and prior experience. Maintenance and calibration performed before sampling must be

**“BEFORE & AFTER”  
PROJECT PROCEDURES FOR FIELD PERSONNEL**

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documented to provide evidence that the equipment was adequately maintained and calibrated and to keep a permanent record of equipment servicing and performance.

A list of all the documents, equipment, and supplies required for the sampling event should be prepared and used. It can be frustrating and time consuming to forget equipment and supplies, so some up-front preparation is warranted. The following sections provide a list of the documentation, equipment, and supplies, which should assist in preparing a site-specific equipment and supply checklist. Once prepared, the checklist and project requirements should be reviewed with the Project Manager.

**“BEFORE” DOCUMENTATION SUMMARY**

Prior to going into the field, the field team should review and understand all of the project documents including, but not limited to:

- The Health and Safety Plan (HASP)
- The Site Analytical Plan (SAP), Sampling Plan, or similar document
- The Quality Assurance Project Plan (QAPP)
- The Work Plan
- Project specific Field Operating Procedures and field forms
- Site Maps
- Equipment operation manuals
- Chain-of-Custody forms
- Shipping labels and custody seals
- Any reference materials (i.e., conversion tables, volume calculation, etc.). The Pocket Ref, Third Edition by Thomas Glover is a great source for the field.

If at any time, the field team does not understand the project required protocol, procedures, sample locations, etc.; the Project Manager should be consulted for clarification.

**“BEFORE & AFTER”  
PROJECT PROCEDURES FOR FIELD PERSONNEL**

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**“BEFORE” EQUIPMENT SUMMARY**

Prior to going into the field, the field team should review the following equipment checklist, noting that project specific equipment may not be included in this list:

- Water level indicator
- Pumps, sample tubing, flow controllers, power cord(s), batteries, compressors, generators, etc.
- Bailers (disposable, PVC, stainless steel, glass), rope
- Flow-through cell
- Field meters with adequate calibration solutions (pH/Eh meter, conductivity meter, dissolved oxygen meter, turbidity meter, batteries, etc.)
- Garden hose
- Explosive gas meter and/or photoionization detector (PID) with calibration supplies
- Complete set of hand tools including a sharp knife, screw drivers, pliers, hacksaw, flashlight, large pipe wrench, hammer, bolt cutters, and replacement locks
- Fish hook with weight and string
- Field filtering equipment and supplies
- Decontamination supplies, such as scrub brushes, Alconox®, distilled water, potable water, 5-gallon bucket, paper towels, aluminum foil
- 5-gallon bucket(s)
- Measuring cup
- Sample bottles/containers (with extras) and preservatives
- Stainless steel spoons, trowels, shovels
- Shipping containers (i.e., coolers)
- Clipboard
- Calculator
- Water resistant clock or watch with second hand
- First aid kit

**“BEFORE & AFTER”  
PROJECT PROCEDURES FOR FIELD PERSONNEL**

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**“BEFORE” SUPPLIES SUMMARY**

Prior to going into the field, the field team should review the following supplies checklist, noting that project specific supplies may not be included in this list:

- Laboratory grade non-phosphate detergent (Alconox®)
- Appropriate personal protective equipment appropriate to the contaminants of concern, such as nitrile gloves, Tyvek, boots, hardhat, safety glasses, hearing protection, etc.
- Bags of ice
- Plastic garbage bags
- Plastic sheeting
- Sufficient quantities of potable and laboratory grade deionized water for cleaning and equipment blanks
- Methanol
- Isopropyl alcohol
- Clean rags and paper towels
- Electrical tape, duct tape, and wide transparent tape
- Hand soap
- Regular, ballpoint, and indelible pens
- Hollow braid polyethylene rope

After providing adequate notification (lab, state and/or federal agencies), performing the presampling maintenance and calibration, obtaining the site and well keys, and packing the supplies and equipment, the field activities are ready to be performed.

**“AFTER” – PROJECT FILE REVIEW & CREATION**

It is the responsibility of each field crew member to review his/her own field notes and time sheet for accuracy and completeness. All errors to the field notes should be corrected, dated, and initialed for Project Manager review. Once reviewed by the field team member, the Project Field Book, all field forms, photographs, chain-of-custodies etc. must be

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## FOP 076.0

### **“BEFORE & AFTER” PROJECT PROCEDURES FOR FIELD PERSONNEL**

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photocopied, scanned (if required), downloaded, etc. and then given to the Project Manager in an organized file folder in a timely manner. Avoiding delay during this step is critical, especially when there are severe time constraints for the project.

#### **REFERENCES**

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

# FIELD OPERATING PROCEDURES

## Temporary Well (Piezometer) Construction Procedures



**TEMPORARY WELL (PIEZOMETER)  
CONSTRUCTION PROCEDURES**

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**PURPOSE**

Temporary wells (or piezometers) will be installed within selected geoprobe boreholes or test pits for the purpose of evaluating groundwater characteristics, such as flow direction and generally quality. This procedure describes temporary well construction and installation for boreholes drilled using direct push and test pit methodologies. Refer to Benchmark's Geoprobe Drilling Procedure FOP and Test Pit Excavation and Logging Procedures FOP prior to installing a temporary well. Nominal dimensions and materials for the temporary well are shown in the attached temporary well construction diagram.

**GEOPROBE PROCEDURE**

1. Advance borehole in accordance with Benchmark's Geoprobe Drilling Procedure FOP to the required depth. The nominal inside diameter (ID) of the direct-push stem used should be at least 1 inch larger than the outside diameter (OD) of the riser and screen selected for the temporary well installation.
2. Remove the direct-push rods from the borehole and verify the depth using weighted measuring tape confirming the depth to groundwater observed during sample evaluation. If the borehole annulus collapses due to non-cohesive soils (i.e., sand and gravel), additional attempts should be made by the direct push rig to clear the sloughed material. If sloughing continues and the borehole cannot remain open, discontinue temporary well installation and consult the Project Manager and/or Work Plan.
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 direct-push stem to seal the over drilled portion of the borehole. Be sure to note bentonite chip thickness on Field Borehole/Monitoring Well Installation Log.

**TEMPORARY WELL (PIEZOMETER)  
CONSTRUCTION PROCEDURES**

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4. Due to the transient nature of the temporary well(s), a sand filter pack and well development is not required.
5. Measure the length of the 1-inch PVC temporary well string (i.e. riser and screen), and lower the temporary well string into the borehole annulus to the desired depth. All measurements during the temporary well installation process will be accurate to 0.1 foot.
6. Following well string installation, place cement bentonite chips or pellets around the surface to create a watertight seal and hydrate with potable water. A typical temporary well completion detail is attached as Figure 1.
7. Leave the uncapped temporary well undisturbed for at least 1 hour to allow the bentonite chips/pellets surface seal to adequately hydrate as well as to allow shallow groundwater within the screened formation to stabilize within the well.
8. Permanently label the temporary well with the appropriate alphanumeric identifier as determined by the Project Manager or specified in the Work Plan.
9. Permanently mark a survey location on the north side at the top of the PVC riser with a saw cut. Survey all temporary 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 surveys at the Site. Information obtained will include location ( $x$  and  $y$ ) of the temporary well, and elevation ( $z$ ) of the ground surface and the top of riser.
10. Place a lockable J-plug and dedicated lock on the temporary well, and keep the temporary well locked when not actively attended.
11. Manage all waste materials generated during temporary well installation as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

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## FOP 077.0

### TEMPORARY WELL (PIEZOMETER) CONSTRUCTION PROCEDURES

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12. Record the temporary well construction details on a Field Geoprobe Borehole/Temporary Well Installation Log (sample attached) and Temporary Well Completion Detail (sample attached).
13. Refer to Benchmark's Documentation Requirements for Drilling and Well Installation FOP.

#### TEST PITTING PROCEDURE

1. Advance test pit a minimum of five feet into the shallow groundwater bearing zone in accordance with Benchmark's Test Pit Excavation and Logging Procedures FOP to the required depth.
2. At one end of the test pit, excavate an additional small pilot hole to place the 1-inch PVC temporary well string in a vertical position.
3. Verify the depth using weighted measuring tape confirming the depth to groundwater observed during test pit evaluation.
4. Construct the temporary well with a 1-inch diameter (minimum) PVC well screen and riser according to the observed/measured depth to groundwater. Measure the length of the temporary well string (i.e. riser and screen) and lower the string into the open test pit to the desired depth. All measurements during the temporary well installation process will be accurate to 0.1 foot.
5. Slowly backfill around the temporary well with test pit spoils, making sure to keep the well as close to vertical as possible.
6. Due to the transient nature of the temporary well(s), a sand filter pack and well development is not required.
7. Following well string installation, place cement bentonite chips or pellets around the surface to create a watertight seal and hydrate with potable water. A typical temporary well completion detail is attached as Figure 1.

**TEMPORARY WELL (PIEZOMETER)  
CONSTRUCTION PROCEDURES**

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8. Leave the uncapped temporary well undisturbed for at least 1 hour to allow the bentonite chips/pellets surface seal to adequately hydrate as well as to allow shallow groundwater within the screened formation to stabilize within the well.
9. Permanently label the temporary well with the appropriate alphanumeric identifier as determined by the Project Manager or specified in the Work Plan.
10. Permanently mark a survey location on the north side at the top of the PVC riser with a saw cut. Survey all temporary 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 surveys at the Site. Information obtained will include location ( $x$  and  $y$ ) of the temporary well, and elevation ( $z$ ) of the ground surface and the top of riser.
11. Place a lockable J-plug and dedicated lock on the temporary well, and keep the temporary well locked when not actively attended.
12. Manage all waste materials generated during temporary well installation as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.
13. Record the temporary well construction details on a Temporary Well Completion Detail (sample attached).
14. Refer to Benchmark's Documentation Requirements for Drilling and Well Installation FOP.

**ATTACHMENTS**

Figure 1 Typical Temporary Well Construction Detail (Figure 1)

Field Geoprobe Borehole/Temporary Well Installation Log (sample)  
Temporary Well Completion Detail (sample)

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## FOP 077.0

### TEMPORARY WELL (PIEZOMETER) CONSTRUCTION PROCEDURES

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#### REFERENCES

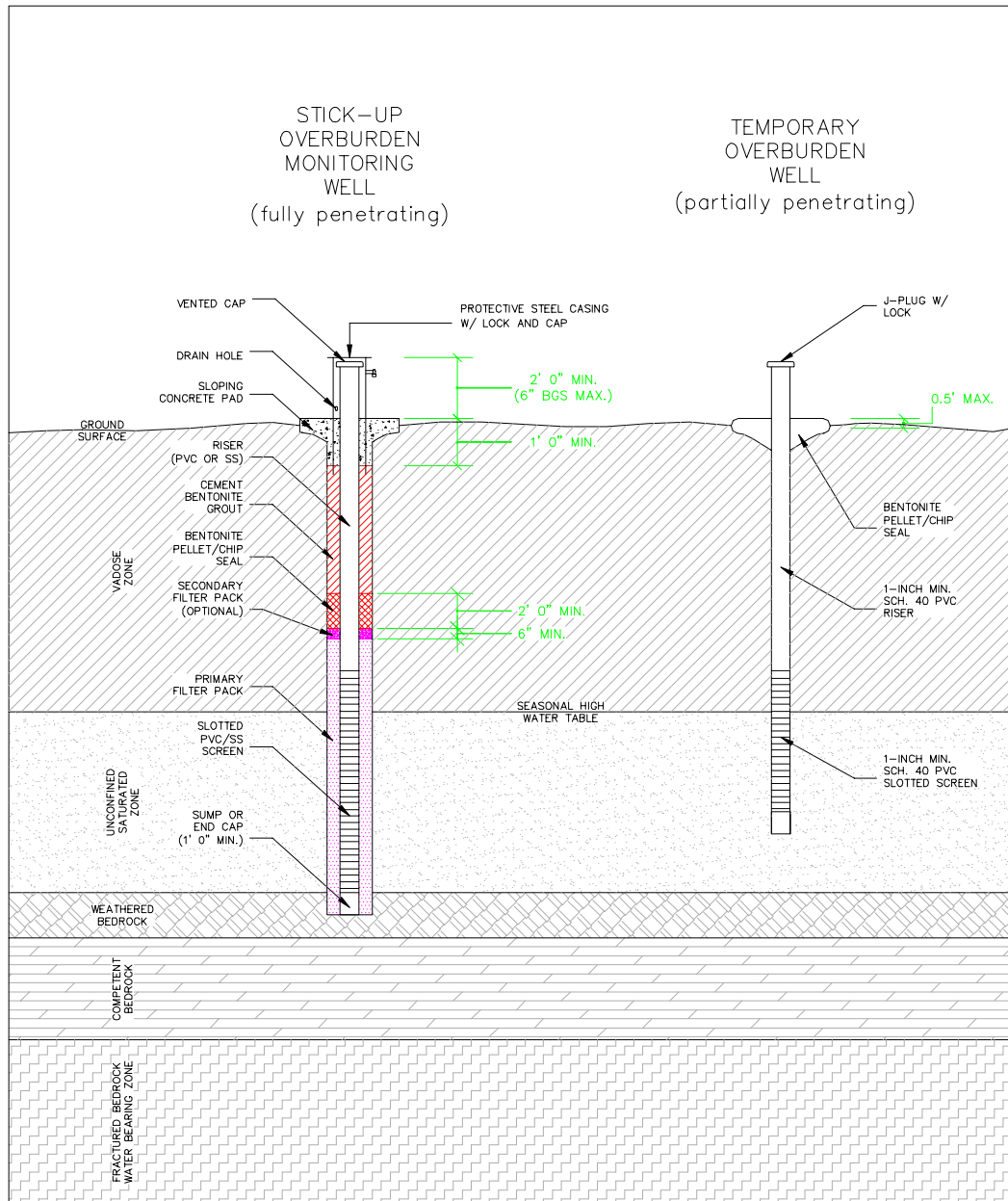
##### Benchmark FOPs:

- 015 *Documentation Requirements for Drilling and Well Installation*
- 032 *Management of Investigation Derived Waste*
- 065 *Test Pit Excavation and Logging Procedures*
- 078 *Geoprobe Drilling Procedures*

# TEMPORARY WELL (PIEZOMETER) CONSTRUCTION PROCEDURES

FIGURE 1

## TYPICAL TEMPORARY WELL CONSTRUCTION DETAIL



## TEMPORARY WELL (PIEZOMETER) CONSTRUCTION PROCEDURES

[illegible]

## TEMPORARY WELL (PIEZOMETER) CONSTRUCTION PROCEDURES



### TEMPORARY WELL COMPLETION DETAIL

Project Name: _____	WELL NUMBER: _____
Client: _____	Date Installed: _____
Boring Location: _____	Project Number: _____

<b>Driller Information</b>	
Company:	
Driller:	
Helper:	
Permit Number:	
Drill Rig Type:	

<b>Well Information</b>	
Land Surface Elevation:	ftmsl (approximate)
Drilling Method:	
Sample Collection Method:	
Fluid:	
Fluid During Drilling:	gallons (approximate)

<b>Material of Construction</b>	
Material:	
Size:	
Manufacturer:	
Application:	

<b>Well Development</b>	
Well Purpose:	
Technique(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purged:	gallons
Static Water Level:	ftTOR
Pump Depth:	
Pumping Duration:	minutes
Yield:	gpm
Specific Capacity:	gpm/ft

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

PREPARED BY: \_\_\_\_\_ DATE: \_\_\_\_\_



# FIELD OPERATING PROCEDURES

## Geoprobe Drilling Procedures

**GEOPROBE DRILLING PROCEDURES**

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**PURPOSE**

This guideline presents a method for direct-push drilling a borehole through unconsolidated materials, including soils or overburden.

**PROCEDURE**

The following procedure will be used to drill a borehole for sampling and/or well installation, using direct-push methods and equipment.

1. Follow Benchmark's Field Operating Procedure (FOP) for Drill Site Selection Procedure prior to implementing any drilling activity.
2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).
3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form (sample attached).
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's FOPs or manufacturers recommendations.
5. Ensure all drilling equipment (i.e., rods, 4-foot sampler, dedicated PVC sleeves) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with Benchmark's Drilling and Excavation Equipment Decontamination Procedures FOP.
6. Mobilize the Geoprobe™ rig to the site and position over the borehole.
7. Level and stabilize the rig and recheck the rig location against the planned drilling location.

**GEOPROBE DRILLING PROCEDURES**

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8. Fully advance the sampler into the subsurface using an ATV-mounted direct-push Geoprobe™ drill rig and 1.5-inch diameter sampler, typically 4-feet in length and fitted with a dedicated PVC sleeve, for each four-foot core of soil.
9. Retrieve the 4-foot sample core from the driller, place on a piece of polyethylene tarp, and cut open using a sharp utility knife.
10. Visually characterize each 4-foot soil core using the Unified Soil Classification System (USCS) in accordance with Benchmark's Soil Description Procedures Using the USCS FOP.
11. Scan each 4-foot core for total volatile organic vapors with a calibrated Photovac 2020 PID equipped with a 10.6 eV lamp, and report any visual and/or olfactory observations. Record PID scan measurements in the Project Field Book and appropriate field forms.
12. If required, collect a representative soil sample for headspace determinations. In general, soil samples representative of each 4-foot core interval are collected, placed in a sealable plastic bag, and kept at or near room temperature (approximately 65-70° F) for a minimum of 15 minutes prior to measurement. Record PID headspace determination measurements in the Project Field Book and appropriate field forms.
13. Check sampler and rods periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.
14. Continue drilling until reaching the assigned total depth, or until sampler refusal occurs. Sampler refusal is when the drilling penetration drops below 0.1 feet per 2 minutes, with the full weight of the rig on the sampler.
15. Plug and abandon boreholes not used for temporary well installation in accordance with Benchmark's Field Operating Procedure for Abandonment of Borehole. Boreholes to be used as temporary wells should be completed in accordance with Benchmark's Temporary Well (Piezometer) Construction Procedures FOP.

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## FOP 078.0

### GEOPROBE DRILLING PROCEDURES

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16. Decontaminate all non-dedicated drilling tools between boring locations using potable tap water and a phosphate-free detergent (i.e., Alconox™) in accordance with Benchmark's Drilling and Excavation Equipment Decontamination Procedures FOP.

#### OTHER PROCEDURAL ISSUES

- Borings will not be over drilled (rat holed) without the express permission of the Benchmark field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.
- Potable water may be placed in the sampler stem if critically necessary for borehole control or to accomplish sampling objectives. This will be performed only with the express permission of the Benchmark field supervisor.

#### ATTACHMENTS

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

#### REFERENCES

##### Benchmark FOPs:

- 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*

## GEOPROBE DRILLING PROCEDURES



## DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**

Date:

Project No.: **0041-009-500**

Drilling Company:

Client: **RealCo., Inc.**

Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, either swage coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or load side? Clamps should be alternated and should be of the correct size and number for the cable size to which they are 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. They have positive action to close the throat except when manually opened for the purpose of disconnecting a load?		
Drive shafts, belts, chain drives and universal joints are properly guarded to prevent accidental insertion of hands and fingers or tools?		
Outriggers shall be extended prior to and while the rig is being used on the cradle. Hydraulic outriggers must maintain pressure to keep the rig level and stabilize the drill rig even while unattended.		
Outriggers shall be properly supported and secured to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement. Controls should not be blocked or locked in any position.		
Safeties on any device shall be properly maintained.		
Controls shall be operated smoothly and carefully and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		

ITEMS TO CHECK	OK	ACTION NEEDED
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## FOP 078.0

### GEOPROBE DRILLING PROCEDURES



#### DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**

Date:

Project No.: **0041-009-500**

Drilling Company:

Client: **RealCo., Inc.**

Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
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 are energized and visibly grounded, drill rigs will be operated proximate to, under, by, or over power lines only in accordance with the following:  .333 © (3) (ii) 50 kV or less - minimum clearance is 10 feet For 50 kV or over - 10ft. Plus 1/2 in. For each additional 10kV <b>Benchmark Policy: Maintain 20 feet clearance</b>		
29 CFR 1910.333 © (3) (iii) While the rig is in operation, the minimum 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: \_\_\_\_\_

## FOP 078.0

### GEOPROBE DRILLING PROCEDURES



#### TAILGATE SAFETY MEETING FORM

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

#### HOSPITAL INFORMATION:

Name: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
Phone No.: \_\_\_\_\_ Ambulance Phone No. \_\_\_\_\_

#### SAFETY TOPICS PRESENTED:

Chemical Hazards: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
Physical Hazards: \_\_\_\_\_ Slips, Trips, Falls  
\_\_\_\_\_  
\_\_\_\_\_

#### PERSONAL PROTECTIVE EQUIPMENT:

Activity:	Head	Eye	Hand	Foot
Activity: _____	A	B	C	D
Activity: _____	A	B	C	D
Activity: _____	A	B	C	D
Activity: _____	A	B	C	D
Activity: _____	A	B	C	D

New Equipment: \_\_\_\_\_  
\_\_\_\_\_

Other Safety Topic (s): \_\_\_\_\_ Environmental (aggressive fauna)  
\_\_\_\_\_, \_\_\_\_\_ tobacco products is prohibited in the Exclusion Zone (EZ)  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### ATTENDEES

Name Printed	Signatures
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting conducted by: \_\_\_\_\_  
\_\_\_\_\_

FIELD OPERATING PROCEDURES

Stockpile Sampling  
Procedures for  
Chemical Analysis



**STOCKPILE SAMPLING PROCEDURES  
FOR CHEMICAL ANALYSIS**

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**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.

**STOCKPILE SAMPLING PROCEDURES  
FOR CHEMICAL ANALYSIS**

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**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.

**STOCKPILE SAMPLING PROCEDURES  
FOR CHEMICAL ANALYSIS**

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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**

Benchmark FOPs:

046 *Sample Labeling, Storage and Shipment Procedures*

FIELD OPERATING PROCEDURES

Stockpile & Borrow  
Source Sampling  
Procedures for Physical  
Analysis

**STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES  
FOR PHYSICAL ANALYSIS**

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**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.

**STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES  
FOR PHYSICAL ANALYSIS**

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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

**STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES  
FOR PHYSICAL ANALYSIS**

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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

**STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES  
FOR PHYSICAL ANALYSIS**

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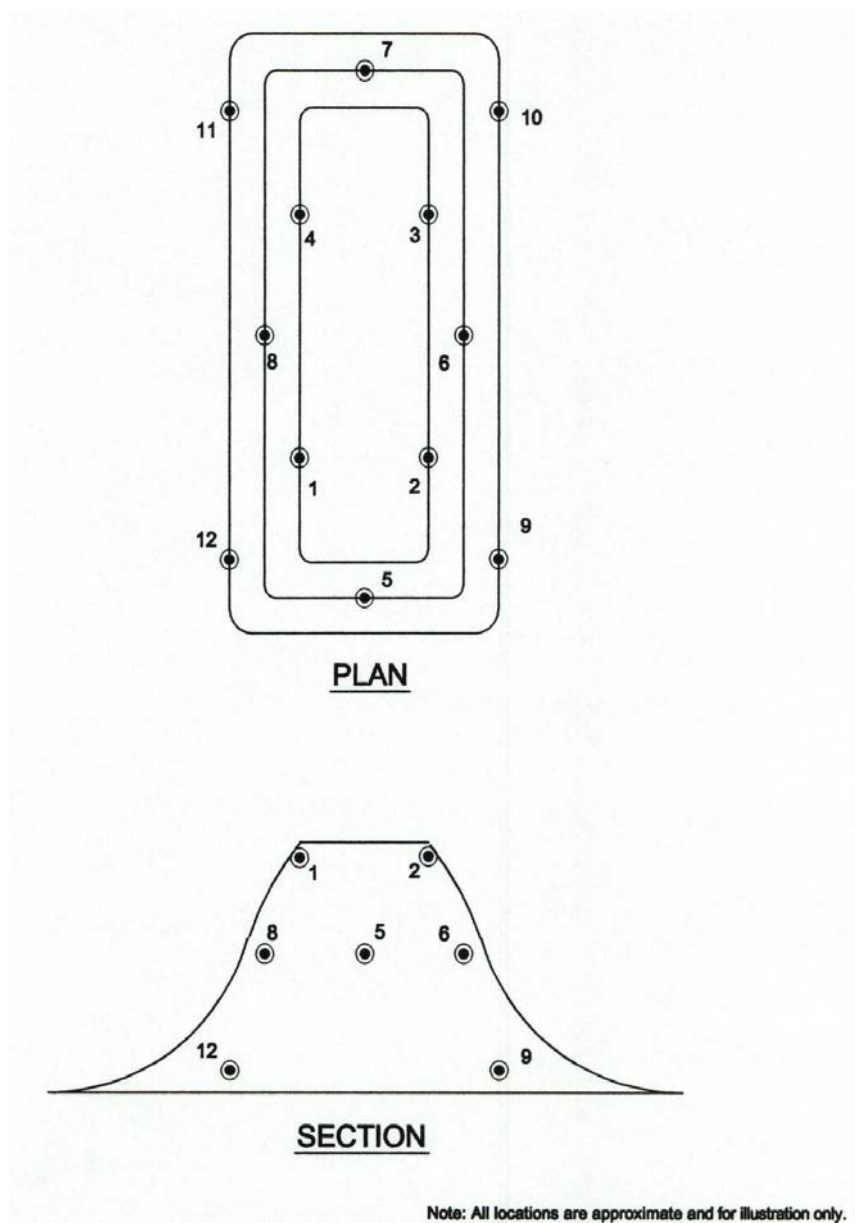
**REFERENCES**

None



**STOCKPILE & BORROW SOURCE SAMPLING PROCEDURES  
FOR PHYSICAL ANALYSIS**

**FIGURE 4  
1,000 CY STOCKPILE SAMPLING METHODOLOGY**



# FIELD OPERATING PROCEDURES

## Waste Sampling Procedures

**WASTE SAMPLING PROCEDURES**

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**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

**WASTE SAMPLING PROCEDURES**

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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

**WASTE SAMPLING PROCEDURES**

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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

**WASTE SAMPLING PROCEDURES**

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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.

**WASTE SAMPLING PROCEDURES**

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- 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 determine 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

## WASTE SAMPLING PROCEDURES

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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



## WASTE SAMPLING PROCEDURES

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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;

WASTE SAMPLING PROCEDURES

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- labels, markings;
- composition and type (steel/poly and open/bung);
- condition, age, rust
- sampling accessibility

Drums showing evidence of pressurization and crystals should be further 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.

WASTE SAMPLING PROCEDURES

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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.

**WASTE SAMPLING PROCEDURES**

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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.

WASTE SAMPLING PROCEDURES

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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, Dipstick™, 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

**WASTE SAMPLING PROCEDURES**

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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, Mucksucker™, 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

WASTE SAMPLING PROCEDURES

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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*

## WASTE SAMPLING 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 $> \frac{1}{2}$ 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 $> \frac{1}{2}$ 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.
Dipstick™ /	impoundments, containers,	Not recommended for tanks $> 11$ feet deep.
Mucksucker™	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.



FIELD OPERATING PROCEDURES

Active Subslab  
Depressurization Pre-  
Design Testing  
Procedure

**ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN  
TESTING PROCEDURE**

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**BACKGROUND**

The New York State Department of Health (NYSDOH) has published a draft document entitled “Guidance for Evaluating Soil Vapor Intrusion in the State of New York.” ([www.health.state.ny.us/nysdoh/gas/svi\\_guidance/](http://www.health.state.ny.us/nysdoh/gas/svi_guidance/)). As of February 2005, this document has been guiding NYSDOH and New York State Department of Environmental Conservation (NYSDEC) decisions concerning the need for subslab vapor mitigation at sites undergoing investigation, cleanup and monitoring under formal NY State remedial programs (e.g., Brownfield Cleanup Program sites, Inactive Hazardous Waste Site Remediation Program sites, etc.).

**PURPOSE**

This guideline presents a general description of the method for determining the number of extraction points, location and placement of these points, and the desirable sub-slab capture configuration. Extraction points are used to depressurize the subsoil in order to capture sub-slab vapors from the underlying sub-soil. This information can be used in evaluating the effectiveness of the final sub-slab depressurization and vapor capture designs.

**BUILDING PREPARATION**

Prior to performing the pre-design testing procedure, the building’s slab should be inspected for any cracks or deformations that may compromise the sub-slab vacuum seal. A pre-testing inspection should be performed for each test location. The inspection should evaluate the type of structure, floor layout, airflows and physical conditions of the building(s) being studied.

**ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN  
TESTING PROCEDURE**

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**PROCEDURE**

1. Perform a building inspection. Seal any foundation/slab cracks, utility penetrations, and other openings that may serve as a vacuum break during the testing procedure. Turn off any equipment that may affect pressure gradients within the testing area.
2. Identify a minimum of one (1) location for the placement of simulated vacuum extraction point (TEST).
3. From the center of each TEST location, use a 100-foot tape and piece of chalk to draw concentric circled/arcs at distances of 5, 10, 15, 20, 30, 40, and 50 feet (measurement points (MP)).
4. Drill a 5 inch slab core at the TEST location. Remove as much sub-slab bedding material at the TEST location through the core hole as possible, optimally one cubic foot.
5. Insert vacuum inducing testing apparatus into 5 inch core hole at the TEST location, ensuring proper sealing.
6. Drill  $\frac{3}{4}$  inch holes at each measurement point (MP) at the marked distances from the center TEST location. Pack modeling in each measurement point floor penetration.
7. Initiate simulated vacuum at the extraction point/ TEST location.
8. With all other negative pressure reading locations remaining sealed, remove the modeling clay from the each MP individually, and record the resultant.
9. Reseal the 10 foot reading location with modeling clay and repeat the pressure reading at each subsequent negative pressure reading location. Ensure that all locations not being read are sealed with modeling clay.
10. Record all pertinent field data in the Project Field Book.
11. Reseal all floor penetrations.

**ACTIVE SUBSLAB DEPRESSURIZATION PRE-DESIGN  
TESTING PROCEDURE**

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**REQUIRED EQUIPMENT**

- Personal protective equipment (PPE) (if applicable)
- 100 foot tape measure
- Chalk
- 4 ½ inch Husqvarna core drill
- ¾ inch Hilti hammer drill
- Sufficient modeling clay
- Concrete sealant
- Vacuum inducing apparatus (patent pending)
- Micro-manometer
- Camera
- Cell phone
- Field forms
- Project Field Book

**REFERENCES**

New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*, February 2005.

FIELD OPERATING PROCEDURES

Calibration &  
Maintenance of  
Portable Particulate  
Meter

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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**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<sup>3</sup> to 400 mg/m<sup>3</sup>. 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  $\pm 2\%$  of reading  $\pm$  precision over the temperature range of  $-4^{\circ}$  to  $158^{\circ}$  F ( $-10^{\circ}$  to  $50^{\circ}$  C) and 10 to 95% relative humidity (non-condensing). The precision is  $\pm 1\%$  of reading or  $\pm 0.001$  mg/m<sup>3</sup>, whichever

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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is greater (1-second averaging) and  $\pm 0.3\%$  of reading or  $\pm 0.0003 \text{ mg/m}^3$ , whichever is greater (10-second averaging).

**INSTRUMENT PANEL VIEW**

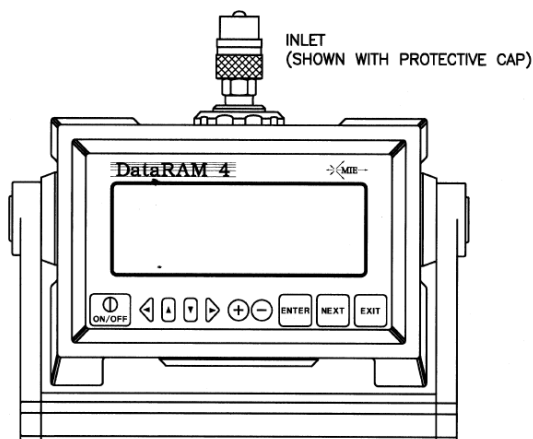


FIGURE 1. FRONT-PANEL VIEW OF DataRAM

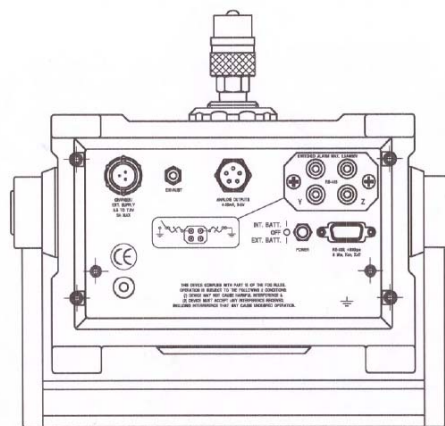


FIGURE 2. BACK-PANEL VIEW OF DataRAM

**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

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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DataRAM 4 charger/power supply can be connected continuously to the instrument whether the DataRAM 4 is on or off. If the charger/power supply is not connected, the internal battery will discharge very slowly depending on storage temperature. Low storage temperature reduces battery capacity. High storage temperatures, however, reduce battery life which is of the order of 8 years at 20°C (68°F), and only 2 years at 40°C (104°F).

In general, the user should maintain the battery charge as high as possible in order to extend its charge/discharge cycling capacity (this characteristic differs from that of nickel-cadmium batteries).

Instrument Storage

If the DataRAM 4 is to be stored for an extended period of time (i.e., 3 months or more), place the 3-position switch on the back panel in its OFF position (mid-position), in order to minimize gradual battery discharge. This will have no effect on data retention or internal clock function. It is recommended, however, that the battery be recharged every 3 months in order to prolong battery life.

During storage always snap on quick-connect cap over the instrument inlet to protect the sensing optics from gradual dust contamination. Store DataRAM 4 in a dry environment.

Filter Replacement

To replace either of two types of filters used with DataRAM 4, place the instrument on its back rubber feet (front panel facing upward). On the bottom surface of the DataRAM, locate the large threaded plastic filter cover and holding the cross bar, rotate this cover counterclockwise. Remove cover and the filter holder within the open cavity.

*HEPA Filter Cartridge Replacement*

The DataRAM 4 is shipped from the factory with the HEPA filter cartridge installed. This cartridge can be identified by its metallic cover. Remove this cartridge. Clean the internal black rubber gasket against which the cartridge is normally compressed. Install new HEPA-type cartridge (MIE part no. MSA-95302) by inserting its wider ridged end first. Reposition threaded plastic cover engaging threads carefully; rotate cover clockwise, hand tightening firmly. Properly dispose of used cartridge to prevent inadvertent re-use.



**CALIBRATION AND MAINTENANCE OF PORTABLE  
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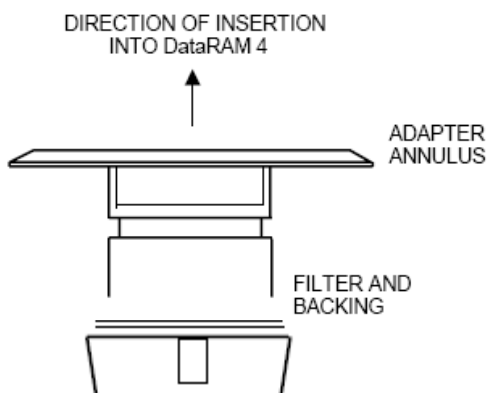
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*Analytic Filter Installation/Replacement*

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 leakage. 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*



**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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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 become 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:

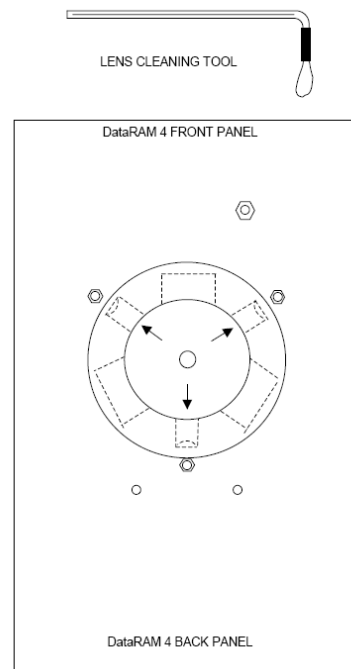
- **Make sure to shut off power completely before proceeding with cleaning**
- Install the stainless steel cover on the inlet of the DataRAM 4 to protect this fitting.
- Place the DataRAM 4 upside down on a table, resting the instrument on the inlet cover and the rear protective bumper.
- Unscrew the 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).

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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- 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).*



**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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**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  $\pm 1\%$ .

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.

**CALIBRATION AND MAINTENANCE OF PORTABLE  
PARTICULATE METER**

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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  $\mu\text{m}$
- Geometric standard deviation of lognormal size distribution: 2.5
- Bulk density: 2.60 to 2.65 g/cm<sup>3</sup>
- 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

# FIELD OPERATING PROCEDURES

## Field Quality Control Procedures

## FIELD QUALITY CONTROL PROCEDURES

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### 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

FIELD QUALITY CONTROL PROCEDURES

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of the sample collection point will not be disclosed to the analytical laboratory, therefore the field sample containers will be returned to the laboratory identified only as the “blind duplicate.” The well or sample location will be recorded in the Project Field Book or handheld RuggedReader® Pocket PC and on the field data sheets, and the results will be compared to review analytical precision. Sample analysis will be identical to the original sample per the project work plan. The Blind Duplicate sample must be collected simultaneously from the same source under identical conditions as the original sample.

- **Matrix Spike/Matrix Spike Duplicate (MS/MSD)** – A sufficient volume of sample will be collected at one sampling location per sampling event for MS/MSD analysis per matrix (i.e., soil and groundwater only). The laboratory will report the results of the MS/MSD analysis, which will be reviewed for sampling and analysis precision and accuracy. Sample analysis will be identical to the original sample per the project work plan. The MS/MSD sample must be collected simultaneously from the same source under identical conditions as the original sample.
- **Equipment (Rinsate) Blank** – In general, dedicated sampling equipment is used to minimize field decontamination time and avoid the need for equipment blanks; however there may be instances where the use of non-dedicated equipment cannot be avoided. An equipment blank will be collected for each day of sampling activity when non-dedicated sampling equipment is used. These equipment blank samples will be used as a QC check of the decontamination procedures for sampling equipment. Sample analysis for the equipment blank will consist of the most comprehensive parameter list used for risk assessment in which the non-dedicated equipment was used for environmental sample collection. During most projects, every effort to use dedicated sampling equipment should be made in order to minimize field decontamination time and avoid the need for equipment blanks. Equipment Blank sampling procedure is as follows:
  - Non-dedicated equipment are to be decontaminated in accordance with Benchmark’s Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures prior to use in the field. If organic-free



FIELD QUALITY CONTROL PROCEDURES

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- deionized water (generally provided by the laboratory) is not available for decontamination, equipment will be allowed to thoroughly air dry.
- Once properly rinsed or allowed to air dry, analyte-free water (provided by the laboratory) is poured appropriately over or through the decontaminated sample collection device, collected in a sample container, and returned to the laboratory as a sample.
  - **Field Blank** – A field blank is a sample of the unused final decontamination rinse water that is collected at the sampling site and returned to the laboratory as a sample. Sample analysis for the field blank will consist of the most comprehensive parameter list used during the investigation.
  - **Split Sample** – A split sample is a sample that has been portioned into two or more containers from a single sample container or sample mixing container. Samples for VOC analysis should never be mixed prior to splitting.
  - **Blank Wipe Samples** – There are two types of blank wipe samples, an equipment blank and a field blank that may be required per the project work plan, both are described below:
    - Equipment Blank – Required only if reusable templates are used for wipe sample collection. The decontaminated template is wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.
    - Field Blank – Clean disposable gloves are wiped with a hexane saturated swab. The swab is placed in the appropriate sample container and returned to the laboratory as a sample.

REFERENCES

Benchmark FOPs:

040 *Non-disposable and Non-dedicated Sampling Equipment Decontamination*

FIELD OPERATING PROCEDURES

Outdoor Ambient Air  
VOC Sample  
Collection Procedure

## OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE

---

### PURPOSE

This procedure describes the methods for collecting outdoor ambient air samples for volatile organic compound (VOC) analysis via USEPA Method TO-15 using Summa® canisters (or approved other). Typically, outdoor air samples are collected to characterize and document site-specific VOCs that may be present in outdoor ambient air. For sample collection associated with intrusive activities that may potentially release VOCs to the ambient air, sample location(s) typically are collected downwind of the intrusive activity at the perimeter of the work area and/or exclusion zone for the Site. Upwind sample location(s) may be utilized if regional facilities (e.g. gasoline service station, factories) are located proximate to the Site to assess off-site ambient VOC contributions (background).

### SAMPLE COLLECTION PROCEDURES

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

- A site map should be prepared to indicate the outdoor ambient air sample locations including all site improvements (e.g., buildings, access roads, etc.), public roads/streets (if applicable), the location of potential VOC contributors (e.g., gasoline stations, factories, lawn movers, etc.), compass orientation (north), and scale.
- Weather conditions (e.g., precipitation, wind speed, outdoor temperature, and barometric pressure) should be reported on the Air Canister Field Record (sample attached); and
- Any pertinent observations, such as odors, readings from field instrumentation, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) should be recorded.

## OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE

---

The following describes the outdoor air sampling procedure:

1. Typically, a 6-liter, passivated (inert), stainless steel, evacuated sampling sphere (e.g., Summa canister) (or approved other) will be supplied by the laboratory that will be conducting the analysis. The canister should be received from the laboratory, certified clean, evacuated, and prepared for sampling.
2. Sampling will take place in accordance with the project work plan. Selected sample locations will be sufficiently spaced to allow location(s) to be field modified, if necessary.
3. The number of Summa canisters required as well as the flow rate of the constant differential low volume flow controllers will be supplied by the laboratory in accordance with the project work plan.
4. Prior to placement, complete an Air Canister Field Record (sample attached) of each canister, which includes: project information, field staff, weather conditions, canister serial number, flow controller number, sample date(s)/time(s), shipping date(s), canister lab vacuum, field vacuum check, initial field vacuum, final field vacuum, and duration of sample collection.
5. The pressure in the canisters must be monitored with the laboratory provided pressure gauge at the beginning and the end of the sampling period as well as before and after shipment of the canisters at the laboratory. **The target final field vacuum must be approximately 5 inches of mercury. Samples with a final field vacuum of greater than 10 inches of mercury, or equal to zero, will be flagged** and usability of the data will depend on the sample volume and reporting limits that can be achieved.
6. Canisters may be placed on the ground provided there is a clear plastic sheet beneath it to prevent cross contamination. The intake tubing, however, must be positioned at a height of approximately 3 to 5-feet above grade to collect air at an elevation representative of ambient air within the breathing zone. Typically, the canister is chained and locked to a secure step ladder with the intake tubing tethered to the ladder.

**OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE**

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7. Ship the canisters to the laboratory under chain-of-custody command within three days of sample collection so that no sample will exceed the 30-day holding time (since receipt from the lab) per USEPA TO-15.
8. Air samples will be analyzed by Gas Chromatography/Mass Spectroscopy (GC/MS) in accordance with EPA Method TO-15, or as specified. Analytical results will be reported as concentrations of each VOC at each location during each sampling event, typically in parts per billion by volume (ppbv).
9. Sample collection should take place on warm, dry days. If rain or high humidity conditions develop during sampling, the sampling event should be suspended. Temperature, barometric pressure, and wind speed should be monitored during the sampling event, for use in analysis of the results. The combination of sampling location, height, and meteorological conditions will assure that sampling will measure VOCs at their highest concentrations.

**QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)**

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

## OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE

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Some methods require collecting samples in duplicate to assess errors. Duplicate and/or split samples should be collected in accordance with the requirements of the sampling and analytical methods being implemented.

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

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

### ATTACHMENTS

Air Canister Field Record (sample)

### REFERENCES

United States Environmental Protection Agency. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*. Second Addition (EPA/625/R-96/010b). January 1999.

## OUTDOOR AMBIENT AIR VOC SAMPLE COLLECTION PROCEDURE



## AIR CANISTER FIELD RECORD

**PROJECT INFORMATION:**

Project:

Job No:

Location:

Field Staff:

Client:

SAMPLE I.D.:

**WEATHER CONDITIONS:**

Ambient Air Temp. - A.M.:

Ambient Air Temp. - P.M.:

Wind Direction:

Wind Speed:

Precipitation:

Size of Canister:

Canister Serial No.:

Flow Controller No.:

Sample Date(s):

Shipping Date:

Sample Type: ☐ Indoor Air ☐ Outdoor Air☐ Subslab, complete section below ☐ Soil Gas

Soil Gas Probe Depth:

**FIELD SAMPLING INFORMATION:**

READING	TIME	VACUUM (inches Hg) or PRESSURE (psig)	DATE	INITIALS
Lab Vacuum (on tag)				
Field Vacuum Check <sup>1</sup>				
Initial Field Vacuum <sup>2</sup>				
Final Field Vacuum <sup>3</sup>				
Duration of Sample Collection				

**LABORATORY CANISTER PRESSURIZATION:**

Initial Vacuum (inches Hg and psia)	
Final Pressure (psia)	
Pressurization Gas	

**SUBSLAB SHROUD:**

Shroud Helium Concentration:

Calculated tubing volume: x 3 =

Purged Tubing Volume Concentration:

Is the purged volume concentration less than or equal to 10% in shroud?

☐ YES, continue sampling☐ NO, improve surface seal and retest**NOTES:**<sup>1</sup> Vacuum measured using portable vacuum gauge (provided by Lab)<sup>2</sup> Vacuum measured by canister gauge upon opening valve<sup>3</sup> Vacuum measured by canister gauge prior to closing valve

COMPOSITE TIME (hours)	FLOW RATE RANGE (ml/min)
15 Min.	316 - 333
0.5 Hours	158 - 166.7
1	79.2 - 83.3
2	39.6 - 41.7
4	19.8 - 20.8
6	13.2 - 13.9
8	9.9 - 10.4
10	7.92 - 8.3
12	6.6 - 6.9
24	3.5 - 4.0

Signed:

# APPENDIX D

## PROJECT DOCUMENTATION FORMS



# INSPECTOR'S DAILY REPORT

<div> <div>Page</div> <div></div> <div>of</div> <div></div> </div>	
CONTRACTOR:	JOB NO.:
CLIENT:	DATE:

LOCATION:		DAY: Su M Tu W Th F Sa	
WEATHER:	TEMP: °F	START:	END:

[illegible]

# INSPECTOR'S DAILY REPORT

**(CONTINUED)**

Page  of

CONTRACTOR:	JOB NO.:
CLIENT:	DATE:

## MEETINGS HELD & RESULTS:

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## CONTRACTOR'S WORK FORCE AND EQUIPMENT

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

## REMARKS:

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## REFERENCES TO OTHER FORMS:

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## SAMPLES COLLECTED:

Sample Number:

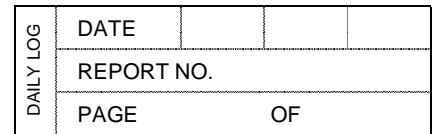
Approx. Location of Stockpile:

No. of Stockpile

Date of Collection:

Weather:

Field Observations:



## 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		

Date: \_\_\_\_\_

## CORRECTIVE MEASURES REPORT

Project: \_\_\_\_\_

Job No: \_\_\_\_\_

### WEATHER CONDITIONS:

Location: \_\_\_\_\_

Ambient Air Temp. - A.M.: \_\_\_\_\_

CQA Monitor(s): \_\_\_\_\_

Ambient Air Temp. - P.M.: \_\_\_\_\_

Client: \_\_\_\_\_

Wind Direction: \_\_\_\_\_

Contractor: \_\_\_\_\_

Wind Speed: \_\_\_\_\_

Contractor's Supervisor: \_\_\_\_\_

Precipitation: \_\_\_\_\_

Corrective Measures Undertaken (reference Problem Identification Report No.)

Retesting Location:

Suggested Method of Minimizing Re-Occurrence:

Approvals (initial):

CQA Engineer: \_\_\_\_\_

Project Manager: \_\_\_\_\_

Signed:

\_\_\_\_\_  
CQA Representative

# APPENDIX E

## SITE-SPECIFIC HASP

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# **SITE HEALTH AND SAFETY PLAN for BROWNFIELD CLEANUP PROGRAM RI ACTIVITIES**

**SOUTHSIDE PLAZA SITE  
BCP SITE NO. C907043  
JAMESTOWN, NEW YORK**

---

April 2020

0505-019-001

Prepared for:

**Kazmarek Mowrey Cloud Laseter LLP**  
1230 Peachtree Street, N.E., Suite 900  
Atlanta, GA 30309

Prepared by:



2558 Hamburg Turnpike, Suite 300  
Buffalo, NY 14218  
(716) 856-0599

**SOUTHSIDE PLAZA SITE  
HEALTH AND SAFETY PLAN FOR RI ACTIVITIES**

**ACKNOWLEDGEMENT**

**Plan Reviewed by (initial):**

Corporate Health and Safety Director:	_____ Thomas Forbes
Project Officer:	_____ Michael Lesakowski
Project Manager:	_____ Lori Riker
Designated Site Safety and Health Officer:	_____ Tom Behrendt

**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
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**SOUTHSIDE PLAZA SITE  
HEALTH AND SAFETY PLAN FOR RI ACTIVITIES**

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HEALTH AND SAFETY PLAN FOR RI ACTIVITIES**

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Attachment A	Emergency Response Plan
Attachment B	Hot Work Permit Form
Attachment C	Community Air Monitoring Plan

## 1.0 Introduction

### 1.1 General

In accordance with OSHA requirements contained in 29CFR 1910.120, this Health and Safety Plan (HASP) describes the specific health and safety practices and procedures to be employed by Benchmark Environmental Engineering & Science, PLLC (Benchmark) employees during Remedial Investigation (RI) activities at the Southside Plaza Site (Site) located in the City of Jamestown, Chautauqua County, New York. This HASP presents procedures for Benchmark employees who will be involved with RI field activities; it does not cover the activities of other contractors, subcontractors or individuals on the Site. These firms will be required to develop and enforce their own HASPs as discussed in Section 2.0. Benchmark 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 field activities to provide real-time data for on-going assessment of potential hazards.

### 1.2 Background

The 5-acre Site consists of one tax parcel identified as 704-744 Foote Avenue: SBL No. 404.07-8-3. The Site is developed with two structures including a retail strip mall (Building 1) and a separate restaurant tenant space north of the strip mall (Building 2). Building 1 is currently occupied by several commercial tenants including TOPS Friendly Markets (TOPS), KeyBank, Cellular One, Dollar Tree, Spa Nails, and The UPS Store. Building 2 is currently occupied by McDonald's. The Site also includes a paved parking lot east of the structures, a paved parking lot/access road west of the structures, and some vegetated areas.

The Site was improved with several residential properties from at least the 1890s to 1955. A strip mall (Building 1) and a former separate structure north of the strip mall (former Building 2) were built between 1955-1958 and 1960. Two historical dry cleaners were present from 1956 to at least 1975 in Building 1 tenant space historically addressed as

736 Foote Avenue (Triangle Cleaners and Anderson Cleaners). In addition, two historical dry cleaners occupied the Building 1 tenant space historically addressed at 750 Foote Avenue from approximately 1980 to at least 1994 (Anderson Cleaners and Whirley-Wash Dry Cleaners). The dry cleaners will be referenced herein as the former Anderson Cleaners location (736 Foote Avenue) and the former Whirley-Wash location (750 Foote Avenue).

The Applicant owns the Subject Site referred to as the Southside Plaza Site, while others own the south adjoining property referred to as South Foote Avenue Plaza (SFAP). There has been some debate amongst these two property owners whether the former Whirley-Wash was located on-site (i.e., on the Southside Plaza Site) or off-site (i.e., the south adjoining SFAP property). However, a letter dated August 29, 2019 from Mr. Karim Abdulla of Barclay Damon, LLP (representing the SFAP property) submitted to Kazmarek Mowrey Cloud Laseter LLP (KMCL) (representing the Southside Plaza Site) and NYSDEC provides documentation that contends that both dry cleaners were located on the Southside Plaza Site and not the SFAP property. The letter contends that Whirley-Wash was located in a historic tenant address of 750 Foote Avenue, which fell within the addresses of the Southside Plaza Site (i.e., 704-750 Foote Avenue) at that time; the south adjoining SFAP property was historically addressed 752-778 Foote Avenue at the time and therefore “off-site”. No other former or current Building 1 tenants present a potential concern.

The former Building 2 was historically occupied by two former gas stations from the mid-1950s to the late 1970s; Bish’s South Side Service Station is known to have been located at the Site in 1969 and Cuifolo’s Service Center is known to have been located at the Site in 1975. The former Building 2 was demolished between 1975 and 1980. The existing Building 2 was constructed in 1980 for use as a McDonald’s. There is no evidence of underground storage tank (UST) usage at the former dry cleaner locations; however, two 500-gallon oil tanks and four 3,000-gallon gasoline tanks are known to be on-site per the City of Jamestown Fire Department. No information is available regarding petroleum bulk storage (PBS) registration or tank closure.

Previous environmental studies completed at the Site indicate that the Site is underlain by soil/fill impacted by chlorinated volatile organic compounds (CVOCs) yielding concentrations above 6NYCRR Part 375 Unrestricted Use Soil Cleanup Objectives (USCOs, Ref 2) and Residential Use Soil Cleanup Objectives (RSCOs) and groundwater impacted by CVOCs yielding concentrations above 1.1.1 TOGS Groundwater Quality Standards/Guidance Values (GWQS/GV, Ref 3). The highest concentrations of CVOCs in soil and

groundwater were observed proximate the former Whirley-Wash and/or the former Anderson Cleaners. Elevated concentrations of CVOCs were also observed in sub-slab vapor samples collected in the vicinity of the former Whirley-Wash. A sub-slab depressurization system (SSDS) was installed in February 2013 at the location of the former Whirley-Wash, within the existing TOPS. No CVOCs have been detected above detection limits in the TOPS indoor air since system installation, confirming that the SSDS is effectively mitigating CVOc concentrations in the sub-slab vapor of Building 1.

### 1.3 Known and Suspected Environmental Conditions

Several site investigations have been completed at the Site and at the south adjoining South Foote Avenue Plaza (SFAP) property. Findings of the investigations are detailed below:

#### April 2007 – Phase I Environmental Site Assessment

EMG Corporation (EMG) completed a Phase I Environmental Site Assessment (ESA) for Lehman Brothers Bank, FSB in April 2007. EMG identified the following recognized environmental condition (REC):

- The Site was historically occupied by a dry cleaner (Anderson Cleaners/Triangle Cleaners), which was formerly located in the southern portion of the Site, from 1956 until at least 1976.

#### November 2008 – Limited Site Investigation Report

Apex Companies, LLC (Apex) completed site investigation activities for Phillips Edison & Company Limited (PECO) in August 2008 and submitted a report summarizing the results in November 2008. The investigation consisted of sub-slab vapor sampling at two locations (SS-01 & SS-02) inside the existing TOPS and shallow soil gas sampling at two exterior locations (SV-01 & SV-02). Additionally, four soil borings were advanced to approximately 16 fbg (SB-01 through SB-04). Three soil borings were converted into temporary groundwater wells (SB-01 through SB-03). Findings are detailed below:

- Mitigation recommended for tetrachloroethene (PCE) at SV-01. Monitoring recommended for PCE and 1,1,1-trichloroethane (1,1,1-TCA) at SS-01, PCE at SS-02, and trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) at SV-01.
- Only PCE (62 ug/L) was detected above 1.1.1 TOGS Groundwater Quality Standards/Guidance Values (GWQS/GV) at SB-01; total lead was detected above

GWQS/GV at all three temporary well locations, dissolved lead was less than the method detection limit (MDL).

- No volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) were detected in the soil above MDLs.
- A discolored layer of soil at 1-2 fbg was observed at SB-02. Lead was detected in the soil at SB-02 above 6NYCRR Part 375 Unrestricted Soil Cleanup Objectives (USCOs) with a concentration of 125 mg/kg. Total lead was also detected in the groundwater from a temporary well point installed in soil boring SB-02 at a concentration (0.093 mg/L), which is above the GWQS/GV (0.025 mg/L). Analysis for dissolved lead was conducted on the temporary well point samples filtered in the laboratory; none of the three samples contained dissolved lead concentrations above the method detection limit indicating the lead is associated with the suspended solids.

#### March-May 2010 – Additional Site Investigation

Apex completed additional site investigation activities in March 2010 and submitted a report summarizing the results to PECO in May 2010. The investigation consisted of one interior sub-slab vapor investigation within the existing UPS store (SS-UPS) paired with one indoor air sample. Five soil borings were advanced and converted into temporary monitoring wells (SB-4/GW-4 through SB-9/GW-9). Findings are detailed below:

- No monitoring or mitigation recommended within the UPS store.
- Groundwater above GWQS/GV for PCE in all temporary wells except GW-7.
- Soil detected below MDLs except methylene chloride (MC), which was detected at all borings below USCOs. PCE detected at SB-8 below USCOs.

As a result of the groundwater contamination indicated in the November 2008 and May 2010 investigation reports submitted to PECO, Apex recommended the installation of five permanent monitoring wells to characterize groundwater contamination across the Site.

#### May-July 2010 – June 2010 Site Investigation

Apex completed site investigation activities between May and June 2010 and submitted a report summarizing the results to PECO in July 2010. The investigation consisted of five soil borings/permanent monitoring wells (MW-1 through MW-5). Findings are detailed below:

- Groundwater flows northeast across the Site.

- Groundwater was detected above GWQS/GV for PCE at all wells except MW-4 and for TCE at all wells except MW-3 and MW-4. MC and vinyl chloride (VC) were also detected above GWQS/GV at MW-1. Maximum concentrations were observed in MW-2 (PCE at 2,300 ug/L and TCE at 39 ug/L). MW-2 is screened at 5.5-16 fbgs and water was observed at 6 fbgs. MW-2 is located downgradient of the former Anderson Cleaners.
- Soil detected below MDLs except MC, which was detected at all borings below USCOs and PCE and TCE at MW-3 (8-10 fbgs); PCE was detected below USCOs at 37 parts per billion (ppb) and TCE was detected below USCOs at 4 ppb. No elevated photoionization detector (PID) or visual/olfactory evidence of contamination observed.

#### February-May 2011 – April 2011 Site Investigation

Apex completed site investigation activities between February and April 2011 and submitted a report summarizing the results to PECO in May 2011. The investigation consisted of two additional permanent monitoring wells, MW-6 and MW-7 along the southern and western borders. Findings are detailed below:

- Groundwater was detected above GWQS/GV for cis-1,2-DCE, MC, PCE, TCE, and VC at MW-6.
- The highest concentrations of PCE (2,300 ug/L) and TCE (39 ug/L) were detected at MW-2, located cross/downgradient of the former Anderson Cleaners.
- The second highest concentrations of PCE (1,200 ug/L) and TCE (28 ug/L) were detected at MW-6, located cross/downgradient of the former Whirley-Wash along the southern boundary of the Site.
- Soil was detected below MDLs except MC, which was detected at both borings below USCOs and PCE at MW-7 (12-14 fbgs) detected at 110 ppb below USCOs.

#### December 2011-January 2012 – Off-Site Site Investigation

Apex completed off-site investigation activities on the adjoining SFAP property, located south adjacent to the Site in December 2011 and submitted a report summarizing the results to the New York State Department of Environmental Conservation (NYSDEC) and Southside Station, Inc. in January 2012. The investigation consisted of four additional wells, MW-8, MW-9, MW-10A, and MW-11. Findings are detailed below:

- PCE concentrations at the off-site wells were lower than PCE concentrations observed in on-site downgradient concentrations. Groundwater was detected above GWQS/GV for PCE at MW-8 and MW-11.



- Soil was detected below MDLs except MC, which was detected at all borings below USCOs and PCE at MW-8 (10-12 fbg), detected at 9.7 ppb below USCOs.

#### March-April 2012 – Sub-Slab Vapor Assessment

Apex completed a sub-slab vapor assessment in March 2012 and submitted a letter report to the NYSDEC and Southside Station, Inc. in April 2012. The assessment consisted of five sub-slab vapor investigation locations inside TOPS (SS-1 through SS-5). The owners of the SFAP denied access to the property for proposed off-site sub-slab vapor sampling. Findings are detailed below:

- Mitigation recommended for 1,2-DCE at SS-5, PCE at SS-4 and SS-5, and TCE at SS-5. Monitoring recommended for TCE at SS-4.

#### July 2012 – Off-Site Sub-Slab Vapor Assessment at Southside Foote Avenue Plaza

Apex completed a sub-slab vapor assessment at the adjoining SFAP property and submitted a report summarizing the results to the NYSDEC and Southside Station, Inc. in July 2012. The assessment consisted of four sub-slab vapor sample locations, two in the Salon 1 tenant space (SS-6 and SS-7) and two in the US Postal Service tenant space (SS-8 and SS-9). Findings are detailed below:

- Mitigation recommended for PCE and TCE at SS-6, and PCE at SS-7. Monitoring recommended for PCE at SS-9.

#### December 2012 – Phase I Environmental Site Assessment

EBI Consulting (EBI) completed a Phase I ESA for Five Mile Capital Partners, LLC (FMCP) dated December 2012. EBI identified the following RECs:

- The Site was historically occupied by a gas station, which was formerly located in the northern portion of the Site (at the location of the existing McDonald's restaurant).
- The Site was historically occupied by a dry cleaner, which was formerly located in the southern portion of the Site.
- The Site is listed as a Brownfield site. Groundwater at the Site is contaminated with PCE, TCE, and breakdown products. Several monitoring wells have been installed to characterize the extent of contamination.
- The Site is a Resource Conservation and Recovery Act (RCRA) non-generator, former RCRA-Large Quantity Generator (LQG), of halogenated solvents (including PCE and TCE).
- Six 55-gallon drums were observed along the rear wall of the strip mall.



May 2013 – Sub-Slab Depressurization System Installation Report

Apex submitted an Interim Remedial Measures (IRM) Work Plan to Southside Station, Inc. for the design, installation, and monitoring of a SSDS within TOPS in February 2013. The SSDS was installed on February 26 and 27, 2013 in conformance with the NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York, October 2006. The system was constructed with three suction points along the southern property boundary (SP-1, SP-2, and SP-3). A U-tube style manometer installed at SP-3 indicated a vacuum of 1.3 inches water column. Apex noted that action should be taken if this measurement dropped significantly below its initial value. Initial performance testing was also conducted at test points and indoor air sample locations surrounding the SSDS to verify the system's effectiveness. Apex concluded these results indicated the SSDS was providing adequate vacuum to mitigate potential vapor intrusion of dry-cleaning solvent vapors at the Site and on the adjoining SFAP property. An email to Apex from Anthony Lopes of the NYSDEC transmitting indoor and outdoor air sample results on May 7, 2013 confirms this conclusion. The SSDS Installation Report was submitted to Southside Station Inc. c/o PECO on May 1, 2013.

August 2013 – Addendum to Phase I Environmental Site Assessment and NYSDEC Regulatory File Review

EBI completed an addendum to their December 2012 Phase I ESA for Kasowitz, Benson, Torres & Friedman LLP in August 2013. EBI updated their report by summarizing the activities completed at the Site by Apex (as discussed above) to date. No further conclusions or recommendations were made.

August 2013 – Environmental Review and Comments

Bell Oldow completed a review of EBI's "Addendum to Phase I Environmental Site Assessment and New York State Department of Environmental Conservation Regulatory File Review" for FMCP in August 2013. The purpose of the review was to summarize environmental conditions at the Site for any potential new owners.

October 2014 – Phase I Environmental Site Assessment

AEI Consultants (AEI) completed a Phase I ESA for Kazmarek Mowrey Cloud Laseter LLP (KMCL) and LNR Partners, LLC (LNR) dated October 2014. AEI did not identify any on-site RECs at the Site. AEI identified the following controlled REC (CRECs):

- The Site was formerly occupied by a dry cleaner located at 736 Foote Avenue (Triangle/Anderson Cleaners) from the 1960s to the late 1970s. A second dry cleaner was located at 750 Foote Avenue (Whirley-Wash, formerly Anderson Cleaners, which moved from 736 Foote Avenue to 750 Foote Avenue).
- PCE and TCE were observed at high concentrations in the sub-slab soil vapor. An SSDS was installed May 2013 in TOPS to mitigate PCE and TCE concentrations. Operation and Maintenance (O&M) requirements for the SSDS include periodic inspections and testing.
- PCE, TCE, cis-1,2-DCE, and VC were detected at concentrations exceeding GWQS/GV. The highest concentrations of TCE and PCE were observed directly downgradient of the former Whirley-Wash. At least seven wells were installed to characterize TCE and PCE contamination across the Site.
- The Site entered the NYS BCP, Site No. C907043.
- The gas station formerly located at the northern portion of the Site in the location of the existing McDonald's was identified as a historical REC (HREC). The gas station was identified as Bish's South Side Service Station and Cuifolo's Service Center gas station. The former gas station was identified as a HREC as no petroleum constituents were observed in the soil/groundwater.

May 2015 – Potential Source Area Investigation

Apex submitted a Source Area Investigation Work Plan and a Groundwater Delineation Work Plan to the Southside Station, Inc. in November 2013 and February 2014, respectively. Apex completed source area investigation activities in April 2015 and submitted an investigation report to KMCL in May 2015. The investigation consisted of five soil borings (SB-9, SB-10, SB-12, SB-13, and SB-14). Three soil borings were converted into monitoring wells (MW-12, MW-13, and MW-14). Findings are detailed below:

- Groundwater was detected above GWQS/GV for PCE at all three locations, TCE at MW-12 and MW-13, and 1,1-Dichloroethene (1,1-DCE), 1,1,1-TCA, cis-1,2-DCE, and trans-1,2-Dichloroethene (trans-1,2-DCE) at MW-13.
- The highest concentrations of PCE in groundwater was observed in on-site well MW-13 (32,000 ug/L).

- Soil was detected above USCOs for PCE at SB-12 (4-8 fbgs) and above RSCOs for PCE at SB-13 (6-10 fbgs).
- The highest concentrations of PCE were observed in the soil on the former Whirley Wash subparcel; 1,300 ug/kg (SB-12; 4-8 ft interval) and 14,000 ug/kg (further downgradient SB-13; 6-10 ft interval).

July 2019 – Groundwater Sampling Results and Evaluation of Sub-Slab Depressurization System – ATC Engineering, LLP (ATC)

ATC Engineering, LLP (ATC) submitted a Groundwater Investigation Work Plan to the NYSDEC on January 18, 2019 and January 30, 2019. ATC completed investigation activities in April 2019 and submitted an investigation report to LNR c/o KMCL in July 2019. ATC collected groundwater samples from previously installed MW-1, MW-2, MW-4, MW-6, MW-7, MW-9, MW-10A, MW-12, MW-13, and MW-14 and analyzed them for VOCs and emerging contaminants including 1,4-dioxane, and Perfluoroalkyl substances (PFASs). The investigation also included an inspection of the SSDS and installation of three sub-slab monitoring points (SV-01 through SV-03) proximate to the three previously installed suction points (SP-1 through SP-3), and one indoor air sample (IA-01) within TOPS. Findings are detailed below:

- The depth to groundwater ranged between 2.91 to 6.87 fbgs.
- Groundwater flow direction was observed toward the northeast, consistent with previous investigations.
- CVOCs including cis-1,2-DCE, trans-1,2-DCE, PCE, and TCE were measured in groundwater samples retrieved from wells MW-1, MW-2, MW-6, MW-7, MW-12 and MW-13 at concentrations above the GWQS/GV of 5 µg/L.
- Former Whirley Wash Location: PCE concentrations at 621 ug/L (MW-12) and 27,100 ug/L (MW-13). Cross/downgradient well: PCE at 1,620 ug/L (MW-6).
- Former Anderson Cleaners Location: PCE concentration at 1,420 ug/L in cross/downgradient well (MW-2), and at 3,050 ug/L in further downgradient well (MW-1).
- 1,4-Dioxane was detected at one location and PFAS were detected at three locations at concentrations below the NYSDOH recommended maximum contaminant levels (MCLs).
- An adequate vacuum measurement was observed at SV-01 and SV-02; however, a vacuum measurement of 0.0 inches water column was observed at SV-03. Despite the potentially insufficient vacuum in the area of SV-03, the SSDS was observed to be

operating within normal range, with the U-tube style manometer at SP-3 reading at 1.7 inches water column. No visual observations were observed suggesting there were any problems associated with the SSDS and no CVOCs were detected in the indoor air, confirming that the SSDS was sufficiently reducing sub-slab vapor concentrations to a level protective of public health.

The RI will be performed in support of the BCP to determine the nature and extent of impacts from these known environmental conditions and determine if others exist on this parcel.

#### 1.4 Parameters of Interest

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

- **Volatile Organic Compounds (VOCs)** – VOCs potentially present at elevated concentrations include CVOCs (1,1-dichloroethene, 1,1,1-trichloroethane, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride).
- **Inorganic Compounds** – The inorganic compound potentially present at elevated concentrations is lead.

#### 1.5 Overview of RI Activities

Benchmark personnel will be on-site to observe and perform the following field activities to be completed as part of the RI:

1. **Surface/Near-Surface/Subsurface Soil Sampling:** Benchmark will collect soil samples for the purpose of determining the nature and extent of potential COPC impacts in surface, near-surface, and subsurface soil/fill.
2. **Soil Vapor Sampling:** Benchmark will collect 4-hour soil vapor samples both on-site and off-site to determine the potential for off-site soil vapor intrusion.
3. **Monitoring Well Installation/Development and Sampling:** Benchmark will observe the installation of groundwater monitoring wells, develop the wells, and collect groundwater samples for the purpose of determining the nature and extent of potential COPC impacts. Benchmark will also develop and sample previously installed monitoring wells.

## 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 section is to identify the personnel who impact the development and implementation of the HASP and to describe their roles and responsibilities. This section also identifies other contractors and subcontractors involved in work operations and establishes the lines of communications among them for health and safety matters. The organizational structure described in this section is consistent with the requirements of 29CFR 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 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 Corporate Health and Safety Director is ***Mr. Thomas H. Forbes, P.E.*** The Corporate Health and Safety Director is responsible for developing and implementing the health and safety program and policies for Benchmark, 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'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 ***Ms. Lori E. Riker, P.E.*** The Project Manager has the responsibility and authority to direct all Benchmark work operations at the Site. The Project Manager coordinates safety and health functions with the Site Safety and Health Officer (SSHO) and bears ultimate responsibility for proper implementation of this HASP. The Project Manager 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 workers with work assignments and overseeing their performance.
- Coordinating health and safety efforts with the 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. Tom A. Behrendt*** and the alternate SSHO is ***Ms. Charlotte M. Clark***. 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 personnel on the Site.
- Serving as the point of contact for safety and health matters.
- Ensuring that Benchmark field personnel working on the Site have received proper training (per 29CFR Part 1910.120(e)), that they have obtained medical clearance to wear respiratory protection (per 29CFR 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 HASP equally or more stringent than Benchmark's HASP. Benchmark assumes no responsibility for the health and safety of anyone outside its direct employ. Each Contractor's HASP shall cover all non-Benchmark Site personnel. Each Contractor shall assign a SSHO who will coordinate with Benchmark's SSHO as necessary to ensure effective lines of communication and consistency between contingency plans.

In addition to Benchmark and Contractor personnel, other individuals who may have responsibilities in the work zone include subcontractors and governmental agencies (i.e., the NYSDEC) performing Site inspection work. The Contractor shall be responsible for ensuring that these individuals have received OSHA-required training (29CFR 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 direct contact with and incidental ingestion of soil, and 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 PPE, 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, CVOC impacts have been identified in the soil/fill material present 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.

- **1,1-Dichloroethene (CAS #75-35-4)** has a sweet chloroform-like odor. Also known as 1,1-DCE, it is a breakdown product of the anaerobic reduction of TCE, which effects the central nervous system.
- **1,1,1-Trichloroethane (CAS #71-55-6)** is a colorless, sweet-smelling liquid that was once produced industrially in large quantities for use as a solvent. Also known as 1,1,1-TCA, symptoms of acute inhalation exposure include dizziness, nausea, vomiting, diarrhea, loss of consciousness, and decreased blood pressure.
- **Cis-1,2-Dichloroethene (CAS #156-59-2)** is a highly flammable organochloride with a sharp odor. Also known as 1,2-DCE, it is a breakdown product of the anaerobic reduction of trichloroethene or TCE, which effects the central nervous system.
- **Trans-1,2-Dichloroethene (CAS #156-60-5)** is a highly flammable organochloride with a sharp odor. Also known as 1,2-DCE, it is a breakdown product of the anaerobic reduction of trichloroethene or TCE, which effects the central nervous system.



- **Tetrachloroethene (CAS #127-18-4)** was formally widely used in dry cleaning operations as a solvent. Also known as PCE, it is harmful by ingestion inhalation and skin absorption. Exposure can cause dermatitis, dizziness, nausea, liver and kidney damage. This compound is a suspected carcinogen.
- **Trichloroethene (CAS #79-01-6)** is a chlorinated hydrocarbon with a sweet smell. Also known as TCE, it was commonly used in degreasing operations. Acute (short-term) and chronic (long-term) inhalation exposure to TCE can affect the human central nervous system (CNS), with symptoms such as dizziness, headaches, confusion, euphoria, facial numbness, and weakness.
- **Vinyl Chloride (CAS #75-01-4)** is a breakdown product of TCE and is classified by EPA as a human carcinogen. Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in CNS effects, such as dizziness, drowsiness, and headaches in humans. Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage.
- **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 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 by using protective clothing (Section 7.0), safe work practices (Section 6.0), and proper decontamination procedures (Section 12.0).

### 3.2 Physical Hazards

RI field activities at the 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 operations and sampling activities at the Site. Since it is impossible to list all potential sources of injury, it shall be the responsibility of everyone to exercise proper care and caution during all phases of the work.

## 4.0 TRAINING

### 4.1 Site Workers

All personnel performing RI 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 29CFR 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 three 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 29CFR 1910.120(e)(5) and is specifically designed to meet the requirements of OSHA 29CFR 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 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 HASP.
- 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'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 29CFR 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 fieldwork. 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 health and safety 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, eight additional hours of specialized supervisory training, in compliance with 29CFR 1910.120(e)(4).

## **4.3 Emergency Response Training**

Emergency response training is addressed in the Emergency Response Plan (see Attachment A).

## **4.4 Site Visitors**

Each Contractor's SSHO will provide a site-specific briefing to all Site visitors and other non- Benchmark 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 employees as stipulated under 29CFR Part 1910.120(f). These exams include initial employment, annual and employment termination physicals for all Benchmark 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. Health Works is 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 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 years 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 multi-plastic 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 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 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 SSHO. 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 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 HASP.
- 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 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 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 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 (Level A): totally encapsulating chemical resistant suit.
- Chemical-resistant clothing (Level B): hooded 1 to 2-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 SSFO.
- 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 on 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 are identified in Table 3.

## 8.0 EXPOSURE MONITORING

### 8.1 General

Based on the results of historic sample analyses 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 on real-time field monitoring data.

#### *8.1.1 On-Site Work Zone Monitoring*

Benchmark personnel will conduct routine, real-time air monitoring along the upwind and downwind perimeters during all intrusive investigative phases such as installation of soil borings and monitoring wells. 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 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.

The generic CAMP in Attachment C defines ground intrusive activities to 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 near individuals not involved in the Site activity (i.e., on a curb of a busy street) as discussed in Section 8.1.4. The action levels below will be used during periodic monitoring.

### ***8.1.3 Interior Community Air Monitoring***

Whenever possible, interior work activities will occur when the buildings are not occupied. However, air monitoring will be conducted when the building is occupied and unoccupied. Monitoring equipment will include a continuous recording particulate monitor with data logging capability and a PID for organic vapors; one unit will be placed within 50 feet laterally of the work area (to be determined each day) and the field technician will have one PID meter with him/her at all times.

If monitoring indicates action limit exceedances (5 ppm organic vapor, 150 ug/m<sup>3</sup> of airborne particulate) the Site contractor will be informed and corrective actions will be required (e.g., work stoppage). Furthermore, during and subsequent to work activities each day, any visible dust will be removed using hand towels and/or a portable mechanical vacuum unit.

### ***8.1.4 Special CAMP Requirements***

Appendix C includes special requirements that will be followed for outdoor work within 20 feet of potentially exposed individuals or structures and indoor work with co-located residences or facilities. The use of engineering controls to control dust and odors should not be necessary during the RI activities planned for the Site.

## **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 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 (e.g., well/boring installation) using a real-time particulate monitor as specified in this HASP. In the absence of such monitoring, appropriate respiratory protection for particulates shall be donned. Sustained readings obtained in the breathing zone may be interpreted (regarding other Site conditions) as follows for Benchmark 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 Attachment 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 Attachment 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 handling of Site soil/fill. Action levels based on the instrument readings shall be as follows:

- Less than 50 mg/m<sup>3</sup> - Continue field operations.
- 50-150 mg/m<sup>3</sup> - Don dust/particulate mask or equivalent
- Greater than 150 mg/m<sup>3</sup> - Don dust/particulate mask or equivalent. Initiate engineering controls to reduce respirable dust concentration (e.g., wetting of excavated soils or tools at discretion of SSHO).

Readings from the field equipment will be recorded and documented on the appropriate Project Field Forms. All instruments will be calibrated daily before use 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 personnel on-site, the following criteria shall also be adhered to for the protection of downwind receptors consistent with NYSDOH requirements (Attachment 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 SSHO must be notified and work activities shut down. The SSHO 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 NYSDEC and NYS Department of Health (NYSDOH) personnel to review.

▪ **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.

▪ **MAJOR VAPOR EMISSION RESPONSE PLAN:**

Upon activation, the following activities will be undertaken:

1. All Emergency Response Contacts as listed in this HASP and the Emergency Response Plan (Attachment A) will be advised.
2. The local police authorities will immediately be contacted by the SSHO and advised of the situation.
3. Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two sustained successive readings below action levels are measured, air monitoring may be halted or modified by the SSHO.

The following personnel are to be notified in the listed sequence if a Major Vapor Emission Plan is activated:

Responsible Person	Contact	Phone Number
SSHO	Police	911
SSHO	State Emergency Response Hotline	(800) 457-7362

Additional emergency numbers are listed in the Emergency Response Plan included as Attachment A.

▪ **EXPLOSIVE VAPORS:**

- Sustained atmospheric concentrations of greater than 10% LEL in the work area - Initiate combustible gas monitoring at the downwind portion of the Site perimeter.
- Sustained atmospheric concentrations of greater than 10% LEL at the downwind Site perimeter – Halt work and contact local Fire Department.

▪ **AIRBORNE PARTICULATE COMMUNITY AIR MONITORING**

- Respirable (PM-10) particulate monitoring will be performed on a continuous basis at the upwind and downwind perimeter of the exclusion zone. The monitoring will be performed using real-time monitoring equipment capable of measuring PM-10 and integrating over a period of 15-minutes for comparison to

the airborne particulate action levels. The equipment will be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration will be visually assessed during all work activities. All readings will be recorded and will be available for NYSDEC and NYSDOH review. Readings will be interpreted as follows:

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter ( $\text{ug}/\text{m}^3$ ) 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  $150 \text{ ug}/\text{m}^3$  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  $150 \text{ ug}/\text{m}^3$  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  $150 \text{ ug}/\text{m}^3$  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 (see Attachment A).

### **8.3 CAMP Notification Requirements**

CAMP data summary tables will be submitted to NYSDEC and NYSDOH weekly. Any exceedances of CAMP action levels and corrective measures taken will be reported to NYSDEC and NYSDOH within 24 hours and be included in daily reports.

## 9.0 SPILL RELEASE/RESPONSE

This section 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, countermeasures and reporting, consistent with OSHA requirements in 29CFR 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:

- CERCLA Hazardous Substances identified in 40CFR Part 302, where such materials pose the potential for release in excess of their corresponding Reportable Quantity (RQ).
- Extremely Hazardous Substances identified in 40CFR Part 355, Appendix A, where such materials pose the potential for release in excess of their corresponding 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 40CFR 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 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 (40CFR Part 112.4). Harmful quantities are considered by USEPA to be volumes that could form visible sheen on the water or violate applicable water quality standards.

- The potential exists for any amount of petroleum to reach any waters of NY State, including groundwater. 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 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 (see Attachment A) will be implemented immediately if a release occurs.

Following the initial report of a spill, the Project Manager will evaluate 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, NYSDOH) 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 then 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 remain and 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.: (800) 3480316
- Environmental Products & Services of Vermont, Inc.: (800) 577-4557
- Allied Environmental Services, Inc.: (800) 992-5781

#### **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 employees. The SSHO and/or his or her designee will be responsible for monitoring Benchmark field personnel for symptoms of heat/cold stress.

### 10.1 Heat Stress Monitoring

PPE 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 several factors, including environmental conditions, clothing, workload, physical conditioning and age. PPE 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, and 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°F 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 next 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°F. 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°F 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°F. No Benchmark employee will be permitted to continue wearing semi-permeable or impermeable garments when his/her oral temperature exceeds 100.6°F.

## 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°F) 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 (Do not give the victim any liquid containing alcohol or caffeine) and a warm water bath (102 to 108°F).
- 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 SSHO's discretion when suspicion is based on changes in a worker's performance or mental status.
  - At a worker's request.
  - As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind chill less than 20°F or wind chill less than 30°F with precipitation).
  - As a screening measure, whenever anyone worker on-site develops hypothermia.

Any person developing moderate hypothermia (a core body temperature of 92°F) 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 field activities will be established daily and communicated to all employees and other Site users by the SSHO. It shall be each Contractor's SSHO'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 zone 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 PPE 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 zone considered non-contaminated or "clean." Support equipment will be 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 PPE. Entrance of all personnel must be approved by the SSHO.

The SSHO will maintain a Health and Safety Logbook containing the names of Benchmark workers and their level of PPE. 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 Employees

The degree of decontamination required is a function of the 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 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 Exclusion 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 29CFR 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 HASP 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 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 29CFR 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 employees is not anticipated to be necessary to complete the RI activities identified in Section 2.0. If 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 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's Corporate Health and Safety Director. Benchmark 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 NFPA.

### 14.4 Hot Work

If the scope of work necessitates welding or blowtorch operation, the hot work permit presented in Attachment B will be completed by the SSHO and reviewed/issued by the Project Manager.

## 15.0 EMERGENCY INFORMATION

In accordance with OSHA 29CFR Part 1910, an Emergency Response Plan is included with this HASP as Attachment A. Figure 1 in Attachment A presents the hospital route map.

## 16.0 REFERENCES

1. New York State Department of Environmental Conservation. *DER-10; Technical Guidance for Site Investigation and Remediation*. May 2010.
2. New York State Department of Environmental Conservation. *6 NYCRR Part 375 Environmental Remediation Programs*. December 2006.
3. New York State Department of Environmental Conservation Division of Water Technical and Operational Guidance (TOGS). *1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*. June 1998.

## TABLES

**TABLE 1**  
**TOXICITY DATA FOR CONSTITUENTS OF POTENTIAL CONCERN**

**SOUTHSIDE PLAZA SITE**  
**JAMESTOWN, NEW YORK**

Parameter	Synonyms	CAS No.	Code	Concentration Limits		
				PEL	TLV	IDLH
Volatile Organic Compounds (VOCs): ppm						
1,1-Dichloroethene	1,1-DCE	75-35-4	Ca	none	5	ND
1,1,1-Trichloroethane	1,1,1-TCE	71-55-6	none	350	350	700
cis-1,2-dichloroethene	Cis-DCE	156-59-2	none	200	200	1,000
trans-1,2-dichloroethene	Trans-DCE	156-60-5	none	200	200	1,000
Tetrachloroethe	Perc, PCE	127-18-4	Ca	100	25	150
Trichloroethene	TCE	79-01-6	Ca	100	50	1,000
Vinyl chloride	VC	75-01-4	Ca	1	1	ND
Inorganic Compounds: mg/m <sup>3</sup>						
Lead	none	7439-92-1	none	0.05	0.15	100

**Acronyms:**

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

IDLH = Immediately Dangerous to Life or Health.

ND indicates that an IDLH has not as yet been determined.

TLV = Threshold Limit Value, established by American Conference of Industrial Hygienists (ACGIH), equals the maximum exposure concentration allowable for 8 hours/day @ 40 hours/week.

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:

TLV-TWA (TLV-Time-Weighted Average) which is averaged over the normal eight-hour day/forty-hour work week. (Most TLVs.)

TLV-STEL or Short Term Exposure Limits are 15 minute exposures that should not be exceeded for even an instant. It is not a stand alone value but is accompanied by the TLV-TWA.

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 maximum exposure concentration allowable for 8 hours/day, 40 hours/week.

**TABLE 2**  
**POTENTIAL ROUTES OF EXPOSURE TO THE CONSTITUENTS OF POTENTIAL CONCERN**  
**SOUTHSIDE PLAZA SITE**  
**JAMESTOWN, NEW YORK**

Activity <sup>1</sup>	Direct Contact with Soil/Fill	Inhalation of Vapors or Dust	Direct Contact with Groundwater
<b>Remedial Investigation Tasks</b>			
1. Surface/Subsurface Soil Sampling	X	X	
2. Soil Vapor Sampling	X	X	
3. Monitoring Well Installation/Development and Sampling	X	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 TASKS**  
**SOUTHSIDE PLAZA SITE**  
**JAMESTOWN, NEW YORK**

Activity	Respiratory Protection <sup>1</sup>	Clothing	Gloves <sup>2</sup>	Boots <sup>2, 3</sup>	Other Required PPE/Modifications <sup>2, 4</sup>
<b>Remedial Investigation Tasks</b>					
1. Surface/Subsurface Soil Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
2. Soil Vapor Sampling	Level D (upgrade to Level C if necessary)	Work Uniform or Tyvek	L/N	outer: L inner: STSS	HH SGSS
3. 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

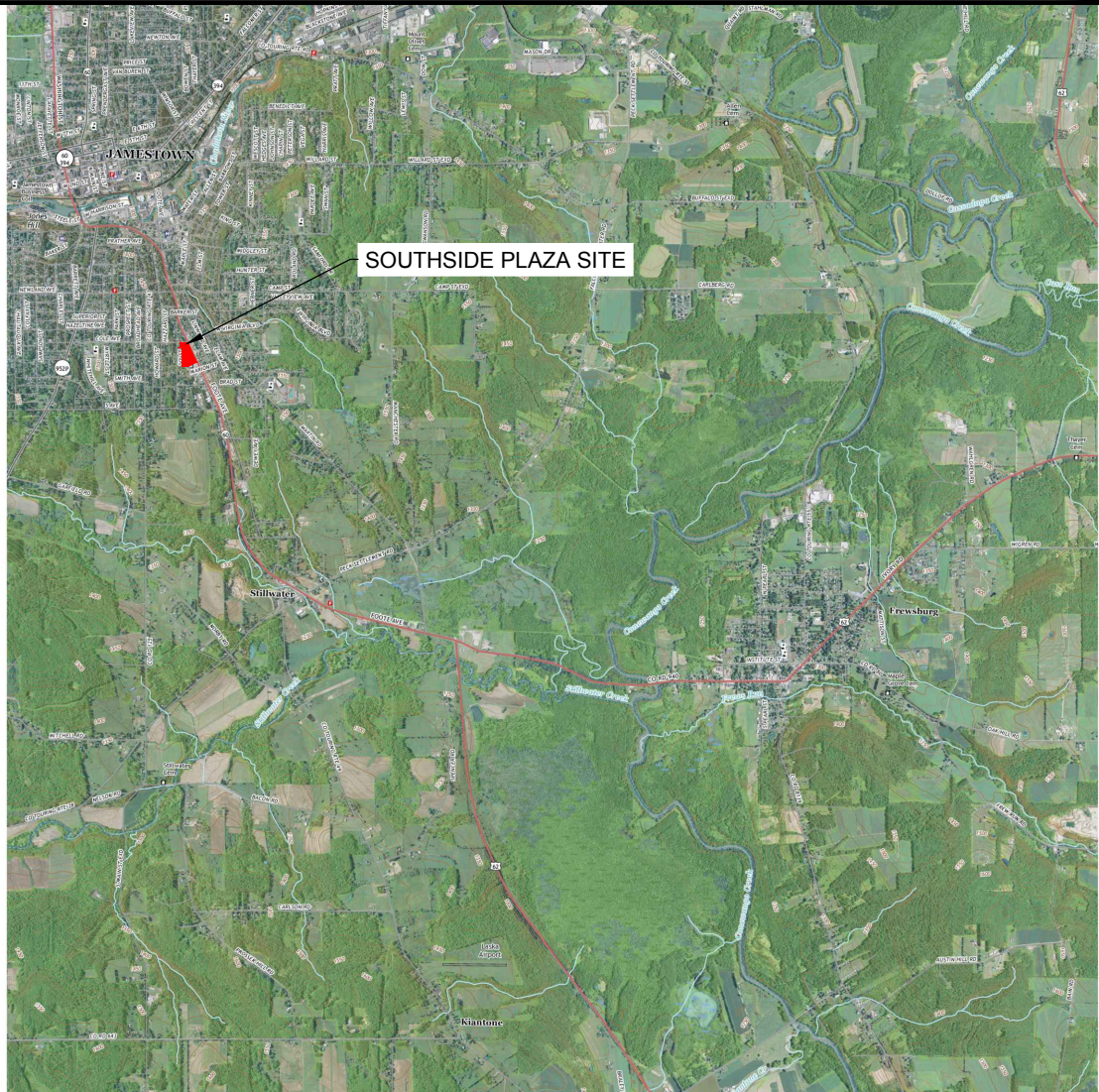
**Notes:**

1. Respiratory equipment shall conform to guidelines presented in Section 7.0 of this HASP. The Level C requirement is an air-purifying respirator equipped with organic compound/acid
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
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

## FIGURES



FIGURE 1



BASEMAP: USGS JAMESTOWN 2016 QUADRANGLE



SCALE: 1 INCH = 6000 FEET  
SCALE IN FEET  
(approximate)



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

PROJECT NO.: 0505-019-001

DATE: OCTOBER 2019

DRAFTED BY: RFL

## SITE LOCATION & VICINITY MAP

HEALTH AND SAFETY PLAN

SOUTHSIDE PLAZA SITE  
704-744 FOOTE AVENUE  
JAMESTOWN, NEW YORK

PREPARED FOR

KAZMAREK MOWREY CLOUD LASETER LLP

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SCALE: 1 INCH = 100 FEET  
SCALE IN FEET  
(approximate)



LEGEND:

----- PROPERTY BOUNDARY

SITE PLAN (AERIAL)

HEALTH AND SAFETY PLAN  
SOUTHSIDE PLAZA SITE  
704-744 FOOTE AVENUE  
JAMESTOWN, NEW YORK

PREPARED FOR

KAZMAREK MOWREY CLOUD LASETER LLP

**BENCHMARK**  
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ENGINEERING &  
SCIENCE, PLLC

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

JOB NO.: 0505-019-001

FIGURE 2

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# ATTACHMENT A

## EMERGENCY RESPONSE PLAN

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# **EMERGENCY RESPONSE PLAN for BROWNFIELD CLEANUP PROGRAM RI ACTIVITIES**

**SOUTHSIDE PLAZA SITE  
BCP SITE NO. C907043  
JAMESTOWN, NEW YORK**

---

April 2020

0505-019-001

Prepared for:

**Kazmarek Mowrey Cloud Laseter LLP**

1230 Peachtree Street, N.E., Suite 900  
Atlanta, GA 30309

Prepared by:



2558 Hamburg Turnpike, Suite 300  
Buffalo, NY 14218  
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**SOUTHSIDE PLAZA SITE  
EMERGENCY RESPONSE PLAN FOR RI ACTIVITIES**

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Figure 1            Hospital Route Map

## 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) activities at the Southside Plaza Site in Jamestown, New York. This attachment to 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 29CFR 1910.120(l) and provides the following site-specific information:

- Pre-emergency planning.
- Personnel roles, lines of authority, and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Evacuation routes and procedures.
- Decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- Emergency personal protective equipment (PPE) and equipment.

## 2.0 PRE-EMERGENCY PLANNING

This Site has been evaluated for potential emergency occurrences, based on site hazards, the required work tasks, the site topography, and prevailing weather conditions. The results of that evaluation indicate the potential for the following Site emergencies to occur at the locations indicated.

Type of Emergency:

1. Medical, due to physical injury

Source of Emergency:

1. Slip/trip/fall

Location of Source:

1. Non-specific

### 3.0 ON-SITE EMERGENCY RESPONSE EQUIPMENT

Emergency procedures may require specialized equipment to facilitate worker rescue, contamination control and reduction, or post-emergency clean up. Emergency response equipment available on the Site is listed below. The equipment inventory and storage locations are based on the potential emergencies described above. This equipment inventory is designed to meet on-site emergency response needs and any specialized equipment needs that off-site responders might require because of the hazards at this Site but not ordinarily stocked.

Any additional 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 daily during performance of field activities. The map will be marked to identify critical on-site emergency planning information, including emergency evacuation routes, a place of refuge, an assembly point, and the locations of key site emergency equipment. Site zone boundaries will be shown to alert responders to known areas of contamination. There are no major topographical features, however the direction of prevailing winds/weather conditions that could affect emergency response planning are also marked on the map. The map will be posted at site-designated place of refuge and inside the Benchmark personnel field vehicle.

## 5.0 EMERGENCY CONTACTS

The following identifies the emergency contacts for this ERP.

### Emergency Telephone Numbers:

**Project Manager: *Lori E. Riker***

Work: (716) 856-0599

Mobile: (716) 474-7510

**Corporate Health and Safety Director: *Thomas H. Forbes***

Work: (716) 856-0599

Mobile: (716) 864-1730

**Site Safety and Health Officer (SSHO): *Tom A. Behrendt***

Work: (716) 856-0599

Mobile: (716) 818-8358

**Alternate SSHO: *Charlotte M. Clark***

Work: (716) 856-0599

Mobile: (716) 220-1201

<b>UPMC CHAUTAUQUA WCA (ER):</b>	(716) 664-8120
<b>FIRE:</b>	911
<b>AMBULANCE:</b>	911
<b>POLICE:</b>	911
<b>STATE EMERGENCY RESPONSE HOTLINE:</b>	(800) 457-7362
<b>NATIONAL RESPONSE HOTLINE:</b>	(800) 424-8802
<b>NYSDOH:</b>	(716) 847-4385
<b>NYSDEC:</b>	(716) 851-7220
<b>NYSDEC 24-HOUR SPILL HOTLINE:</b>	(800) 457-7252

### The Site location is:

704-744 Foote Avenue

Jamestown, New York 14701

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 SSHO 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 SSHO to review evacuation routes and procedures as necessary and to inform all Benchmark 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 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 SSHO 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 the UPMC Chautauqua WCA 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 SSHO 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 UPMC Chautauqua WCA ER (see Figure 1):

The following directions describe the best route from the Site to UPMC Chautauqua WCA ER:

- Proceed northwest on Foote Avenue toward Cole Avenue for 0.5 miles
- Make a slight right to stay on Foote Avenue
- Turn right onto Prather Avenue
- Turn left at the second entrance (ER; Emergency Room), located at the corner of Prather Avenue and Sherman Street.

## 9.0 EMERGENCY RESPONSE CRITIQUE & RECORD KEEPING

Following an emergency, the SSHO and Project Manager shall review the effectiveness of this Plan in addressing notification, control and evacuation requirements. Updates and modifications to this Plan 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.

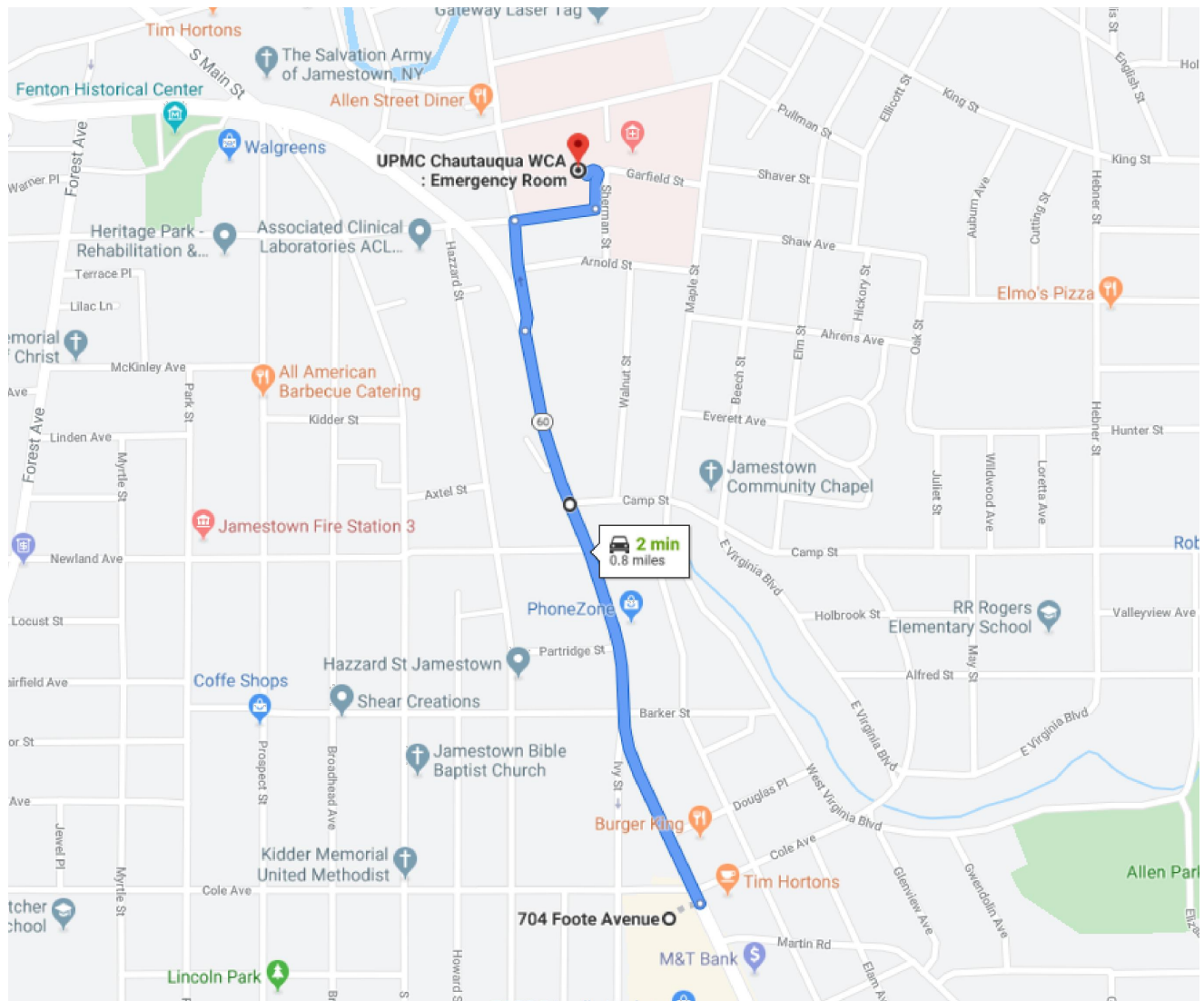
## **10.0 EMERGENCY RESPONSE TRAINING**

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.

## FIGURE



**FIGURE 1**



SCALE: 1 INCH = 800 FEET  
SCALE IN FEET  
(approximate)

**DIRECTIONS:**

1. HEAD NORTHWEST ON FOOTE AVENUE TOWARD COLE AVENUE (0.5 MILES)
2. SLIGHT RIGHT TO STAY ON FOOTE AVENUE (0.1 MILES)
3. TURN RIGHT ONTO PRATHER AVENUE (384 FEET)
4. TURN LEFT, DESTINATION ON THE RIGHT (236 FEET)



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

PROJECT NO.: 0505-019-001

DATE: NOVEMBER 2019

DRAFTED BY: CMC

**HOSPITAL ROUTE MAP**

EMERGENCY RESPONSE PLAN

SOUTHSIDE PLAZA SITE  
704-744 PLAZA SITE  
JAMESTOWN, NEW YORK

PREPARED FOR

KAZMAREK MOWREY CLOUD LASETER LLP

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# ATTACHMENT B

## HOT WORK PERMIT FORM

## 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

Originating 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 ( $\text{mcg}/\text{m}^3$ ) 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  $150 \text{ mcg}/\text{m}^3$  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  $150 \text{ mcg}/\text{m}^3$  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  $150 \text{ mcg}/\text{m}^3$  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.

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## **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 (PM<sub>10</sub>) with the following minimum performance standards:
  - (a) Objects to be measured: Dust, mists or aerosols;
  - (b) Measurement Ranges: 0.001 to 400 mg/m<sup>3</sup> (1 to 400,000 :ug/m<sup>3</sup>);
  - (c) Precision (2-sigma) at constant temperature: +/- 10 :g/m<sup>3</sup> for one second averaging; and +/- 1.5 g/m<sup>3</sup> 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/m<sup>3</sup>, 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/m<sup>3</sup> (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/m<sup>3</sup>, the upwind background level must be confirmed immediately. If the working site particulate measurement is greater than 100 ug/m<sup>3</sup> 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/m<sup>3</sup> 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 PM<sub>10</sub> 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/m<sup>3</sup> 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.

### Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures

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/m<sup>3</sup>, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 mcg/m<sup>3</sup> 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.

### Special Requirements for Indoor Work With Co-Located Residences or Facilities

Unless a self-contained, negative-pressure enclosure with proper emission controls will encompass the work area, all individuals not directly involved with the planned work must be absent from the room in which the work will occur. Monitoring requirements shall be as stated above under “Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures” except that in this instance “nearby/occupied structures” would be adjacent occupied rooms. Additionally, the location of all exhaust vents in the room and their discharge points, as well as potential vapor pathways (openings, conduits, etc.) relative to adjoining rooms, should be understood and the monitoring locations established accordingly. In these situations, it is strongly recommended that exhaust fans or other engineering controls be used to create negative air pressure within the work area during remedial activities. Additionally, it is strongly recommended that the planned work be implemented during hours (e.g. weekends or evenings) when building occupancy is at a minimum.